

Sunshine Trading and Financial Market Equilibrium

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In this article, we consider the possibility that some liquidity traders preannounce the size of their orders, a practice that has come to be known as “sunshine trading.” Two possible effects preannouncement might have on the equilibrium are examined. First, since it identifies certain traders as informationless, preannouncement changes the nature of any informational asymmetries in the market. Second, preannouncement can coordinate the supply and demand of liquidity in the market. We show that preannouncement typically reduces the trading costs of those who preannounce, but its effects on the trading costs and welfare of other traders are ambiguous. We also examine the implications of preannouncement for the distribution of prices and the amount of information that prices reveal.

Much attention has been focused in recent years, especially following the crash of October 1987, on the liquidity of financial markets. Some have suggested that liquidity would be enhanced if traders engaged in “sunshine trading.” A trader following a

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sunshine trading strategy preannounces to the other traders in the market that he or she will trade a specific number of shares or contracts several hours (or perhaps longer) before the order, is actually submitted.¹ In this article we examine some of the implications of such preannouncements for the expected trading costs of liquidity traders, the welfare of speculators, and the characteristics of prices. Our model attempts to capture the following two frequently mentioned features of preannouncement.

(i) *Coordination of the supply and demand of liquidity.* By informing potential traders who can take the other side of the preannounced orders and by allowing the market to prepare to absorb these orders, preannouncement facilitates the match between the demand and supply of liquidity in the market [see Grossman (1988, p. 278) and Miller et al. (1989)]. This could lower the price impact of the order. An analogy can be found in the housing market, for example, where announcing broadly the availability of a house for sale clearly increases the price a seller can expect to obtain.

(ii) *Identification of informationless trades.* Preannouncement has been used by such traders as index fund managers and portfolio insurers; whose trading motives are not based on private information [see, e.g., Kidder, Peabody & Co. (1986, 1987)]. If used only by such traders, the preannouncement of an order would identify it as uninformative, which would typically change its price impact as well as the impact of other orders.

There are three types of traders in our model. First, there is a pool of risk-averse *speculators* with rational expectations who submit price-contingent orders. These speculators play the role of market makers, since they are the ones who absorb the liquidity shocks of other traders. Second, there are potential sunshine traders, whom we call *announcers*. These are liquidity traders who, if possible, preannounce their orders. Finally, there are *nonannouncers*, that is, liquidity traders who do not preannounce even when the announcers do so. The nonannouncers might be smaller liquidity traders whose demand for immediacy is such that preannouncement would not be feasible for them.²

¹ To our knowledge sunshine trading was first undertaken (on a limited and informal basis) by the portfolio insurance firm of Leland, O'Brien and Rubinstein (LOR) [see Kidder, Peabody & Co. (1986)]. Miller et al. (1989, p. 224) recommend that the Commodity Futures Trading Commission give "urgent priority" to a review of the sunshine trading practice. Although under current regulations traders have some freedom to pursue sunshine trading strategies, a number of institutional and regulatory changes may be necessary to make the practice successful. For example, sunshine trading must be formally distinguished from "prearranged trading," which is illegal. Also needed is a technology for the enforcement of commitments made through preannouncements, and a formal mechanism for preannouncement to reach all traders.

² It is also possible that there will be some small fixed costs associated with preannouncing orders (e.g., the costs of transmitting the information to the exchange or to other traders). For small

For preannouncement to affect the size of the market, it must be the case that not all speculators are present on the trading floor at all times. To capture this we follow Grossman and Miller (1988) and introduce a fixed cost that speculators must incur in order to trade in the risky asset. This includes the opportunity cost of the time spent monitoring the activity in the market and the cost of freeing up capital for trading. It also includes the cost of submitting limit orders. If a speculator chooses to enter the market, he must incur the cost prior to trading; however, if preannouncement takes place, the entry decision can be made after the preannouncement.

Our analysis proceeds in two parts. First, we analyze the informational effects of preannouncement by assuming that entry costs are zero, so that all speculators are present in the market. We assume that speculators obtain diverse private signals about the payoff of the risky asset. Then we focus on the effect of preannouncement on the size of the market by assuming a positive entry cost but no informational asymmetry. These two issues are treated separately so that the effects of each can be isolated and readily identified.

We show that with heterogeneous information (and zero entry cost) preannouncement strictly lowers the expected trading costs of the announcers but raises the expected costs of nonannouncers. The reason for this is that the adverse-selection costs generally borne by liquidity traders when informed traders are present vanish for announcers when they preannounce but become significantly higher for nonannouncers when preannouncement is introduced. We show, however, that preannouncement reduces the total expected trading costs of all liquidity traders. That is, the reduction in the announcers' expected costs more than compensates for the increase in the expected trading costs of the nonannouncers. Moreover, although speculators are typically made ex ante worse off by preannouncement, the savings in the expected trading costs of the liquidity traders are higher than the certainty equivalent of the losses incurred by speculators. We have looked at other models with heterogeneous information and this result seems robust to the specification of the information structure.

Not surprisingly, we show that (with information asymmetry and zero entry costs) preannouncement unambiguously increases the informativeness of the price at the time the trade is made and lowers the variance of the price change that follows the trade. The variance of the price at the time of the trade, however, can be higher or lower with preannouncement.

traders these costs even though they are small, may exceed the benefits of preannouncement. These traders will therefore choose to be nonannouncers. We do not explicitly model fixed costs here, but it is clear that if such costs are small they will not change qualitatively our results.

If entry is costly for speculators, preannouncement affects the equilibrium size of the market. Specifically, the fraction of speculators who enter the market and trade becomes an increasing function of the total size of the preannounced orders. We show that if there are no nonannouncers, the expected trading costs of the announcers are lower with preannouncement than they are without preannouncement when the entry cost is sufficiently high. Similar results (obtained numerically) hold for both announcers and nonannouncers if some nonannouncers exist. The cost reduction occurs for two reasons. First, preannouncement reduces the risk a speculator takes when entering the market. This risk occurs because speculators do not recover their entry costs when the size of the liquidity demand turns out to be small. The reduction in this risk brought about by preannouncement tends to increase the average size of the market. Second, the correlation of the market size with the announcers' orders also tends to lower announcers' expected costs, although this benefit of preannouncement is not shared by the nonannouncers.

If the entry cost is low, all or almost all of the speculators enter the market even when no preannouncement takes place. There is very little potential for preannouncement to increase the size of the traders' population. At the same time for low realizations of the preannounced demand, preannouncement lowers the entry level and this raises trading costs.

We show that if entry costs are positive, preannouncement unambiguously increases the speculators' ex ante expected utility. Thus, if entry costs are significant, preannouncement has benefits for all trader types.

The effect of preannouncement on the variability of the price is ambiguous when entry is costly for speculators. (This is similar to the result obtained in the presence of information asymmetries, although it occurs for different reasons.) Specifically, preannouncement reduces the variance of the price if and only if the entry cost is sufficiently high. However, the price variability might be higher with preannouncement even in those situations where preannouncement reduces the announcers' expected trading costs.

Several recent articles contain discussions of issues related to this article. Grossman (1988) argues that there is a significant difference between synthetic and real securities in an environment where the demand for hedging strategies is not known. In this case, the price of a real security (such as a put option) can provide information about the hedging demand; whereas if the security is created synthetically, less information will be transmitted to the market. Trading in the real security can be thought of as a preannouncement of the hedging demand of the trader. Grossman (1988) also argues that such trading

can affect the supply of liquidity and capital to the market in a way similar to the effect of preannouncement in our model with costly entry of speculators.

Gennotte and Leland (1990) use a model similar to ours to examine the elasticity of price changes with respect to the demands of various types of traders. In their model, some fraction of the investors (possibly all investors) receive some information about the supply of the risky asset. The authors examine how market crashes can occur when the number of these supply-informed investors is small and there are hedging demands such as portfolio insurance whose size is not known to speculators. They show that when most traders in the market are unaware of the supply as it is affected by the demand of hedgers, discontinuities in the price function can exist, which can lead to market crashes. Preannouncement would clearly provide more information about supply and would presumably reduce the chance of these crashes occurring.

Röell (1990) examines the effect of dual capacity trading in a model in which there is one strategic perfectly informed agent and a large number of uninformed speculators, and where each broker-dealer is able to identify certain trades as liquidity motivated and knows their size. Her results on the effect of dual capacity trading on the trading costs of various types of liquidity traders are similar to our conclusions on the effect of preannouncement on these costs in the model with heterogeneous information and zero entry cost. Röell also shows that in her model liquidity traders would like as many broker-dealers to be able to identify them as possible, which implies that they would like their demands to be preannounced publicly. This is consistent with our results that announcers' expected trading costs are reduced by preannouncement, and it suggests that many of our results would hold up in a model in which traders are imperfectly competitive. The trading costs in Röell's setting are only due to adverse selection, while in our model the risk aversion of speculators provides an additional component to these costs. Risk aversion also means that, unlike Röell's model, trading in our model is not a zero-sum game among traders of different types.

Finally, Madhavan (1990) examines "transparent" market mechanisms or trading environments in which traders can revise their orders after seeing the orders of other traders. He contrasts these with "non-transparent" mechanisms, in which traders are unable to condition on the demands of other traders. In certain circumstances, traders can learn more about the liquidity demand in a transparent mechanism than they would in a nontransparent mechanism. This additional information, available to traders under market transparency, has some

of the same consequences as the information produced by sunshine trading.

The balance of the article is organized as follows. The model is presented in Section 1. In Section 2, we analyze the informational effect of preannouncement (i.e., the effect that is due to the identification of some of the order flow as uninformative). In Section 3, we consider the effect of preannouncement when entry of speculators is costly. *Sections 2 and 3 can be read independently.* Concluding remarks are offered in Section 4.

1. The Model

Our model of the financial market is a standard normal-exponential rational expectations model similar to Hellwig (1980) and others. There is one risky asset and one riskless asset. Trading takes place in period 1 and consumption in period 2. The riskless asset, which is the numeraire, has a price of 1 in period 1 and pays off one unit of the consumption good in period 2. (Our assumptions concerning the riskless asset simplify the notation and do not affect our results.) The risky asset pays off a random amount F in period 2.

There is a continuum of speculators $v \in [0, 1]$ who can, if they choose to enter the market, trade in the risky asset. As mentioned in the introductory section, these speculators absorb the orders from the liquidity traders and can therefore be thought of as market makers who provide liquidity. Prior to trading, speculator v observes the signal $\tilde{Y}_v = \tilde{F} + \tilde{\xi}_v$, where the $\tilde{\xi}_v$'s are independent across traders. In addition to the speculators, there are two types of liquidity traders who trade in the market, *announcers* and *nonannouncers*. The announcers have a total demand *per speculator* for the risky asset denoted A , with variance a . If preannouncement takes place, these traders disclose the value of A to the speculators before trading takes place, and *they are required to trade precisely this number of shares in the subsequent trading period.* In preannouncing their demands, the announcers identify themselves as liquidity traders. The nonannouncers' demands are never known to the speculators prior to trad-

⁴The requirement that the announcer any through with the preannounced trade is in principle not much different from the requirement that a seller of stock deliver the shares he has committed to sell to the buyer at the time of settlement. The same enforcement technologies can be used here as in any other situation involving financial contracting. What is more problematic is the possibility that the announcer might make offsetting trades that are not preannounced. For example, an announcer might want to sell 100,000 shares. He could preannounce that he will sell 200,000 shares, carry through with the sale as preannounced, but at the same time submit an order that is not preannounced to buy 100,000 shares. The rules governing preannouncement should prohibit an announcer from trading in the interval between the preannouncement and the time of the transaction. Since preannouncement will be used by institutions trading large amounts, offsetting trades, if they are to be of any value, must also be relatively large and should be easy to identify.

ing. The total demand *per speculator* of the nonannouncers is denoted by N , and its variance is denoted by n . (The actual number of liquidity traders of each type is irrelevant to our discussion, since the equilibrium only depends on the parameters of the aggregate demand of each type.)

For tractability and simplicity, we make the following assumptions about preferences and distributions.

(A1) *Constant absolute risk aversion.* Speculators have exponential utility functions with identical risk aversion coefficient of 1.

(A2) *Normal distributions.* The random variables $\tilde{F}$, $\tilde{\epsilon}$, $\tilde{A}$, and $\tilde{N}$ normally distributed and mutually independent and have zero means.¹ The error terms $\tilde{\epsilon}$ each have variance s^2 . The variance of $\tilde{F}$ is normalized to 1 (without loss of generality).

(A3) *Rational expectations equilibrium.* Speculators maximize ex ante expected utility using their private information and any public information, including the equilibrium price; the market in the risky asset clears.

We assume, as in Grossman and Miller (1988), that there is a fixed cost that speculators must incur in order ‘to be present and trade in the market for the risky asset. This might represent the opportunity cost of the time spent being present in the market or the cost of freeing up capital for trading. There may also be a cost for monitoring the market or for submitting an order. We assume that entry costs are incurred before private Information signals about F are observed. The size of the market’ (i.e., the fraction of speculators actually trading) is therefore determined endogenously by the entry decisions of speculators. When preannouncement takes place, the entry decisions of speculators can be made contingent on ‘the preannounced liquidity demand rather than on its distribution. ‘Formally, the assumption is as follows.

(A4) *Fixed cost of trading.* In order to trade in the market for the risky asset, a speculator must incur some fixed cost $b \geq 0$ prior to, trading, but after orders are preannounced?

¹ It is natural to assume that $\tilde{A}$, $\tilde{N}$, and $\tilde{\epsilon}$ have zero means. Our qualitative results would not change if the mean value of $\tilde{F}$ is different from zero.

² The assumption that all speculators are symmetrically informed is not important for the main conclusions of the article. However, some of our results are sensitive to the symmetry assumption, and when appropriate we will comment on variations of the model in which the quality of private information is uneven across speculators.

³ The existence of variable costs that depend on the size of the trade would significantly complicate our model but would probably not change our qualitative conclusions as long as there were also a fixed-cost component.

From our assumptions it follows that if a fraction λ of the speculators enters the market, then for market clearing the price must be set so that the per capita demand by those speculators who enter the market is $-(\tilde{A} + \tilde{N})/\lambda$ shares. This will be relevant in Section 3. Until then, it is assumed that $b = 0$, so that $\lambda = 1$.

2. The Informational Effects of Preannouncement

In this section, we explore the effects of preannouncement that are due to the fact that the preannouncement identifies certain orders as coming from liquidity traders. To isolate these informational effects, we assume that the entry cost of speculators is equal to zero so that all speculators are present in the market. We assume, however, that each speculator receives an informative private signal [i.e., that s , the variance of the error terms in private signals, is finite (but strictly positive)]. The model is thus a version of Hellwig's (1980) noisy rational expectations model with an infinite number of traders [see also Admati (1985) and Pfleiderer (1984)]. Thus, absent preannouncement, the linear rational expectations equilibrium price is⁷

$$\tilde{P} = \gamma_F \tilde{F} + \gamma_A \tilde{A} + \gamma_N \tilde{N}, \quad (1)$$

where

$$\gamma_F = \frac{s(a + n) + 1}{(s^2 + s)(a + n) + 1}, \quad (2)$$

and

$$\gamma_A = \gamma_N = \frac{s(s(a + n) + 1)}{(s^2 + s)(a + n) + 1}. \quad (3)$$

Note that when preannouncement does not take place, the total unpredictable liquidity demand is $\tilde{A} + \tilde{N}$. This explains why $\gamma_A = \gamma_N$ and why all of the coefficients are functions of a and n only through $a + n$.

Calculating the expected trading costs of liquidity traders is straightforward. Since the total demand of nonannouncers is $\tilde{N}$, their expected trading costs, denoted by C_N , are given by

$$C_N = E(\tilde{N}(\tilde{P} - \tilde{F})) = E(\tilde{N}(\gamma_F \tilde{F} + \gamma_A \tilde{A} + \gamma_N \tilde{N} - \tilde{F})) = \gamma_N n, \quad (4)$$

⁷Note that $\tilde{A}$ and $\tilde{N}$ are the *demands* of the liquidity traders, not their supply as in much of the rational expectations literature. The fact that there is no constant term in the equilibrium price function is due to the assumption that the expected values of all variables are zero.

where the last equality uses the fact that $\tilde{N}$, $\tilde{A}$ and $\tilde{F}$ are mutually independent. Similarly, the expected trading costs of the announcers when they do not preannounce their demands are $C_A = \gamma_A a$.

Now suppose that preannouncement takes place. Since the total liquidity demand is $A + N$ and the expected value of N is zero, the expected value of the liquidity demand given a preannouncement of A is simply A . With A preannounced, the unpredictable part of the liquidity demand is equal to N , with variance equal to n . This is less than $a + n$, the variance of the unpredictable liquidity demand in the model without preannouncement. The change in the predictability of liquidity demand is reflected in part by the fact that the price coefficients become independent of a , the variance of A .

Throughout the article we attach a superscripted * to those variables and coefficients associated with the trading regime in which preannouncement takes place. This will distinguish them from those associated with the regime with no preannouncement. From the results of Hellwig (1980), Pfleiderer (1984), and Admati (1985), it follows that the equilibrium price with preannouncement is given by

$$\tilde{P}^* = \gamma_F^* \tilde{F} + \gamma_A^* \tilde{A} + \gamma_N^* \tilde{N},$$

where

$$\gamma_F^* = \frac{sn + 1}{(s^2 + s)n + 1}, \quad (6)$$

$$\gamma_N^* = \frac{s(sn + 1)}{(s^2 + s)n + 1},$$

and

$$\gamma_A^* = \frac{s^2 n}{(s^2 + s)n + 1}. \quad (8)$$

Note that the term $\gamma_A^* \tilde{A}$ is now a constant known to speculators and it does not affect the informativeness of the price. The expected trading costs of the nonannouncers when preannouncement takes place are given by $C_N^* = \gamma_N^* n$, while those for the announcers are $C_A^* = \gamma_A^* a$.

The following result summarizes the implications of preannouncement for the expected trading costs of the liquidity traders, for the ex ante welfare of speculators, and for the characteristics of the price.

Proposition 1.

(a) *The expected trading costs of the announcers are strictly lower when preannouncement takes place than when it does not.*

- (b) The expected trading costs of the nonannouncers are strictly higher when preannouncement takes place than when it does not.
- (c) Preannouncement strictly lowers the *ex ante* expected utility of speculators.
- (d) The total expected trading costs of all liquidity traders are lower with preannouncement, and these savings in expected costs are higher than the warfare losses of the speculators as measured by the difference in the certainty equivalents of their surplus with and without preannouncement.
- (e) The equilibrium price with preannouncement ($\tilde{P}^*$) is more informative about F than is the equilibrium price without preannouncement (P).
- (f) The variance of $(\tilde{F} - \tilde{P}^*)$ is strictly lower than the variance of $(F - P)$.
- (g) For some parameters the variance of $\tilde{P}^*$ exceeds the variance of P , and for other parameters the reverse holds.

Proof. See the Appendix.

In the rest of this section, we will discuss and provide some intuition for these results. Consider first parts (a) and (b) concerning the expected trading costs of liquidity traders. It is convenient to decompose, liquidity traders' costs into two components. One component can be termed the *risk-bearing cost*. It is due to the fact that when a liquidity trader submits an order, the price must adjust to induce the risk-averse speculators to bear the risk of taking the other side of the trade. To quantify this cost, we can think of a hypothetical economy in which the conditional variance of F given public information is the same as the equilibrium conditional variance in the 'model with diverse information. The second component of the trading costs of liquidity traders can be termed the *adverse-selection cost*. It is due to the link between an unannounced order and the forecasts of the payoff made by speculators. For example, an unannounced buy order increases the aggregate demand for the risky asset at any price. Each speculator, not knowing the source of this increase in demand, assumes that there is some possibility that the increase is due to most speculators receiving favorable signals about the payoff of the risky asset. Each speculator therefore adjusts his forecast upward, and this in turn causes the price to increase (i.e., to move in a direction unfavorable to the liquidity trader).⁸ The adverse-selection cost in the economy

*The adverse-selection cost is very similar to the trading cost that arises in models where the price is set by risk neutral market makers [e.g., Glosten and Milgrom (1985), Kyle (1985), and Subrahmanyam (1991)]. In those models the risk-bearing costs are of course equal to zero. Subrahmanyam (1991) also examines the pricing of a risky asset when market makers are risk averse, in which case both the risk-bearing and the adverse selection costs are present.

with diverse private information is equal to the difference between the total cost of trading and the risk-bearing cost.⁹

Preannouncement has the effect of reducing the risk-bearing costs for both announcers and nonannouncers, since it provides more information to speculators and therefore reduces the riskiness of the risky asset. It also reduces the adverse-selection costs for the announcers. These costs vanish with preannouncement since the preannounced liquidity demand of the announcers has no informational content and does not lead to a revision of expectations. However, the adverse-selection costs of the nonannouncers are significantly higher with preannouncement. This increase is larger than the decrease in their risk-bearing cost, and so preannouncement leads to an increase in the expected trading costs of the nonannouncers.

Although the effects of preannouncement on the adverse-selection costs of the announcers and the nonannouncers are different, preannouncement has an unambiguous effect on the total adverse-selection costs—it is easy to show that ***the total adverse-selection costs of all liquidity traders are lower with preannouncement***. This, together with the fact that the risk-bearing costs of both announcers and nonannouncers decrease with preannouncement, leads to the result that preannouncement reduces the total expected trading costs of all liquidity traders [see part (d)].¹⁰

Part (c) of Proposition 1 states that preannouncement makes speculators ex ante worse off. When there is less noise in the price, there is less uncertainty about the payoff of the risky asset, and speculators are able to extract less consumer surplus from liquidity traders. The surplus arises because the price of the risky asset is set to compensate the speculators for the risk added by the *marginal* share of the risky asset they buy or sell. The total amount paid or received by each speculator therefore more than compensates for the total risk taken on by each speculator in meeting the liquidity demand. This surplus is increasing in each speculator's conditional variance of the risky asset's payoff, since the higher is the conditional variance, the more steeply sloped is each speculator's demand for the risky asset.

⁹ It is easy to show that the risk-bearing costs for the nonannouncers, if there is no preannouncement, are equal to $s^2 n(a + n)/b$, where $b = (s^2 + s)(a + n) + 1$. The adverse-selection costs if no preannouncement takes place are equal to sn/b . With preannouncement, the risk-bearing and adverse-selection cost for nonannouncers are $s^2 n^2/k$, and sn/k respectively, where $k = (s^2 + s)n + 1$. The announcers' risk-bearing and adverse-selection costs without preannouncement are $s^2 a(a + n)/b$ and sa/b , respectively. With preannouncement, they are $s^2 an/k$ and 0, respectively.

¹⁰ The effect of preannouncement on the adverse-selection costs is similar to the effect of dual capacity trading on the trading costs in the model of Röell (1990). Her analysis suggests that the result that adverse-selection costs are higher for nonannouncers, lower for announcers, and lower in the aggregate would hold in a model with imperfect competition.

It should be noted that part (c) (but not the other parts of the proposition) is sensitive to the assumption that all speculators have the same precision of private information. One can construct examples where the precision of private information differs across speculators and where some of the speculators are made better off by preannouncement. This occurs because preannouncement reduces the informational advantage that the better informed speculators have over speculators with poor private information, and this benefits the poorly informed speculators. In fact, when speculators are heterogeneous, it is possible that the aggregate welfare of the speculators (as measured by the sum of the certainty equivalents) will be higher with preannouncement. The conclusions of parts (a), (b), and (d), however, do seem robust to the information structure. For example, we have analyzed the effects of preannouncement in a model where the information structure is identical to that found 'in Grossman and Stiglitz (1980)--that is, some fraction of the speculators observe a common signal and the remaining traders are uninformed. We find that all parts of Proposition 1 continue to hold except part (c). When the fraction uninformed is sufficiently small but positive, the uninformed are better off with preannouncement and can compensate the informed for their loss in welfare due to preannouncement. The more typical result, however, is that speculators as a class are made worse off by preannouncement, as is the case when all traders have information with the same precision.

The result [in part (d)] that the savings in liquidity traders' expected costs is more than sufficient to compensate speculators for the losses they incur with preannouncement is due to the risk aversion of the speculators. The expected trading costs paid by liquidity traders are, in fact, only part of the surplus enjoyed by the speculators, because some of these costs compensate speculators for taking on risks. Preannouncement leads to more than a redistribution of the surplus among the different types of traders; since the risk that must be borne by the speculators is diminished, there is an overall gain. If liquidity traders are interested in minimizing their expected trading costs, then part (d) can be rephrased by stating that preannouncement increases the social welfare, as measured by the certainty equivalent of the surplus gained by speculators less the expected trading costs of the liquidity traders.

It is useful to discuss the net reduction in expected trading costs brought about by preannouncement. This is equal to the aggregate reduction in expected trading costs of all liquidity traders less the welfare loss of speculators measured as the change in certainty equivalents. From part (d), the net reduction in expected trading costs is positive. We also have the following.

Corollary. *The net reduction in expected trading costs is (i) decreasing in n , the variance of nonannouncers' demands, (ii) increasing in a , the variance of announcers' demands, if n is held constant., (iii) increasing in a if the total liquidity demand variance $a + n$ remains constant., and (iv) ambiguous a function of s , the variance of $\tilde{\epsilon}_s$.*

Intuitively, if n is larger, then preannouncement has less of an effect on the equilibrium, and so the magnitude of the net gain is smaller. Similarly, when a is larger, the effect of preannouncement is more pronounced. These statements continue to be true if we keep the total variance of liquidity demands constant, since an increase in a means that relatively more of the liquidity traders are announcers. To understand (iv), note that when $s = 0$ trading costs are zero in both regimes, since in this case there is no uncertainty about F . As s increases, the quality of each speculator's signal deteriorates and so speculators put less and less weight on their signals. Also, less information is revealed by the price, as evidenced by the fact that both γ_F and γ_F^* vanish as s increases. As $s \rightarrow \infty$, speculators put no weight on their own signals or on the price in forming expectations, and so again preannouncement has no effect. Preannouncement has its greatest effect when the quality of speculators' signals is neither very good nor very poor.

Parts (e)-(g) of Proposition 1 concern the effect of preannouncement on the variability of price changes and on the variability of the price itself. Parts (e) and (f) state that preannouncement leads to a more informative price (and, therefore less variable price changes). This is intuitively obvious, since traders have strictly better information about F through the price when preannouncement takes place. Part (g) states that preannouncement has an ambiguous effect on the variance of the price itself. Recall that $\tilde{P} = \gamma_F \tilde{F} + \gamma_A \tilde{A} + \gamma_N \tilde{N}$; thus, using the independence of F , A , and $\tilde{N}$, $\text{Var}(\tilde{P}) = \gamma_F^2 + \gamma_A^2 a + \gamma_N^2 n$. Since preannouncement allows agents to predict $\tilde{F}$ better, the price becomes more sensitive to $\tilde{F}$ (i.e., $\gamma_F^* > \gamma_F$). Second, consistent with the effect preannouncement has on the trading costs of the various liquidity traders, the price becomes less sensitive to the demands of the announcers ($\gamma_A^* < \gamma_A$), but more sensitive to the demands of the nonannouncers ($\gamma_N^* > \gamma_N$). The overall effect on the variance of the price depends on the configuration of the model's parameters.

Note that, although all the above results compare a situation where some liquidity traders preannounce their demands with the case where no trader preannounces, it is easy to see that analogous conclusions would hold if we consider the effect of increasing the fraction of liquidity demands that are preannounced (i.e., enabling some of the

nonannouncers to preannounce). By arguments very similar to those used in the proof, it is clear that such a change would lower the expected trading costs of those previous nonannouncers who have become announcers, as well as the expected trading costs of those who remain announcers, while increasing the expected trading costs of those who remain nonannouncers. Speculators would be ex ante worse off, but the total savings in expected trading costs would be larger than the certainty equivalent of the losses to speculators. Results analogous to parts (e)-(g) in Proposition 1 would hold for the characteristics of the price.

3. A Model with Entry Costs for Speculators

3.1 The model without nonannouncers

We now examine the notion that preannouncement might create a better match between the demand for and supply of liquidity in the market when the entry of speculators is costly ($b > 0$). In order to obtain some explicit results in light of the Complexity of the model of this section, we abstract below from issues related to private information by assuming that traders do not observe any private signals. Thus, all traders assess the distribution of F to be standard normal. Even with this assumption, the model is significantly more complicated if there are some nonannouncers (i.e., if some liquidity traders are unable to preannounce their trade). To gain some intuition for the general results, we therefore start with the case where all liquidity traders are announcers ($n = 0$) comparing the situation where all liquidity traders preannounce to that where none of them does. The case $n > 0$ is discussed in the next subsection.

Recall that absent preannouncement, each speculator's entry decision is based only on the distribution of A , the announcers' demand. However, when A is preannounced, each speculator bases his decision to enter on this realization. The following lemma gives the equilibrium entry levels.

Lemma 1.

(a) Let $\lambda(a, b)$ be the equilibrium level of entry in the model without preannouncement as a function of a , the variance of A , and the entry cost b . Then

$$\lambda(a, b) = \min \left[\left(\frac{a}{\exp(2b) - 1} \right)^{1/2}, 1 \right]. \quad (9)$$

(b). Let $\lambda^*(\tilde{A}, b)$ be the equilibrium level of entry when preannouncement takes place as a function of preannounced liquidity

demand $\tilde{A}$ and the entry cost b . Then

$$\lambda^*(\tilde{A}, b) = \min \left[\frac{|\tilde{A}|}{(2b)^{1/2}}, 1 \right]. \quad (10)$$

Proof. See the Appendix.

Note that both $\lambda(a, b)$ and $\lambda^*(\tilde{A}, b)$ are nonincreasing in b and strictly decreasing in b for $\lambda \in (0, 1)$. Obviously, the higher is the entry cost, the lower is the equilibrium market size. Note also that when there is no preannouncement, an increase in the variance of the announcers' demand a increases the benefit of entering for any fixed level of entry. A higher value of a means that the expected size of the announcers' demand for liquidity is larger and so a fixed number of speculators can expect to earn higher surplus from being present in the market. Similarly, when there is preannouncement, the equilibrium market size λ is increasing in $|\tilde{A}|$ for $\lambda \in (0, 1)$.

It is important to note that, as long as the entry level is sensitive to the preannounced order, the equilibrium entry level equalizes the magnitude of the price impact of the announcers' orders across different order sizes. Specifically, an order of A leads to a change in the price (relative to a zero order) equal to $\tilde{A}/\lambda^*(\tilde{A}, b)$. When $|\tilde{A}| \leq \sqrt{2b}$, this is either $\sqrt{2b}$ or $+\sqrt{2b}$, depending on whether the order is a sale or a purchase. In other words, as long as the order size is not too large, an increase in the order size elicits more entry but does not affect the terms of trade. Without preannouncement, however, the magnitude of the price impact, $A/\lambda(a, b)$, always depends on the size of the order.

The announcers' trading costs obviously depend on the equilibrium level of entry. We define $C(a, b)$ to be the announcers' expected trading cost without preannouncement, and $C^*(a, b)$ to be the unconditional expected trading cost of the announcers when preannouncement takes place. We have

$$C(a, b) = -E \left(\tilde{A} \left(\tilde{F} - \frac{\tilde{A}}{\lambda(a, b)} \right) \right) = E \left(\frac{\tilde{A}^2}{\lambda(a, b)} \right) = \frac{a}{\lambda(a, b)}, \quad (11)$$

and

$$C^*(a, b) = -E \left(\tilde{A} \left(\tilde{F} - \frac{\tilde{A}}{\lambda^*(\tilde{A}, b)} \right) \right) = E \left(\frac{\tilde{A}^2}{\lambda^*(\tilde{A}, b)} \right). \quad (12)$$

The following proposition, which is the main result of this section, describes the effects of preannouncement on the expected trading costs of the announcers and the ex ante expected utility of the speculators.

Proposition 2.

(a) Preannouncement lowers the expected trading costs of the announcers if and only if the entry cost b is sufficiently high. Formally, for every $a > 0$, there exists $b > 0$ such that $C^*(a, b) < C(a, b)$. For $b > b$, $C^*(a, b) < C(a, b)$ and for $b < b$, $C^*(a, b) > C(a, b)$.

(b) For every $b > 0$, the ex ante expected utility of speculators is strictly higher with preannouncement.

Proof: See the Appendix.

To understand part (a) of the proposition, consider first the case where the entry cost b is very small. In this case, all or almost all of the speculators enter the market absent preannouncement. If b is so small that $\lambda(a, b) = 1$ (i.e., all speculators enter), then preannouncement actually increases the announcers' expected trading costs, because for $|\tilde{A}| < \sqrt{2b}$, $\lambda^*(\tilde{A}, b) < 1$. When such realizations of $|\tilde{A}|$ are preannounced, fewer speculators enter the market than would be the case without preannouncement and so expected trading costs are higher. The same logic applies if $\lambda(a, b)$ is slightly smaller than 1.¹¹

Consider now what happens when the entry cost b is large, so that $\lambda(a, b)$ is significantly smaller than 1. In this case, preannouncement increases the average entry level, because it reduces the risk borne by speculators entering the market. Without preannouncement, a speculator who pays b and enters the market is, in effect, betting that $|\tilde{A}|$ will be large. Indeed, for a fixed λ , a speculator's trading profit given A is increasing in $|\tilde{A}|$. Without preannouncement, b must be paid before A is known and entry into the market is therefore riskier than it is with preannouncement. Moreover, the larger is the cost b , the greater is this risk. Since speculators are risk averse, this risk leads to a relatively low entry level when there is no preannouncement and this creates high expected trading costs for liquidity traders. If entry decisions can be made after A is preannounced, risk is reduced. Thus, on average, more speculators enter the market when there is preannouncement, and this lowers expected trading costs for announcers.

Another effect of preannouncement is that the entry level becomes positively correlated with $|\tilde{A}|$. In fact, as long as $\lambda^*(\tilde{A}, b) < 1$, $\lambda^*(\tilde{A}, b)$ is linear and strictly increasing in $|\tilde{A}|$. This is another effect that reduces the announcers' expected trading costs, since it means that for large realizations of $|\tilde{A}|$ more than the average number of speculators enter. Thus, costs on large orders are lower than what they would be without preannouncement. Of course, the trading costs on

¹¹ Note that this discussion implies that: $\lambda(a, b) < 1$, where b satisfies $C(a, b) = C^*(a, b)$. It follows that b must be greater than $\frac{1}{2} \log(1 + a)$, the level of entry cost that makes speculators absent preannouncement just indifferent between entering and not entering when $\lambda = 1$.

small orders are larger with preannouncement, since for small preannounced orders little entry takes place. However, since the large orders receive more weight in calculating expected trading costs than do the small orders, the overall effect is to lower expected trading costs. Also note that when b is high, the range of realizations of $|A|$ for which $\lambda^*(A, b)$ is perfectly positively correlated with $|A|$ is larger.

The intuition for part (b) of the proposition, which says that speculators are made ex ante better off by preannouncement, is roughly as follows. There are two cases. The first case occurs when $\lambda(a, b) < 1$. In this case, speculators are indifferent between entering and not entering when there is no preannouncement. If large realizations of $|A|$ are preannounced, however, speculators are made strictly better off by entering. For these realizations they strictly prefer that preannouncement takes place and, therefore, ex ante they are strictly better off with preannouncement. The second case occurs when $\lambda(a, b) = 1$. In this case, all speculators enter when there is no preannouncement. For very small realizations of A , however, these speculators are ex post (given $\tilde{A}$) worse off for having entered. Had these realizations been preannounced, entry would have been lower and there would have been no ex post regret. Therefore, in both cases, speculators' ex ante expected utility is higher with preannouncement.

We now compare the variance of P with that of P^* .¹² It is straightforward to show that

$$\text{Var}(\tilde{P}) = E\left(\frac{\tilde{A}^2}{\lambda(a, b)}\right) = \max[\exp(2b) - 1, a], \quad (13)$$

and

$$\begin{aligned} \text{Var}(\tilde{P}^*) = E\left(\frac{\tilde{A}^2}{(\lambda^*(A, b))^2}\right) &= 4b\left(\Phi\left(\sqrt{\frac{2b}{a}}\right) - \frac{1}{2}\right) \\ &+ 2\left(\frac{ba}{\pi}\right)^{1/2} \exp\left(-\frac{b}{a}\right) + 2a\left(1 - \Phi\left(\sqrt{\frac{2b}{a}}\right)\right), \end{aligned} \quad (14)$$

where $\Phi(\cdot)$ is the standard normal distribution function.

Note that $\text{Var}(\tilde{P})$ is nondecreasing in both b and a . (More precisely, it is independent of b when b is small relative to a and independent of a when b is large relative to a . When it depends on both a and b , it is strictly increasing in these parameters.) The variance of $\tilde{P}^*$ is strictly increasing in both a and b for all parameters. The comparison

¹² In the last section, we also considered the variances of $\tilde{F} - \tilde{P}$ and $\tilde{F} - \tilde{P}^*$. When speculators have no private information about $\tilde{F}$, as in the model of this section, $\text{Cov}(\tilde{F}, \tilde{P}) = \text{Cov}(\tilde{F}, \tilde{P}^*) = 0$. Thus, the variances of $\tilde{F} - \tilde{P}$ and $\tilde{F} - \tilde{P}^*$ are equal to $1 + \text{Var}(\tilde{P})$ and $1 + \text{Var}(\tilde{P}^*)$, respectively.

of $\text{Var}(\tilde{P})$ and $\text{Ku}(\tilde{P}^*)$ leads to ambiguous results in general. However, it can be shown that if the entry cost b is sufficiently high, $\text{Var}(\tilde{P}) > \text{Var}(\tilde{P}^*)$, while the opposite inequality holds if b is sufficiently small. It should be noted, however, that for certain parameters, $\text{Var}(\tilde{P}) < \text{Et}(\tilde{P}^*)$, yet $C(a, b) > C^*(a, b)$. Thus, it is possible that the expected trading costs for announcers are lower with preannouncement even though the variance of the price is higher.¹³

In summary, if the cost of entry is sufficiently high, preannouncement lowers both the expected trading costs of the announcers and the variance of the equilibrium price. The assumption that the entry cost is sufficiently high is essentially equivalent to the assumption that for normal levels of the demand for liquidity only a fraction of the potential pool of speculators (liquidity providers) enter in the market. This seems to be a realistic assumption.

We have seen that preannouncement increases the expected trading costs of the announcers only when the equilibrium size of the market without preannouncement is close to or equal to its upper bound. It is important to note that if λ is allowed to grow without bound (i.e., if there is an unlimited pool of speculators), then the analysis would be simplified and the results would be similar to those we have obtained for a large entry cost. Specifically, if λ is unbounded, preannouncement always lowers the expected trading costs of the announcers, because the benefits of the increased average entry and the correlation of the market size with their orders would continue to be relevant for all parameter values. Moreover, if λ is unbounded, speculators have the same ex ante expected utility with and without preannouncement, since in both cases they are always indifferent between entering and not entering. Finally, the variance of the price without preannouncement when λ is unbounded is $\exp(2b) - 1$. This always exceeds the variance of the price with preannouncement, which in this case is simply equal to $2b$.

3.2 The model with some nonannouncers

We now analyze the model with $n > 0$ (i.e., in which there is random liquidity demand by nonannouncers). This case is more complicated than the one analyzed in the previous subsection, since there is residual uncertainty about the liquidity demands even when preannouncement takes place. First we have the following lemma.

Lemma 2.

(a) Let $l(a, n, b)$ be the entry level absent preannouncement as a

¹³ This can occur because $\text{Et}(\tilde{P}^*)$ is the expectation of $[\lambda^*(\tilde{A}, b)]^2$, while $C^*(a, b)$ depends upon the expectation of $\tilde{A}^2/\lambda^*(\tilde{A}, b)$.

function of the variance of announcers' demands a , the variance of nonannouncers' demand n , and the entry cost b . Then

$$\lambda(a, n, b) = \min \left[\left(\frac{a + n}{\exp(2b) - 1} \right)^{1/2}, 1 \right]. \quad (15)$$

(b) Let $\lambda^*(\tilde{A}, n, b)$ be the equilibrium level of entry when preannouncement takes place as a function of preannounced liquidity demand $\tilde{A}$, the variance of nonannouncers' demand n , and the entry cost b . If $b > \frac{1}{2} \log(1 + n) + \frac{1}{2} \tilde{A}^2(1 + n)$ then $\lambda^*(\tilde{A}, n, b)$ solves

$$2b = \log \left(1 + \frac{n}{(\lambda^*(\tilde{A}, n, b))^2} \right) + \frac{\tilde{A}^2}{(\lambda^*(\tilde{A}, n, b))^2 + n}. \quad (16)$$

Otherwise $\lambda^*(\tilde{A}, n, b) = 1$.

Proof. See the Appendix.

It is straightforward to show that part (b) of Proposition 2, which says that the ex ante expected utility of speculators is strictly higher with preannouncement, continues to hold when some nonannouncers exist. Since there is no closed form solution for $\lambda^*(\tilde{A}, n, b)$ in Equation (16), however, some of the results concerning the effect of preannouncement on the expected trading costs of liquidity traders will be based on numerical analysis. We will first examine and compare the expected trading costs of both announcers and nonannouncers for different values of the entry cost b . Then we will look at the expected trading costs of the announcers as a function of the variance of nonannouncers' demands. Finally, we will examine the effect on expected trading costs of allowing some of the nonannouncers to join the announcers in preannouncing their demand.

From Lemma 2, the expected trading costs of the announcers and nonannouncers absent preannouncement are given by

$$C_A(a, n, b) = \max \left[a \left(\frac{\exp(2b) - 1}{a + n} \right)^{1/2}, a \right], \quad (17)$$

and

$$C_N(a, n, b) = \max \left[n \left(\frac{\exp(2b) - 1}{a + n} \right)^{1/2}, n \right], \quad (18)$$

respectively.. When preannouncement takes place, the (unconditional) expected trading costs of the announcers and the nonannouncers are $E(\tilde{A}^2/\lambda^*(\tilde{A}, n, b))$ and $E(\tilde{N}^2/\lambda^*(\tilde{A}, n, b))$, respectively. (No closed form solution exists for either of these costs.)

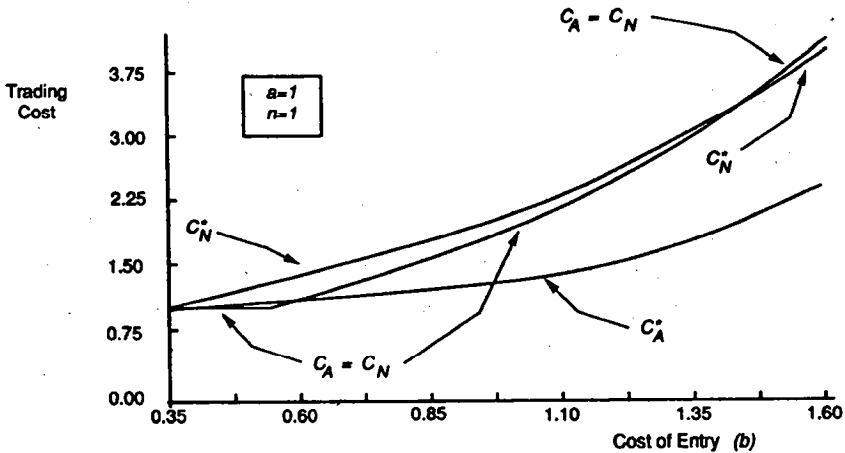


Figure 1
The trading costs of announcers and nonannouncers with and without preannouncement as a function of the cost of entry

In Figure 1, we set $a = n = 1$ and plot the expected trading costs in the two trading regimes for both the announcers and the nonannouncers as a function of b , the entry cost. If b is sufficiently small [specifically, if $b \leq 1/2 \log(1 + n) \approx 0.347$], then no matter what is the preannounced value of $\tilde{A}$, all speculators enter in equilibrium. This means that for values of b in this range $C_A^*(a, n, b) = C_A(a, n, b) = a = 1$ and $C_N^*(a, n, b) = C_N(a, n, b) = n = 1$. For $b < 1/2 \log(1 + a + n) \approx 0.549$, we have $I(a, n, b) = 1$, so all speculators enter absent preannouncement. This implies that for values of b between 0.347 and 0.549, the entry level with preannouncement is never larger, and it is sometimes smaller, than the entry level absent preannouncement. Thus, for these parameters preannouncement increases the expected trading costs of both the announcers and the nonannouncers. Moreover, with preannouncement the expected trading costs of the nonannouncers are larger than the announcers' costs. This is because, as we have already observed, $\lambda^*(\tilde{A}, n, b)$ is positively correlated with the announcer's demand $\tilde{A}$, but it is uncorrelated with the nonannouncers' demand $\tilde{N}$.

If b is sufficiently large so that $\lambda(a, n, b) < 1$ [i.e., absent preannouncement not all the speculators enter, which occurs if $b > 1/2 \log(1 + a + n) \approx 0.549$], then both C_A and C_N exceed 1. As in the previous subsection, preannouncement still increases expected trading costs if $\lambda(a, n, b)$ is sufficiently close to 1. As b increases, $C_A^*(a, n, b)$ eventually falls below $C_A(a, n, b)$. (In the example, this occurs at $b \approx 0.5683$.)

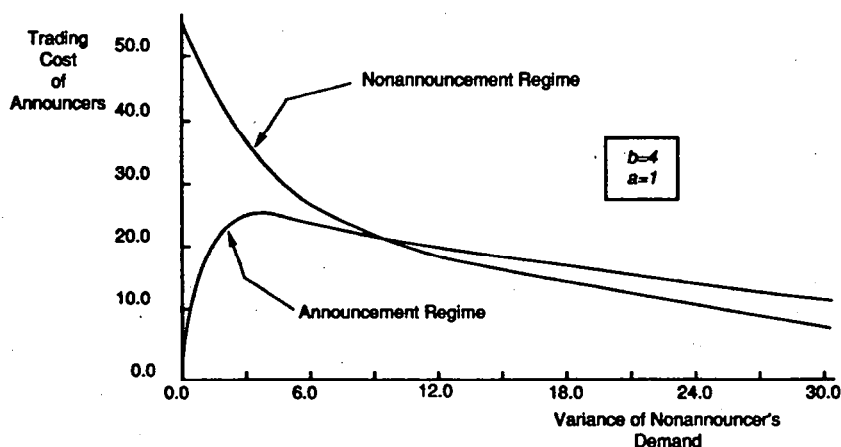


Figure 2
The trading cost of the announcers with and without preannouncement as a function of the variance of the nonannouncers' demand

Figure 1 also shows that if the entry cost b is sufficiently high, the nonannouncers' expected trading costs also decrease when preannouncement takes place, although the critical value of b where this occurs is higher for nonannouncers than for the announcers. Note that the only difference between the expected trading costs of the announcers and the nonannouncers in the model with costly entry is due to the fact that the equilibrium entry level with preannouncement is correlated with the announcers' demand but is independent of the nonannouncers' demand. If the average level of entry is kept fixed, the expected trading costs of the nonannouncers are increased by the randomness in the entry level.¹⁴ As b increases, however, the expected value of $\lambda^*(A, n, b)$ becomes sufficiently larger than $\lambda(a, n, b)$ so that $C_N^*(a, n, b)$ falls below $C_N(a, n, b)$. (When $a = n = 1$, this occurs at $b \approx 1.2935$.)

In Figure 2, we plot the expected trading costs of the announcers with and without preannouncement as a function of the variance of the nonannouncers' demand n . We assume that $b = 4$ and $a = 1$. First, note that the announcers' costs absent preannouncement, $C_A(a, n, b)$, are decreasing in n . This is due to the fact that $\lambda(a, n, b)$ is increasing in n . A more variable liquidity demand implies higher expected trading profits for any, given level of entry and therefore implies a higher equilibrium entry level. However, $C_A^*(n, a, b)$, the announcers' trading costs with preannouncement, are increasing in n for small values

¹⁴ This follows since $C_N^*(a, n, b)/C_N(a, n, b) = E(\lambda(a, n, b)/\lambda^*(\tilde{A}, n, b))$ and from the fact that $E(1/\lambda^*(\tilde{A}, n, b)) > 1/E(\lambda^*(\tilde{A}, n, b))$ by Jensen's inequality.

of n and decreasing in n for large values of n . In particular, starting from a situation in which there are few nonannouncers (so the variance of nonannouncers' demand is small), the addition of more nonannouncers increases the trading costs of the announcers.¹⁵ Eventually, as n becomes large, $C^*_{\text{A}}(a, n, b)$ becomes a decreasing function of n , because in this range the entry level becomes less sensitive to the preannouncement. Indeed, for $n > \exp(2b) - 1$, we have $\lambda^*(\bar{A}, n, b) = 1$ for all $\bar{A}$, so that for sufficiently large n expected trading costs are at their minimal level of $C^*_{\text{A}}(a, n, b) = a$.

So far, we have compared a situation in which some liquidity traders preannounce their orders to the case where no liquidity trader preannounces. It is also interesting to compare the situation where *some* liquidity traders preannounce to that in which *all* liquidity traders preannounce. We now have Proposition 3.

Proposition 3. *Suppose preannouncement by announcers takes place. If $C^*_{\text{A}}(a, 0, b) \leq C^*_{\text{A}}(a, n, b)$, then the expected trading costs of both the announcers and the nonannouncers will be lower should the nonannouncers also preannounce their orders.*

Proof: See the Appendix.

The condition $C^*_{\text{A}}(a, 0, b) \leq C^*_{\text{A}}(a, n, b)$ says that the introduction of the nonannouncers increases the announcers' expected trading costs. We now attempt to provide some intuition for the result. First, it is intuitive that since the correlation between the size of a liquidity order and the market size lowers the expected trading costs of the trader submitting the order, preannouncing lowers the expected costs of previous nonannouncers.

The intuition concerning the existing announcers' trading costs is more complicated. In the proof of the proposition, we show first that the expected trading cost of any individual announcer is lower if additional announcers are introduced. To see this, assume for now that the fraction of speculators who enter (when there are no nonannouncers) is strictly lower than 1. In this case, a small change in

¹⁵ To understand this, note that the unannounced demand introduces additional risk for the speculators when preannouncement takes place. For example, suppose that a large value of $\bar{A}$ is preannounced. If n is very small, then speculators are quite confident that there will be a large demand for liquidity, and this results in a high level of entry. If n is large, however, there is more uncertainty about the reward to entering when a high value of $\bar{A}$ is preannounced. A large and positive realization of A may be offset by a large and negative realization of N . In this case, the expected trading profit of the speculators who trade will be quite small. Thus, as n is increased, the amount of entry that would occur for large preannounced values of $\bar{A}$ is diminished. At the same time, the entry level for small realization of $\bar{A}$ increases as n is increased. For small values of n , the decrease in the announcers' trading costs for small orders is lower than the increase for large orders. As a result, the expected trading costs of the announcers at first increasing in n

the aggregate demand of the announcers has no effect on the price. (The price is either equal to $\sqrt{2b}$ or $-\sqrt{2b}$, depending on the sign of the aggregate demand of announcers.)¹⁶ The trading costs of any announcer are positive if and only if the sign of his trade is the same as the sign of the aggregate demand of the announcers. When an announcer's trade is opposite in sign from the aggregate demand of the announcers, that announcer is providing liquidity to the market in the same way the speculators do,¹⁷ and he receives the same compensation as the speculators. If we introduce additional announcers into the market, it becomes more likely that the demand of any given announcer will be the opposite of the aggregate demand.¹⁸ This lowers the expected trading costs of that announcer. If the parameters are such that $\lambda(a, 0, b) = 1$, then, since the price is affected by the liquidity demand, the expected trading costs of a given announcer can be higher for some realizations of demand when other announcers trade. On average, though, we show that each announcer is better off with additional announcers.¹⁷ Since by assumption the expected trading costs of the announcers are reduced if the nonannouncers are removed from the market, and since we have shown that announcers' costs are reduced when additional announcers are introduced, announcers' expected trading costs are clearly reduced if the nonannouncers are reintroduced into the market as announcers.¹⁸

4. Concluding Remarks

In this article, we have analyzed some of the implications of preannounced trading for financial market equilibrium. We have isolated two effects of preannouncement. One is due to the assumption that preannounced orders come from traders who do not have private

¹⁶To see this, note that $\mathbf{z}$ and $\mathbf{y}$ are independent normally distributed, mean-zero random variables, then the probability that $\mathbf{z}$ and $\mathbf{z} + \mathbf{y}$ are of opposite sign is increasing in the variance of $\mathbf{y}$.

¹⁷Note that If the market size is fixed, then the introduction of additional announcers will not change the expected cost of trading for the original announcers. Assume, for example, that there are two announcers and fix the demand of the first at A_1 . If A_2 , the demand of the second, has the same sign as A_1 , then the presence of the second announcer increases the first announcer's trading costs by $A_1(A_2/\lambda)$, where λ is the fixed fraction of the speculators entering. But it is equally likely, given our distributional assumptions, that the demand of the second announcer is $-A_2$, in which case the trading costs of the first announcer are reduced by $A_1(A_2/\lambda)$. On average then, the second announcer has no effect on the first announcer's trading costs when λ is fixed.

¹⁸By numerical analysis we have found that if only a fraction of the nonannouncers are made into announcers, the expected trading costs of the original announcers and of the nonannouncers who "convert" are reduced. The expected trading costs of the nonannouncers who remain nonannouncers either increase or decrease as a consequence of the change. The ambiguity occurs for the same reasons discussed before: the conversion of nonannouncers into announcers makes λ more variable, which tends to increase the expected trading costs of the nonannouncers. At the same time the conversion increases the average value of λ , which tends to reduce the expected trading costs of the nonannouncers. Either of these effects can dominate.

information. This implies that preannouncement leads to a decrease in the total expected trading costs of liquidity traders, even though it leads to an increase in the expected trading costs of liquidity traders who cannot preannounce. Moreover, the savings in liquidity traders' expected trading costs are more than sufficient to compensate speculators for any losses they might suffer due to preannouncement.

We have also shown that if there is no private information but if liquidity providers (speculators) must incur a cost in order to trade in the risky asset, preannouncement can serve as a mechanism for coordinating the entry of speculators into the market. Specifically, with preannouncement, the size of the market becomes an increasing function of the size of the preannounced order. This tends to lower the expected trading costs of liquidity traders if entry costs are significant. Moreover, the *ex ante* expected utility of speculators is increased with preannouncement.

Concerning the price behavior we show that the identification of liquidity orders means that preannouncement increases the informativeness of the price and reduces the variance of the price change. If entry by speculators is costly and entry costs are sufficiently high, preannouncement leads to a decrease in price variability.

Our analysis is based on a number of explicit and implicit assumptions which deserve further discussion and which raise several issues for future research. Some of them will be discussed in the remainder of this section.

4.1 Are announcers informationless?

As we noted in the introductory section, preannouncement has been originally devised for use by certain institutional traders who are motivated to trade for reasons other than privately held, payoff-relevant information. Our analysis is based on the assumption that announcers are liquidity traders. [Similar assumptions are made in the related work by Gennotte and Leland (1990) and Röhl (1990).] There are a number of reasons that lead us to believe that this assumption is reasonable or that, at least, the preannounced order is most likely not to be based on private information.¹⁹

One set of arguments is based on the institutional framework surrounding preannouncement, which might guarantee that only informationless traders are able to preannounce. If preannouncement is formally established, for example, the rules governing it might restrict announcers to be passive fund managers, portfolio insurers, or others

¹⁹ Although not formally analyzed here, it seems that the basic result that preannouncement reduces the adverse-selection costs for announcers would continue to hold even if a small fraction of the preannounced orders are informationally motivated.

committed to following trading strategies that are not based on privately held, payoff-relevant information. Even if such explicit restrictions are not made, the ability of traders to identify themselves when preannouncing their trades may be sufficient to achieve the same results. Also, the actual preannouncement might be made by intermediaries such as brokers, who would presumably acquire valuable reputations over time for screening out informed traders. To preserve their reputations, the intermediaries would then insure that preannouncement is only made by liquidity traders.

Another argument for why it is reasonable to assume that preannouncement signals an informationless trade is related to the potential costs of preannouncement for an informed trader. By its nature, preannouncement entails a delay in the execution of the order. This delay may well be more costly to informed traders than to liquidity traders. First, there may be a significant chance that private information will become public between the time preannouncements are made and the actual time in which the order is executed. Thus, if the information is likely to be short-lived, an informed trader may not want to delay his trade. Second, preannouncement would be undesirable to an informed trader if it triggers information acquisition that would reduce his subsequent trading profits.²⁰ Although beyond the scope of this article, this could provide an equilibrium justification for the notion that the informational price impact of a preannounced order is significantly smaller than that of an unannounced order.

4.2 The preferences of liquidity traders

As in most models that include traders, our analysis has not explicitly modeled the preferences of the liquidity traders and the sources of their demands. We have instead focused on the expected trading costs of these traders with and without preannouncement. Since announcers are likely to be institutional traders, it is not obvious how their preferences should be modeled. Ross (1989), for example, argues that many institutions should not be thought of as simply passing

²⁰Note that if all informed traders are dissuaded from preannouncing and if information is costly, then in equilibrium the preannouncement will not trigger information acquisition, and so informed traders will want to preannounce. Thus, we might get something akin to the Grossman and Stiglitz (1980) paradox. It is possible, however, to develop signaling models in which preannouncement signals that the announcer either has no information, or he has information that would lead to relatively minor reassessments of the risky asset's value. In such models and for certain parameter values, the informed trader only preannounces when his information signal turns out to be too valuable—since the more valuable the information, the more costly it is for the informed trader if the information is discovered. Preannouncement triggers costly information acquisition since traders who become informed get to trade before the announcer, capturing at least some of his trading profits. Finally, liquidity traders who preannounce choose to do so since the price impact of an unannounced order is all greater than that of a preannounced order, as the former might be submitted by Informed traders with more valuable information.

through in a transparent fashion the demand of the individuals for whom they invest. It is clear, however, that many institutional investors are concerned with the price impact of their trades and their execution costs. This means that expected trading costs (which are directly related to the price impact of orders) play an important role in the preferences of these traders.

If liquidity traders are risk averse, then we must look beyond expected trading costs to examine their welfare and the potential effects of preannouncement. We have seen, for example, that the informational effect of preannouncement tends to increase the informativeness of the equilibrium price. This might reduce some of the risk-sharing benefits of trading between liquidity traders and speculators, and therefore reduce the potential benefits of preannouncement. For example, suppose that announcers have endowment shocks in their holdings of nontraded assets, whose payoffs are correlated with the payoff of the risky asset. If more information about the asset's payoff is revealed at the time of trade because of preannouncement, the risky asset becomes a less effective hedge for the announcers.

Different effects arise if the entry costs of speculators are significant, as in the model of Section 3. In this case we can show that preannouncement would tend to reduce, possibly dramatically, the variance of trading costs. This is in addition to the decrease in expected trading costs brought about by preannouncement. Suppose, for example, that the entry cost is 5 and the variance of the announcers demand is 1. Using the results in Section 3.1, one can show that the variance of the announcers' trading costs with preannouncement is 3.7, while the variance of these costs without preannouncement is 44,050.9 (!). The expected trading costs of the announcers with and without preannouncement are 2.5 and 148.4, respectively. As explained in Section 3.1, the reasons for these differences are that preannouncement significantly increases the average level of entry, and also creates a correlation between the entry level and the size of the preannounced order.

4.3 On selective preannouncement strategies

Throughout our analysis we have not explicitly given announcers the ability to choose whether or not to engage in preannouncement. Our assumption was that announcers preannounce either all realizations of their orders or none. If the practice of preannouncement is established, however, announcers would presumably be able to choose whether to preannounce a particular order or not. Our results can be used to analyze this in a straightforward way, at least in the case where announcers are interested in minimizing their expected trading costs. First, it is easy to see that if entry costs for speculators are zero and

there is private information, announcers would always choose to preannounce if this is possible. Both ex ante and also conditional on any value of their demand, the expected trading costs of each announcer are lower if he preannounces than if he does not.

The situation seems more problematic when entry costs are positive. Our results in Section 3 indicate that preannouncement lowers the announcers' trading costs when their realized order size is large (since more speculators enter in this case) and raises them for small order sizes. One might therefore conclude that if there is only one announcer, for example, he would prefer a *selective preannouncement strategy*, whereby preannouncement is only made if the order size is above a certain level. However, if the announcer cannot *commit* to such a strategy, it cannot be part of an overall equilibrium. To see this, suppose that the announcer's strategy is to preannounce only those orders whose size is greater than K , a positive constant. Also assume that all other traders understand this. Potential traders will make the appropriate statistical inference from the lack of preannouncement and adjust their entry decisions accordingly. It can be shown, however, that in this case there will be realizations of the announcer's demand slightly below K in size for which, ex post, he would prefer to preannounce. Since the announcer cannot commit not to preannounce when these realizations occur, we get a contradiction which implies that the original postulated strategy cannot be part of an equilibrium.

The "unraveling" argument given above implies that if not all speculators enter the market without preannouncement, then the only possible equilibrium of the model in which announcers choose whether to preannounce is one in which all realizations of the announcers' demand are preannounced. If the entry cost is so low that all speculators enter without preannouncement, then there is another equilibrium in which no preannouncement ever takes place. Similar considerations apply when there are several liquidity traders.²¹ Note that in the former case if the parameters are such that the announcers' expected trading costs are higher with preannouncement, then the announcers would be better off if preannouncement is not allowed. Equivalently, they would like to be able to commit to a strategy of never preannouncing.

²¹ In this case, for each liquidity trader i there are realizations of $|A_i|$, the absolute value of that trader's demand, that are so large that trader i would want to preannounce. These realizations are such that the fraction of speculators wishing to enter when A_i is preannounced would be larger than $\lambda(a, b)$.

4.4 Endogenous information acquisition

While our analysis has taken the allocation of information as given, preannouncement is likely to have implications for the incentives to collect private information, which would affect the information allocation and the resulting asset market equilibrium. From the results of Section 2 it follows that preannouncement generally leads to a more informative equilibrium price. This means that it would reduce the incentives to gather costly private information. But less information acquisition generally leads to a higher level of uncertainty associated with the risky asset, which would in turn *raise* the risk-bearing costs borne by both announcers and nonannouncers. In fact, we have constructed examples in which the increase in risk-bearing costs is greater than the savings in adverse-selection costs and consequently the expected trading costs of the announcers are actually higher with preannouncement.²² A complete analysis of this is left for future research.

4.5 Imperfect competition

In our model of the financial market, we assumed that there is a continuum of speculators. Since the actions of each speculator have no measurable effect on the price, each behaves competitively. It is obviously possible to perform an analysis analogous to ours in the context of a model with imperfect competition. As indicated, for example, by the results in Röell (1990), such an analysis is likely to arrive at the same qualitative conclusions as our results in Section 2 concerning the informational effects of preannouncement. In particular, the risk-bearing and adverse-selection costs will continue to exist when speculators are imperfectly competitive and preannouncement will have the same types of effects on these costs as it did in our analysis.

Now consider the model with positive entry costs. With imperfect competition, the expected trading cost of a liquidity trader is decreasing in the number of speculators not only because a larger number of speculators improves the risk-bearing capacity of the market, but also because a larger number of speculators increases the degree of competition. Since preannouncement lowers the risk of entry for speculators, it tends to increase the average size of the market and therefore the average degree of competition. In addition, prean-

²² For example, let $a = 10$ and $n = 1$. Assume that traders can acquire either a signal with precision $\frac{1}{2}$ [$\text{Var}(\epsilon) = 1$] for a cost of 0.29 or a signal of precision $\frac{1}{4}$ [$\text{Var}(\epsilon) = 2$] for a cost of 0.16. The reader can verify that if there is no preannouncement, the only equilibrium is one in which speculators acquire the higher precision signal. On the other hand, with preannouncement, the only equilibrium is the one in which the speculators acquire the lower precision signal. Finally, it can be shown that $\gamma_A = 0.5217$ and $\gamma = 0.5714$. Thus, preannouncement raises the expected trading costs of the announcers.

nouncement introduces a positive correlation between the size of the preannounced order and the degree of competition. This correlation will lower trading costs on large orders and increase them on smaller orders; the net effect will be a reduction in expected trading costs. Because of these effects on the degree of competition, preannouncement may reduce expected trading costs by even more in a model with imperfect competition than it did in our model.

4.6 Front-running

Front-running refers to a situation in which a trader, knowing that an order is about to be placed, trades in the same direction before the order is executed. The front-runner plans to unwind his position after the original order is executed and hopes to profit through the price impact of the original order. Preannouncement would seem to expose announcers to front-running activities that might work to their disadvantage. While a complete dynamic model that captures the possibility of front-running is clearly beyond the scope of this article, a few considerations suggest that front-running will not hurt the announcers in an equilibrium context. In particular, one must distinguish between the case where a few traders (e.g., brokers) have *private* information about an impending sale and engage in front-running and the situation we examine here, in which the preannounced trade is *public* information.

In a dynamic setting, front-runners might actually bring additional liquidity to the market. Assume that there is no private information and that the current price of the risky asset is, say, 98. Now assume that a large sale is preannounced. Given this preannouncement, it is expected that the price of the stock will fall to 96 at the time of the sale to compensate speculators on the other side for bearing risk. A front-runner might attempt to sell at, say, 97, before the preannounced order is executed and then buy back the shares at 96 at the execution of the preannounced order. This is obviously a profitable strategy if it can be done. One must ask, however, why someone would buy from the front-runner at 97 when it is anticipated that the preannounced order will be sold by the announcer at 96. If this buyer were to delay his purchase, he would obviously obtain a better price. Of course, the buyer might be a liquidity trader with a strong demand for immediacy. If this is the case, the front-runner is actually performing a valuable market-making service. He is transferring through time the unannounced liquidity demand to buy to meet the preannounced liquidity demand to sell. In a competitive market, it is difficult to see why this would be detrimental to the interests of the announcer.

It might be thought that with information asymmetries the front-

runner's activities might increase the trading costs of the announcers, since traders might suspect that the front-runner's order is based on private information. In a rational expectations equilibrium, however, the front-runner's strategy will be known and therefore the actual trades will be anticipated once the preannouncement is made. Thus, there should be no effect on the price. Note that this argument relies heavily on the public nature of sunshine trading, as distinct from private information about the order flow that might be available to brokers.

4.7 Exogenous entry of liquidity traders

In our analysis, the only way for preannouncement to change the composition of the market is through its effects on the entry decisions of speculators. The population of liquidity traders was assumed constant. It is quite likely, however, that some of the liquidity traders have discretion over the timing of their trades. In response to preannouncement, these traders could delay or accelerate their orders to improve their terms of trade in the spirit of Admati and Pfleiderer (1988). For example, if a large sell order is preannounced, discretionary liquidity buyers may respond by submitting their orders at the time the preannounced order is to be executed.

Recall that the speculators in our model provide liquidity to the market, but they do this at a cost since they must be compensated for the risk they bear. The discretionary liquidity traders, however, given that they are motivated to trade a particular order even in the absence of the announcers' demand, will presumably require little or 'no compensation to absorb some of the announcer's order. This may further lower the expected trading cost of the announcers. Moreover, nonannouncers may share this benefit as well. As in the case of front-running, a complete analysis of the entry decisions of liquidity traders would require a dynamic model. This is an interesting topic for future research.

Appendix

Proof of Proposition 1

For part (a) we have

$$C_A^* - C_A = - \frac{sa(s(a+n) + s^2n + 1)}{((s^2 + s)n + 1)((s^2 + s)(a+n) + 1)} < 0 \quad (A1)$$

For part (b) we have

$$C_N^* - C_N = \frac{s^3an}{((s^2 + s)n + 1)((s^2 + s)(a+n) + 1)} > 0. \quad (A2)$$

To prove part (c), we use the following lemma, which is proved in Admati and Pfleiderer (1987, proposition 3.1).

Lemma A1. *The ex ante expected utility of a speculator is*

$$-(V/\Psi)^{1/2} \exp(-w), \quad (\text{A3})$$

where w is the trader's initial wealth, $\Psi = \text{Var}(\tilde{F} - \tilde{P})$, and $V = \text{Var}(\tilde{F} | \tilde{Y}_n, \tilde{P})$.

Consider first the economy without preannouncement. Using the equilibrium values of γ_F , γ_A , and γ_N , it is easy to show that

$$\begin{aligned} \text{Var}(\tilde{F} - \tilde{P}) \\ = \frac{s^2(a+n)(s^2(a+n)^2 + s^2(a+n) + 2s(a+n) + 1)}{((s^2 + s)(a+n) + 1)^2} \end{aligned} \quad (\text{A4})$$

and

$$\begin{aligned} \text{Var}(\tilde{F} | \tilde{Y}_n, \tilde{P}) &= \left(1 + \frac{1}{s} + \frac{1}{s^2(a+n)}\right)^{-1} \\ &= \frac{s^2(a+n)}{(s^2 + s)(a+n) + 1}. \end{aligned} \quad (\text{A5})$$

Thus, the expected utility of a speculator in the economy without preannouncement is

$$-\left(\frac{(s^2 + s)(a+n) + 1}{s^2(a+n)^2 + s^2(a+n) + 2s(a+n) + 1}\right)^{1/2} \exp(-w). \quad (\text{A6})$$

In the regime with preannouncement we have

$$\text{Var}(\tilde{F} - \tilde{P}^*) = \frac{s^2n(s^2n(a+n) + (s^2 + 2s)n + 1)}{((s^2 + s)n + 1)^2}, \quad (\text{A7})$$

and

$$\text{Var}(\tilde{F} | \tilde{Y}_n, \tilde{P}^*) = \left(1 + \frac{1}{s} + \frac{1}{s^2n}\right)^{-1} = \frac{s^2n}{(s^2 + s)n + 1}. \quad (\text{A8})$$

The expected utility of a speculator in this case is therefore

$$-\left(\frac{(s^2 + s)n + 1}{s^2n(a+n) + s^2n + 2sn + 1}\right)^{1/2} \exp(-w). \quad (\text{A9})$$

Now since

$$\left(\frac{(s^2 + s)n + 1}{s^2n(a+n) + s^2n + 2sn + 1}\right)$$

$$\begin{aligned}
 & - \left(\frac{(s + s^2)(a + n) + 1}{s^2(a + n)^2 + s^2(a + n) + 2s(a + n) + 1} \right) \\
 & = \frac{sa(s(a + n) + 1)}{(s^2n(a + n) + (s^2 + 2s)n + 1)(s^2(a + n)^2 + s^2(a + n) + 2s(a + n) + 1)} \\
 & > 0,
 \end{aligned}$$

and $\exp(-w)$ is positive, it follows that

$$\begin{aligned}
 & - \left(\frac{(s^2 + s)n + 1}{s^2(an + n^2) + s^2n + 2sn + 1} \right)^{1/2} \exp(-w) \\
 & < - \left(\frac{(s^2 + s)(a + n) + 1}{s^2(a + n)^2 + s^2(a + n) + 2s(a + n) + 1} \right)^{1/2} \exp(-w).
 \end{aligned}$$

Speculators are therefore worse off with preannouncement; this proves part (c).

We now prove part (d). First define Δ to be the total cost savings of the liquidity traders (announcers and nonannouncers) due to preannouncement. From parts (a) and (b) we have

$$\begin{aligned}
 \Delta &= (C_A + C_N) - (C_A^* + C_N^*) \\
 &= \frac{sa(s(a + n) + 1)}{((s^2 + s)n + 1)((s^2 + s)(a + n) + 1)} > 0. \quad (\text{A10})
 \end{aligned}$$

Thus, the total expected trading costs of liquidity traders are lower with preannouncement.

Now let

$$\theta = \frac{(s^2 + s)(a + n) + 1}{s^2(a + n)^2 + s^2(a + n) + 2s(a + n) + 1}, \quad (\text{A11})$$

and

$$\theta^* = \frac{(s^2 + s)n + 1}{s^2(an + n^2) + (s^2 + 2s)n + 1}. \quad (\text{A12})$$

The expected utility of a speculator without preannouncement is $-\theta^{1/2} \exp(-w)$, and with preannouncement it is $-(\theta^*)^{1/2} \exp(-w)$. Let v be the amount of money a speculator would be willing to pay to prohibit preannouncement. In other words, v solves

$$-(\theta)^{1/2} \exp(-w + v) = -(\theta^*)^{1/2} \exp(-w), \quad (\text{A13})$$

or

$$v = \frac{1}{2} \log(\theta^*/\theta). \quad (\text{A14})$$

We want to show that $\frac{1}{2} \log(\theta^*/\theta) < \Delta$ or, in words, that the max-

imum amount speculators would pay to prohibit preannouncement is lower than the savings in trading costs of the liquidity traders due to preannouncement.

First note that since $\theta^* > \theta$,

$$\frac{1}{2} \log\left(\frac{\theta^*}{\theta}\right) < \log\left(\frac{\theta^*}{\theta}\right) < \frac{\theta^*}{\theta} - 1. \quad (\text{A15})$$

It is straightforward to show that

$$\begin{aligned} \frac{\theta^*}{\theta} - 1 &= \frac{sa(s(a+n)+1)}{((s^2+s)(a+n)+1)(s^2an+s^2n^2+s^2n+2sn+1)}. \end{aligned} \quad (\text{A16})$$

Consider now the ratio of $(\theta^*/\theta - 1)$ to A. This is given by

$$\frac{1}{\Delta} \left(\frac{\theta^*}{\theta} - 1 \right) = \frac{s^2n + sn + 1}{s^2an + s^2n^2 + s^2n + 2sn + 1} < 1. \quad (\text{A17})$$

It follows that $\Delta > 1/2 \log(\theta^*/\theta)$.

The proofs of parts (e), (f), and (g) are straightforward and therefore omitted. ■

Proof of Lemma 1

The announcer's demand $\tilde{A}$ represents the number of shares *per speculator* the announcer wishes to buy (if positive) or sell (if negative). If a fraction λ of the speculators enters the market, then for market clearing the price must be set so that each speculator in the market chooses to buy $-\tilde{A}/\lambda$ shares. The demand function submitted by each speculator who enters the market is $(E(\tilde{F}) - \tilde{P})/\text{Var}(\tilde{F})$, which, given our distributional assumptions, is equal to $-\tilde{P}$. Thus, in equilibrium we have $\tilde{P} = \tilde{A}/\lambda$.

We first prove part (a). The variance of $\tilde{F} - \tilde{P}$ when λ enter the market is $1 + \lambda^{-2}a$. Since the variance of $\tilde{F}$ is 1, we know from Lemma A1 that the ex ante expected utility of a speculator who pays b and enters the market when a fraction λ enter is

$$-(1 + a/\lambda^2)^{1/2} \exp(-w + b), \quad (\text{A18})$$

where w is the initial wealth level of the speculator. If $\lambda < 1$, then speculators must be Indifferent between entering and not entering. If a trader does not enter, his ex ante utility is simply $-\exp(-w)$. Equating (A18) with this and solving for λ yields the result if $\lambda < 1$.

If (A18) evaluated at $\lambda = 1$ is greater than or equal to $-\exp(-w)$, then in equilibrium all speculators enter the market (i.e., $\lambda = 1$).

We now prove part (b). If a fraction λ of the speculators enter the market and A is the announced demand, then the price of the risky asset is A/A and each speculator receives $\tilde{A}/I$ shares. Given that the distribution of $\tilde{F}_i$ is normal, expected utility conditional on $\tilde{A}$ is monotonically related to $E(\tilde{w}_i|\tilde{A}) - \frac{1}{2}\text{Var}(\tilde{w}_i|\tilde{A})$, where v_i is the wealth of the speculator after the risky asset has paid off. With a fraction λ of the speculators entering, $E(\tilde{w}_i|\tilde{A}) = w_0 - b + \tilde{A}^2/\lambda^2$; and $\text{Var}(\tilde{w}_i|\tilde{A}) = \tilde{A}^2/\lambda^2$ for each entrant. If a speculator does not enter, then $E(v_i) = w_0$, and $\text{Var}(\tilde{w}_i) = 0$. If $\lambda < 1$, then λ solves $E(\tilde{w}_i|\tilde{A}) - \frac{1}{2}\text{Var}(\tilde{w}_i|\tilde{A}) = w_0$ and $\lambda = (2b)^{-1/2}|\tilde{A}|$. If $-b + \frac{1}{2}\tilde{A}^2 \geq 0$, then the expected utility of entering when $\lambda = 1$ is at least as large as that of not entering, and so in equilibrium all speculators enter. ■

Proof of Proposition 2

Since $\lambda(a, b) = \min(\sqrt{a/(\exp(2b) - 1)}, 1)$, it follows that

$$C(a, b) = E\left(\frac{\tilde{A}^2}{\lambda(a, b)}\right) = \max(\sqrt{a(\exp(2b) - 1)}, a). \quad (\text{A19})$$

Since $\lambda^*(\tilde{A}, b) = \min(|\tilde{A}|/\sqrt{2b}, 1)$, the expected cost of liquidity trading when preannouncement takes place is

$$\begin{aligned} C^*(a, b) &= 2 \int_0^{\sqrt{2b}} \sqrt{2b} A f(A) dA \\ &\quad + 2 \int_{\sqrt{2b}}^{\infty} A^2 f(A) dA, \end{aligned} \quad (\text{A20})$$

where

$$f(A) = \frac{1}{\sqrt{2\pi a}} \exp\left(-\frac{A^2}{2a}\right). \quad (\text{A21})$$

Integrating the right-hand side of (A20), we obtain

$$C^*(a, b) = 2 \sqrt{\frac{ba}{\pi}} + 2a \left(1 - \Phi\left(\sqrt{\frac{2b}{a}}\right)\right), \quad (\text{A22})$$

where $\Phi(\cdot)$ is the standard normal distribution function.

To prove part (a) we will show that

$$(i) \quad \lim_{b \rightarrow \infty} \frac{C(a, b)}{C^*(a, b)} > 1;$$

(ii) $C^*(a, b) > C(a, b)$, for all $b \leq \frac{1}{2} \log(1 + a)$;

(iii) $\frac{\partial(C^*(a, b) - C(a, b))}{\partial b} < 0$, for all $b > \frac{1}{2} \log(1 + a)$.

Since both $C^*(a, b)$ and $C(a, b)$ are continuous functions, (i)-(iii) taken together prove the proposition.

Proof of (i). Since $\exp(2b) > 1 + 2b$, it follows that $C(a, b) = \sqrt{a(\exp(2b) - 1)} > \sqrt{2ab}$. From the fact that $\Phi(\sqrt{2b/a}) < \frac{1}{2}$, we know that $C^*(a, b) < 2\sqrt{ba/\pi} + a$. From this we can conclude that

$$\frac{C(a, b)}{C^*(a, b)} > \frac{\sqrt{2ab}}{2\sqrt{ba/\pi} + a}. \quad (\text{A23})$$

It is easily seen that

$$\lim_{b \rightarrow \infty} \frac{\sqrt{2ab}}{2\sqrt{ba/\pi} + a} \sqrt{\frac{\pi}{2}} > 1. \quad (\text{A24})$$

Proof of (ii). For $b \leq \frac{1}{2} \log(1 + a)$, $\lambda(a, b) = 1$, and $C(a, b) = a$. Note that for all $b > 0$, $C^*(a, b) > a$. This can be seen by rewriting (A20) as

$$C^*(a, b) = a + 2 \int_0^{\sqrt{2b}} (\sqrt{2b}A - A^2)f(A) dA. \quad (\text{A25})$$

Since $\sqrt{2b}A - A^2 > 0$ for $A < \sqrt{2b}$, $C^*(a, b)$ is strictly greater than a .

Proof of (iii). Differentiating $C(a, b)$ and $C^*(a, b)$ with respect to b for $b > \frac{1}{2} \log(1 + a)$ yields

$$\frac{\partial C(a, b)}{\partial b} = \frac{\sqrt{a} \exp(2b)}{\sqrt{\exp(2b) - 1}}, \quad (\text{A26})$$

and

$$\frac{\partial C^*(a, b)}{\partial b} = \sqrt{\frac{a}{\pi b}} \left(1 - \exp\left(-\frac{b}{a}\right) \right). \quad (\text{A27})$$

A sufficient condition for $\partial(C^*(a, b) - C(a, b))/\partial b$ to be negative is that

$$\sqrt{\frac{1}{\pi b}} < \frac{\exp(2b)}{\sqrt{\exp(2b) - 1}}, \quad (\text{A28})$$

or

$$\frac{1}{\pi} < \frac{b \exp(4b)}{\exp(2b) - 1}. \quad (\text{A29})$$

We will show that $b \exp(4b)/(\exp(2b) - 1)$ is greater than $1/2$ for all positive b . First, note that by l'Hospital's rule,

$$\begin{aligned} \lim_{b \rightarrow 0} \frac{b \exp(4b)}{\exp(2b) - 1} \\ = \lim_{b \rightarrow 0} \frac{\exp(4b) + 4b \exp(4b)}{2 \exp(2b)} = \frac{1}{2}. \end{aligned} \quad (\text{A30})$$

Now observe that

$$\begin{aligned} \frac{\partial}{\partial b} \left(\frac{b \exp(4b)}{\exp(2b) - 1} \right) \\ = \frac{\exp(4b)((\exp(2b) - 1)(1 + 2b) - 2b)}{(\exp(2b) - 1)^2}. \end{aligned} \quad (\text{A31})$$

Since $\exp(2b) - 1 > 2b$, it follows that $(\exp(2b) - 1)(1 + 2b) - 2b > 0$. This means that $b \exp(4b)/(\exp(2b) - 1)$ is an increasing function of b and therefore greater than $1/2$ for all positive values of b . From this it follows that $\partial(C^*(a, b) - C(a, b))/\partial b$ is negative for all $b > 1/2 \log(1 + a)$.

We now prove part (b). Consider first the case in which $a < \exp(2b) - 1$. Since $\lambda(a, b) < 1$, in the equilibrium with no preannouncement speculators are indifferent between entering and not entering. The expected utility attained by all speculators is equal to $-\exp(-\omega)$, where ω is the initial wealth level. Define $\mathcal{A} = \{A | A^2 > 2b\}$. With preannouncement, spectators are again indifferent between entering and not entering when $\tilde{A} \notin \mathcal{A}$. Thus, for these realizations of A , the level of utility attained is equal to $-\exp(-\omega)$. However, when $A \in \mathcal{A}$, which occurs with positive probability, speculators strictly prefer to enter, meaning that they achieve a utility level that exceeds $-\exp(-\omega)$. This implies that expected utility is higher with preannouncement.

Now suppose $a \geq \exp(2b) - 1$, so that $\lambda(a, b) = 1$. Let $u(A)$ be the ex post (conditional on $\tilde{A} = A$) expected utility of the speculators when there is no preannouncement and let $u^*(A)$ be expected utility conditional on $\tilde{A} = A$ when there is preannouncement. Define $\mathcal{A}^0 = \{A | A^2 < 2b\}$. When $\tilde{A} \notin \mathcal{A}^0$, $\lambda^*(\tilde{A}, b) = \lambda(a, b) = 1$. For such realizations of $\tilde{A}$ both the equilibrium price and the number of shares traded by each speculator are the same in the two regimes, so $u(A)$

$= u^*(A)$. For any realization $\tilde{A}^0$, $u(A) < -\exp(-w)$. This follows immediately from the fact that for these realizations of $\tilde{A}$, $\lambda^*(A, b) < 1$. Since for $\tilde{A} \in \mathcal{A}^0$, speculators are indifferent between entering and not entering when preannouncement takes place, it follows that for these realizations of $\tilde{A}$, $u^*(A) = -\exp(-w)$. Each speculator's expected utility conditional on $\tilde{A}$ is therefore always at least as large with preannouncement as without preannouncement. Moreover, with positive probability the conditional expected utility is strictly greater with preannouncement. Thus, speculators are ex ante better off with preannouncement. ■

Proof of Lemma 2

Part (i) follows immediately from Lemma 1. To prove part (ii), note that from Lemma A1 it follows that when $\tilde{A}$ is preannounced, the expected utility of a speculator who enters the market when a fraction λ of the speculators also enter is given by

$$-\left(1 + \frac{n}{\lambda^2}\right)^{1/2} \exp\left(-\frac{1}{2\lambda^2}\left(1 + \frac{n}{\lambda^2}\right)^{-1} - w + b\right). \quad (\text{A32})$$

The equilibrium value of $\lambda^*(\tilde{A}, n, b)$ equates the expected utility of entering, given in Equation (A32) above, with the expected utility of not entering, which is $-\exp(-w)$. ■

Proof of Proposition 3

We first show that $C_A^*(x, 0, b)/x$ is a decreasing function of x . From (A22) we have

$$\frac{C_A^*(x, 0, b)}{x} = 2 \sqrt{\frac{b}{x\pi}} + 2 \left(1 - \Phi\left(\sqrt{\frac{2b}{x}}\right)\right). \quad (\text{A33})$$

It is straightforward to show that

$$\frac{\partial C_A^*(x, 0, b)/x}{\partial x} = - \sqrt{\frac{b}{x^3\pi}} \left(1 - \exp\left(-\frac{b}{x}\right)\right), \quad (\text{A34})$$

which is clearly negative. To show that the expected trading costs of the announcers are reduced if the nonannouncers preannounce, we note that if the nonannouncers preannounce, the announcers' expected trading costs will be

$$a \left(\frac{C_A^*(a + n, 0, b)}{a + n} \right). \quad (\text{A35})$$

By the fact that $C_A^*(x, 0, b)/x$ is a decreasing function of x , this is less

than $a(C^*_A(a, 0, b)/a) = C^*_A(a, 0, b)$ and since by assumption $C^*_A(a, 0, b) < C^*_A(a, n, b)$, it follows that the announcers' expected trading costs are reduced if the nonannouncers preannounce.

To show that the expected trading costs of the nonannouncers are lower if they preannounce, we need to show that

$$\frac{C^*_N(a, n, b)}{n} > \frac{C^*_A(a, n, b)}{a}. \quad (\text{A36})$$

Note first that

$$\begin{aligned} \frac{C^*_A(a, n, b)}{a} &= \frac{1}{a} E \left(\frac{\tilde{A}^2}{\lambda^*(\tilde{A}, n, b)} \right) \\ &= E \left(\frac{1}{\lambda^*(\tilde{A}, n, b)} \right) + \left(\frac{1}{a} \right) \text{Cov} \left(\frac{1}{\lambda^*(\tilde{A}, n, b)}, \tilde{A}^2 \right), \end{aligned} \quad (\text{A37})$$

and, since $\tilde{A}$ and $\tilde{N}$ are independent,

$$\frac{C^*_N(a, n, b)}{n} = \frac{1}{n} E \left(\frac{\tilde{N}^2}{\lambda^*(\tilde{A}, n, b)} \right) = E \left(\frac{1}{\lambda^*(\tilde{A}, n, b)} \right). \quad (\text{A38})$$

Since $\lambda^*(\tilde{A}, n, b)$ is a nondecreasing function of $\tilde{A}^2$, which is strictly increasing for sufficiently small realizations of $\tilde{A}^2$, it follows that $\text{Cov}(1/\lambda^*(\tilde{A}, n, b), \tilde{A}^2)$ is negative. [The covariance would be zero if $\lambda^*(\tilde{A}, n, b) = 1$, for all $\tilde{A}$. This, however, is inconsistent with the assumption that $C^*_A(a, n, b) > C^*_A(a, 0, b)$.] Thus, $C^*_N(a, n, b)/n > C^*_A(a, n, b)/a$. This result and the fact that $C^*_A(x, 0, b)/x$ is a decreasing function of x allow us to conclude that

$$\begin{aligned} n \left(\frac{C^*_A(a + n, 0, b)}{a + n} \right) &< n \left(\frac{C^*_A(a, 0, b)}{a} \right) < n \left(\frac{C^*_N(a, n, b)}{n} \right) \\ &= C^*_N(a, n, b). \end{aligned}$$

The first expression in the chain gives the nonannouncers' expected trading costs if they preannounce, and the last gives the expected trading costs if they do not preannounce. Thus, the nonannouncers lower their expected trading costs by preannouncing. ■

References

- Admati, A. R., 1985, "A Noisy Rational Expectations Equilibrium for Multi-Asset Security Markets," *Econometrica*, 53.629-657.
- Admati, A. R., and P. Pfleiderer, 1987, "Viable Allocation of Information in Financial Markets," *Journal of Economic Theory*, 43.76-115.
- Admati, A. R., and P. Pfleiderer, 1988, "A Theory of Intraday Patterns: Volume and Price Variability," *Review of Financial Studies* 1.3-40.

Gennotte, G., and H. Leland. 1990, "Market Liquidity, Hedging and Crashes." *American Economic Review*, 80,999-1021.

Glosten, L. R., and P. R. Milgrom, 1985, "Bid, Ask and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders," *Journal of Financial Economics*, 14,71-100.

Grossman, S. J., 1988, "An Analysis of the Implications for Stock and Futures Price Volatility of Program Trading and Dynamic Hedge Strategies." *Journal of Business*, 61,275-298.

Grossman, S. J., and M. H. Miller, 1988, "Liquidity and Market Structure," *Journal of Financial*, 43, 617-637.

Grossman, S. J., and J. E. Stiglitz, 1980, "On the Impossibility of Informationally Efficient Markets," *American Economic Review*, 70,393-408.

Hellwig, M. F., 1980. "On the Aggregation of Information in Competitive Markets." *Journal of Economic Theory*, 22,477-498.

Kidder, Peabody and Co., 1986 and 1987, "Stock Index Futures: Weekly Commentary," Kidder, Peabody and Co.: Financial Futures Department.

Kyle, A. S., 1985, "Continuous Auctions and Insider Trading," *Econometrica*, 53,1315-1335.

Kyle, A. S., 1989, "Informed Speculation with Imperfect Competition," *Review of Economic Studies*, 56,317-355.

Madhavan, A., 1990, "Security Prices and Market Transparency," working paper, University of Pennsylvania.

Miller, M. H., et al., 1989, "Final Report of the Committee of Inquiry: Appointed by the Chicago Mercantile Exchange to Examine the Events Surrounding October 19,1987," in R. W. Kamphuis, Jr., R. C. Kormendi, and J. W. H. Watson, *Black Monday and the Future of Financial Markets*, Irwin, Homewood, Ill.

Pfleiderer, P., 1984, "The Volume of Trade and the Variability of Prices: A Framework for Analysis in Noisy Rational Expectations Equilibria," working paper, Graduate School of Business, Stanford University.

Röell, A., 1990, "Dual Capacity Trading," *Journal of Financial Intermediation*, 1, 105-124.

Ross, S. A., 1989, "Institutional Markets, Financial Marketing, and Financial Innovation," *Journal of Finance*, 44,541-555.

Subrahmanyam, A., 1991, "Risk Aversion, Market Liquidity, and Price Efficiency." *Review of Financial Studies* 4,417-441.