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Trading and Manipulation Around Seasoned Equity Offerings

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ABSTRACT

We investigate the potential for manipulation due to the interaction between secondary market trading prior to a seasoned equity offering (SO) and the pricing of the offering. Informed traders acting strategically may attempt to manipulate offering prices by selling shares prior to the SO, and profit subsequently from lower prices in the offering. The model predicts increased selling prior to a SO, leading to increases in the market maker's inventory and temporary price decreases. Further, since manipulation conceals information, the ratio of temporary to permanent components of the price movements is predicted to increase.

IN 1988, THE National Association of Securities Dealers, Inc. (NASD) adopted rule 10b–21 which prohibits the covering of short positions established after the announcement of a seasoned équity offering (SO) with securities purchased in the offering. The NASD was concerned that traders could manipulate new issue prices by short selling in the pre-issue market to drive prices down, and profit at the expense of the issuer by subsequently repurchasing the securities at reduced prices in the offering. Some indication that manipulation of this type occurs is provided by Barclay and Litzenberger (1988) and Lease, Masulis, and Page (1991). For a sample of seasoned equity offerings by NYSE and AMEX firms, Barclay and Litzenberger document both significant issue discounts and significant negative excess stock returns prior to the issue date. They suggest that the pre-issue price drops may be due to short sales. Similar price patterns around SOs are documented by Lease *et al.*

This paper models the interaction between secondary market trading prior to a SO and the setting of the offer price[1] to investigate the nature and effects of stock price manipulation around a SO. To ensure success of the offering and compensate uninformed investors for the winner's curse problem they face, new shares have to be issued at a discount from secondary market prices. A strategic trader possessing private information about the security value can influence the offer price by trading in the secondary market prior to bidding in the offering. We show that, even if the strategic trader has positive

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[1] Usually, the offer price is set after the close of trading the day before the offering is to be sold.

information, he may want to sell shares in the secondary market to conceal his information in anticipation of the SO. Such a strategy is profitable if the trader can recoup his secondary market losses through share purchases at a reduced price in the SO.

Typically in microstructure models with sequential trading (e.g., Kyle (1985)), informed traders are unable to follow "manipulative" strategies because they expect to move prices unfavorably each time they trade. The situation around a SO is special because the price-setting and market-clearing mechanisms in the secondary market and in the SO are very different. In the SO, the issuer sets the offer price at a discount from the preceding secondary market closing price. The discount is a function of the informativeness of the secondary market net order flow and is independent of the quantity of bids submitted. Hence, an informed trader can affect the offer price through his secondary market trading prior to the offering since the pre-issue secondary market clearing price and the informativeness of the net order flow are a function of his trades. It is this fact that allows for the possibility of manipulative trading. The informed trader may be hoping to depress the secondary market price through his pre-offer selling. In equilibrium, however, since the market maker expects more selling prior to a SO, such selling affects prices less prior to a SO than at other times. Manipulative trading, however, reduces the informativeness of the secondary market net order flow, thereby increasing the issue discount.

The information structure at the time of the offering is similar to that in Rock (1986), which presents a model of underpricing of initial public offerings. In our model, however, the nature of information asymmetry at the time of the offering is endogenous and depends on the equilibrium trading strategy of the informed traders in the secondary market preceding the offering. Manipulative trading decreases the informativeness of the secondary market order flow, thereby exacerbating the winner's curse problem faced by uninformed bidders and leading to an increase in the SO issue discount required to float the offering. Although the intuition and main results are derived from a model with only one informed trader facing restrictions on the quantity of his secondary market sales (on account of short sales restrictions, for example), we show that the results are robust to the removal of these selling restrictions and the introduction of multiple informed traders.

The model makes several testable predictions. First, it relates the incidence of manipulation and hence the magnitude of the issue discount to the ratio of the issue size and the secondary market order flow. Second, the model predicts that, since manipulation reduces the informativeness of the order flow, the permanent price change for a given order size will be smaller prior to a SO than otherwise. Third, the model predicts a net increase in secondary market sell orders just prior to the offering. Fourth, if the market maker is risk averse, the inventory build up caused by the increased selling induces a temporary price drop. Combining the inventory-induced temporary price drop with the smaller predicted permanent price change yields the prediction of a higher expected ratio of temporary to permanent components of price changes prior to a SO than otherwise. These predictions appear to be generally consistent with the empirical evidence. Smith (1977), Barclay and Litzenberger (1988), and Lease *et al.* (1991) document a significant issue discount and post-issue stock price recovery for seasoned equity issues by NYSE and AMEX firms. Loderer, Sheehan, and Kadlec (1991) document very significant issue discounts and stock price recovery around SOs for NASDAQ firms. Barclay and Litzenberger and Lease *et al.* also document significant negative excess returns in the two days prior to SO issue dates. Further, Lease *et al.* find evidence of selling pressures in the 10 days preceding the new issue.

From a policy standpoint, we show that a ban on short selling prior to seasoned offerings may raise the issue discount and be costly to issuers. Even milder provisions such as the recently adopted NASD rule 10b–21, that increase the costs of manipulation, may in some cases have the unintended consequence of raising the costs of new issues.

To our knowledge, only Parsons and Raviv (1985) have considered the interaction between secondary market trading and seasoned offerings. They show that if investors have heterogeneous valuations of the equity to be issued, the new issue will be sold at a discount from the pre-issue market. However, by assuming that all investors act competitively[2] and by disallowing all short sales, their model rules out the type of strategic behavior which is the focus of this work.

Several recent papers investigate models of market manipulation in different contexts. Jarrow (1989) identifies sufficient conditions under which a price process is susceptible to profitable manipulation by a single strategic trader. Allen and Gale (1992) and Bagnoli and Lipman (1990) examine potential manipulation around public tender offers arising from uncertainty about the seriousness of the offer. Vila (1989) analyzes a situation in which the manipulator, whose trades are concealed among those of liquidity traders, can take actions that affect the true value of the firm. Unlike these models, the manipulator in our model remains anonymous and can affect prices only through secondary market trading. Kyle (1983) and Kumar and Seppi (1992) develop models of manipulation in futures markets where all manipulation occurs through trading strategies. Kumar and Seppi (1992) show that uninformed manipulators can earn positive expected profits by taking a position in a futures contract and subsequently trading in the spot market to manipulate the settlement price. However, their model applies only to futures and other derivative securities.

The remainder of the paper is organized as follows. Section I introduces the game structure, the notation, and the assumptions of the model. The pricing of the seasoned equity offering is discussed in Section II. In Section III we derive the secondary market equilibrium in the absence of a SO. Section IV describes the possible equilibria arising in the secondary market prior to a SO. Section V investigates the robustness of the results when sales are unrestricted and when there is more than one informed trader. The effect of

[2] i.e., they take price as given and act nonstrategically.

risk aversion on part of the market maker is examined in Section VI. Section VII develops the empirical and policy implications of the model. A conclusion briefly summarizes the main results of the paper. All proofs are relegated to the appendix.

I. The Game Structure

We model a trading structure in which one informed trader submits orders in a competitive secondary market and subsequently bids in a seasoned equity offering. The model is later extended to the case with multiple informed traders. The secondary market is cleared by a market maker who absorbs the aggregate order flow from nondiscretionary liquidity traders and the informed trader. In the seasoned equity issue, the issuer first sets the offer price and then the informed trader and discretionary uninformed bidders submit their bids. All players are uninformed, except for the informed trader.[3] After deriving the main results when all players are risk neutral, we examine the effect of the market maker's risk aversion on the price-setting process.

There are two traded securities, a riskless bond which pays zero interest and plays the role of numeraire, and the risky stock subject to the SO. The end of period value of the stock, $\tilde{V}$, is exogenous and follows a two point distribution. The two values are high, V^+, and low, V^-, with respective ex ante probabilities θ and $(1-\theta)$. For simplicity, we set $\theta = 1/2$. The end of period values can be thought of as the future equilibrium prices of the security. Prior to the end of the period, prices are endogenous. There are two "markets," the secondary market and the offering market, in which exchange takes place, and which open sequentially. Five types of players participate in one or both markets. These are the market maker, the security issuer, the nondiscretionary liquidity traders, the uninformed bidders, and the informed strategic trader. The moves of the players and the timing of the game are illustrated in Figure 1 and unfold as follows.

At the outset of the game, at time t_0, the issuer announces the SO, the timing of the offering, and the number of new shares q to be issued. At time t_1, trading takes place in the secondary market between the market maker, liquidity traders, and the informed trader. Just prior to the market opening, at $t_1 - \epsilon$, the informed trader observes a private information signal that perfectly[4] reveals the terminal value of the security. Based on this information, the informed trader strategically chooses his secondary market order Q_I and whether or not to bid in the SO. We restrict trades to integer quantities and, to ease the exposition, we first assume that $Q_I \in \{-1, 0, 1, \ldots\}$. By

[3] Assuming that the issuer is uninformed rules out the possibility of signaling behavior. This assumption is not unreasonable in many instances. For example, some traders may have superior information about actions by the firm's competitors.

[4] The main results remain substantially unchanged if the probability that the informed traders remain uninformed is nonzero. It does however increase substantially the number of strategies and possible equilibria to consider, and hence the complexity of the presentation without adding much to the intuition.

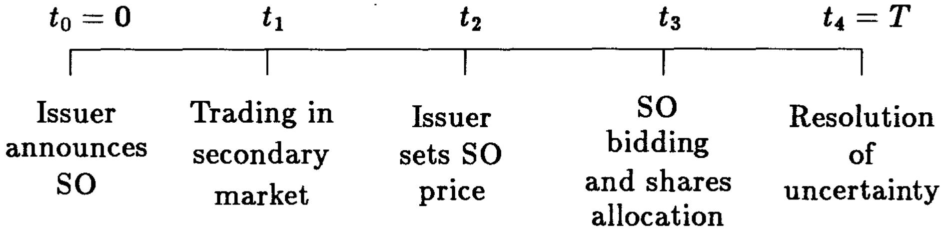

Figure 1. Timing of events in the seasoned equity offering (SO) game.

restricting the quantity sold by the informed trader to be at most one, we are implicitly assuming that short selling is partially restricted and that the informed trader has a zero endowment in the stock. We relax this assumption later and allow Q_I to take any integer value.

Liquidity traders are nondiscretionary traders subject to exogenous liquidity shocks independent of the terminal value of the security. They trade in the secondary market but do not participate in the SO.[5] We assume that the aggregate liquidity order flow $Q_L \in \{-1, 0, 1\}$ is distributed as follows:

$$Q_L = \begin{cases} -1 \text{ with probability } \gamma, \\ \ \ 0 \text{ with probability } (1 - 2\gamma), \\ +1 \text{ with probability } \gamma. \end{cases}$$

As in Kyle (1985), the informed trader market order Q_I is batched with the liquidity traders aggregate order Q_L. The market maker clears the secondary market and absorbs the net order flow $Q = Q_I + Q_L$. A positive Q represents a net buy order flow, while a negative Q represents sell orders. Since the net order flow conveys information about the terminal value of the asset inasmuch as it includes trading by the informed trader, the market maker updates his beliefs based on the observed net order flow. Let θ_Q denote the updated beliefs about the likelihood of the high state on observing a net order flow Q. The market maker sets the price to maximize his expected utility of terminal wealth. Under risk neutrality and in a competitive market the clearing price P_Q equals the expected terminal value of the security conditional on the observed net order flow. All players observe the net order flow Q and the secondary market clearing price P_Q, and hence have updated beliefs θ_Q about the terminal value of the security.

[5] The assumption that liquidity traders do not participate in the SO ensures that the secondary market remains open and is consistent with the view that liquidity traders have an urgent need to trade. Selling is not possible in the offering and even liquidity traders who wish to acquire shares may be unwilling to wait and bid in the offering where they face uncertainty about their allocation. In addition, as we see below, manipulation prior to a SO may have the effect of reducing the liquidity traders' cost of trading in the secondary market prior to the SO.

At time t_2, on the basis of the public information available at the close of the secondary market, the SO issuer sets the issue price P_Q^* for the new shares to ensure complete success of the offering.[6] At time t_3, bidding in the seasoned public offering takes place. Both informed and uninformed bidders participate in the offering. Uninformed bidders are discretionary investors without private information about the firm. They refrain from participating in the SO if, conditional on the public information, they expect losses from bidding. Given the issue price, both the informed trader and uninformed bidders submit their bids, which specify the number of shares they are willing to purchase. The total number of shares bid by either group, if they decide to bid, is known and fixed[7] and is denoted N_I and N_U for the informed and uninformed bidders respectively. Assume that $N_I < q < N_U$: the informed investor cannot absorb the entire SO by himself, while in the absence of an informed bidder there are enough uninformed bidders to subscribe the entire issue. Once all bids are in, shares are rationed on a strictly proportional basis and successful bidders pay the preset offer price for the shares they are allocated. The number of new shares allocated to the informed trader when he participates in the SO is denoted $\alpha_{\mathrm{I}} = q \times [N_I/(N_I + N_U)]$. The number of new shares allocated to uninformed bidders is denoted $\tilde{\alpha}_U$, and takes the following values:

$$\alpha_U = \begin{cases} q & \text{when the informed trader does not bid,} \\ q \times \dfrac{N_U}{(N_I + N_u)} = \dfrac{q}{\beta} & \text{when the informed trader bids,} \end{cases}$$

where $\beta = (N_I + N_U)/N_U$ denotes the inverse of the proportion of SO issue allocated to uninformed bidders when both types bid in the SO.

All uncertainty about prices is resolved at time t_4, the end of the period.[8] Although five dates and four subperiods can be distinguished, the model is in effect a single-period model. We assume that the period is short enough that time preferences can be neglected. It is also assumed that all information and the players' strategies are common knowledge except for (1) the signal received by the informed trader, (2) the individual quantity traded by each trader, and (3) each individual trader's type. In particular, all players are aware that informed traders may trade strategically to take advantage of the

[6] Setting the issue price independently of the actual number of bids received is consistent with the institutional practice. We believe that manipulation would persist even when allowing the price to be dependent on the bids received, through a two-price setup à la Parsons and Raviv (1985) or the determination of a full offer price schedule, as long as there is uncertainty about the uninformed demand.

[7] The limit on the bid size of either uninformed or informed bidders can be justified for example by the existence of budget constraints. Introducing uncertainty in the uninformed demand leaves the nature of the results unchanged while significantly adding to the complexity of the exposition.

[8] The length of the period is unspecified although in general a few weeks separate the announcement of a seasoned public offering and its completion, while only a few hours elapse between the time the issue price is set and the start of the selling.

interaction between the pricing mechanisms in the secondary market and in the SO to maximize profits from their private information.

The following notation is used to simplify the exposition in the remainder of the paper: Q_I^{+*} and Q_I^{-*} denote the informed trader's equilibrium secondary market trades given positive and negative information, respectively. $\bar{V}$ denotes the unconditional expectation $E[\tilde{V}]$ and ΔV denotes the difference between the terminal value of the asset in the high and the low states $V^+ - V^-$. Henceforth, the use of the subscripts, I, L, and U will refer exclusively to the informed trader, liquidity trader, and uninformed bidder, respectively.

II. Secondary Market Clearing In the Absence of a SO

The equilibrium concept used in the paper is Sequential Nash.[9] A player's strategy is the complete characterization of his actions in each period and for each information set. A set of strategies, one for each player, constitutes a Sequential Nash equilibrium only if the strategy of a player consists of actions that are optimal in each period and for each information set, under the assumption that all other players are following their optimal strategies. Such an equilibrium is subgame perfect and requires that the players' beliefs on observing out of equilibrium moves be specified. In our model the only strategic player is the informed trader. Given the informed player's strategy, the strategies of the other players are determined by the fact that they act competitively. We can therefore characterize the equilibria of the game in terms of the informed trader's strategy alone. Prior to determining the informed trader's optimal strategies, the market maker's pricing rule must be determined. In a competitive market, the market maker clears the market at prices that leave him indifferent between trading and not trading the observed order flow given the information conveyed by the order flow and the effect of trading on his inventory.[10] Hence he will choose P_Q such that

$$E_t\left[U(\tilde{W}^t)|Q\right] = E_t\left[U(\tilde{W}^{nt})|Q\right]. \tag{1}$$

where $U(\cdot)$ represents his utility function, $\tilde{W}$ his terminal wealth, and the superscripts (t, nt) indicate whether or not he absorbed the net order flow. Under risk neutrality, equation (1) simplies to:

$$P_Q = E\left[\tilde{V}|Q\right]. \tag{2}$$

As a base case against which the effects of a forthcoming SO can be considered, the secondary market equilibrium trading strategy of the informed trader in the absence of a SO is characterized. With no impending SO, there is a single round of trading before the informed trader's private information becomes public. The equilibrium is characterized in the following

[9] See Kreps and Wilson (1982).

[10] See for example Stoll (1978) and Biais and Hillion (1990).

lemma. To rule out ties, we assume throughout that a trader will always trade when indifferent between trading and not trading in the secondary market.

LEMMA 1: *In the absence of a SO, the informed trader's unique equilibrium strategy is to trade* $Q_I^{-*} = -1$ *if his information is negative and* $Q_I^{+*} = +1$ *if his information is positive. The equilibrium prices are then* $P_{Q>1} = V^+$, $P_0 = \bar{V}$ *and* $P_{-2} = P_{-1} = V^-$.

III. Prices in the Seasoned Equity Offering

To solve for the equilibrium in the presence of a SO, we use backward induction and start with the analysis of the SO. The issuer sets the offer price at time t_2, after the close of the secondary market. His objective is to maximize the issue proceeds while ensuring full subscription of the offering. Since informed bidders refrain from bidding when their information is negative, success of the offering requires the participation of the uniformed investors. For the same reason, uninformed bidders are subject to a winner's curse problem when subscribing to the offering. Hence, to maximize the issue proceeds while ensuring its success, the issuer will set the subscription price P_Q^* such that, given the observed secondary market net order flow, uninformed bidders' expected payoffs from bidding are zero,

$$E\left[\tilde{\alpha}_U\left(\tilde{V} - P_Q^*\right)|Q\right] = 0. \tag{3}$$

The uniformed bidder's expected payoff from subscribing is a function of two random variables: the proportion of the issue allocated to him and the terminal value of the security issued. The following proposition obtains:

PROPOSITION 1: *The issue price ensuring success of the seasoned public offering is determined as*

$$P_Q^* = E\left[\tilde{V}|Q\right] + \frac{\mathrm{Cov}\left[\tilde{\alpha}_U, \tilde{V}|Q\right]}{E[\tilde{\alpha}_U|Q]}. \tag{4}$$

The following corollary follows immediately:

COROLLARY 1: *The SO issue price* P_Q^* *is always lower or equal to the expected terminal value of the security conditional on all public information.*

$$P_Q^* \leq E\left[\tilde{V}|Q\right]. \tag{5}$$

It follows that if the market makers are risk neutral, the SO issue price is set at a discount from the preceding secondary market price. The magnitude of the discount is determined by the severity of the winner's curse problem faced by uninformed bidders. This is similar to the result derived by Rock (1986) in the case of initial public offerings and Parsons and Raviv (1985) for seasoned offerings. In contrast to those models, in our model, a strategic trader can affect the issue discount through the impact of his trades on the net order flow. As trading becomes more informative, the offer price discount decreases. Hence, the precision of the publicly available information is endogenously determined by the trading strategy of the informed traders in the secondary market.

IV. Secondary Market Clearing in the Presence of a SO

We now turn to a discussion of the set of equilibria that would exist under the assumption that the informed trader secondary market sales are restricted to -1 prior to the SO. This restriction eases the exposition since it limits the number of possible equilibria and allows us to fully characterize all the equilibria. There is little lost in terms of economic intuition, however, and we show later that even with no sales restrictions, the pure strategy equilibria that can exist are very similar to those that exist in the more restrictive setting.

If -1 is the largest feasible sell order, the informed investor will always submit an order $Q_I^{-*} = -1$ if his information is negative. Therefore, the number of possible pure strategy equilibria is determined by the equilibrium moves available to the informed investor if his information is positive. Three pure strategy equilibria are possible, each corresponding to one of the three possible orders $Q_I^{+*} = -1$, $Q_I^{+*} = 0$, and $Q_I^{+*} = +1$ that the informed trader could submit if his information was positive.[11] The equilibria will be referred to as equilibria M, PM, and NM, respectively. Mixed strategy equilibria arising from mixing these moves are also possible. Before getting into the details of the equilibria, the results are briefly summarized below.

The M equilibrium is the pure manipulation equilibrium. In this equilibrium, the informed trader always sells in the secondary market, even if his information is positive. The informed trader is willing to sell in the secondary market when his signal is positive to ensure a lower issue price and a larger gain on his share of the SO. This strategy is profitable as long as the secondary market trading loss is smaller than the additional gain from a lower issue price. This occurs when the informed trader's secondary market order size necessary to conceal completely his information is small compared to the number of shares he expects to be allocated in the SO.

The PM equilibrium is a partially manipulative equilibrium in which the informed bidder refrains from trading in the secondary market when his information is positive. By not trading, the informed trader delays the release of his positive information and reduces the informativeness of secondary market prices, thereby securing a lower issue price for the SO. This equilibrium requires that the additional gain from a lower expected issue price

[11] No equilibrium exists with $Q_I^{+*} > 1$ since then the secondary market net order flow is perfectly revealing.

outweigh the opportunity cost of not buying in the secondary market. Second, it requires also that the expected additional benefit of completely concealing the information be insufficient to cover the cost incurred by selling.

The NM equilibrium is the nonmanipulative equilibrium. The informed trader buys in the secondary market when his information is positive and sells when his information is negative. In this case secondary market prices are the most informative, although not perfectly revealing, and the expected issue discount is the smallest. The NM equilibrium arises only when the informed bidder's expected allocation in the seasoned offering is so small that the opportunity cost of refraining from buying in the secondary market is greater than the gain from a lower expected issue price.

We show below that all three possible pure strategy equilibria can exist, and derive the ranges of parameter values under which each one will exist. The discussion shows that the prevalence of manipulation depends critically on the relative sizes of the new equity issue and of the secondary market order flow. The larger the new issue and the smaller the secondary market order flow, the cheaper and the more prevalent is manipulation. To ease the exposition, we restrict the range of one of the model's parameters in the following fashion:

ASSUMPTION A: *Assume γ, the liquidity trades distributional parameter, is less than or equal to* $1/3$.

This assumption is quite natural to the discussion. $\gamma \leq \frac{1}{3}$ requires that the distribution of the liquidity traders aggregate order flow does not put more probability mass in the tails than the uniform distribution.

A. The M Equilibrium

In the M equilibrium, the informed trader submits orders $Q_I^{+*} = Q_I^{-*} = -1$ in the secondary market, irrespective of his private information. The net order flow observed by market participants and cleared by the market maker is thus $Q \in \{-2, -1, 0\}$. Since the secondary market order of the informed trader is independent of his information, the net order flow is uninformative and the uninformed participants' beliefs about the terminal value of the asset remain unchanged. Using equation (2) to compute the market clearing prices and equation (4) to compute the SO offer price yields:

$$P_0 = P_{-1} = P_{-2} = \overline{V}, \tag{6}$$

$$P_0^* = P_{-1}^* = P_{-2}^* = \frac{V^+ + \beta V^-}{1+\beta} = V^- + \frac{\Delta V}{1+\beta}, \tag{7}$$

Given the equilibrium prices, the informed trader's expected gains π from following the equilibrium strategies, conditional on the observed signal, can be computed as follow:

$$\pi[Q_I^{+*} = -1|\text{Eq.M}, V^+] = -\left(V^+ - E\left[P_Q|Q_I^{+*}, \text{Eq.M}\right]\right) + \alpha_I\left(V^+ - E\left[P_Q^*|Q_I^{+*}, \text{Eq.M}\right]\right), \tag{8}$$

$$\pi[Q_I^{-*} = -1|\text{Eq.M}, V^-] = -\left(V^- - E\left[P_Q|Q_I^{-*}, \text{Eq.M}\right]\right). \tag{9}$$

The first term of the RHS of equation (8) is the cost associated with submitting an order $Q_I^{+*} = -1$ in the secondary market, given positive information. The second term represents the expected profits in the SO. Given negative information, the informed trader will not bid in the SO and benefits only from his secondary market trades.

The informed trader, upon observing a positive signal, will be willing to trade $Q_I^{+*} = -1$ and take a loss in the secondary market only if his expected gains in the SO at least offset his secondary market trading losses. This equilibrium exists only if the expected gain from following the equilibrium strategy is greater than or equal to the expected profit from following the out of equilibrium strategies of either abstaining from trading or submitting a buy order in the secondary market. We state the conditions under which equilibrium M exists in the following proposition.

PROPOSITION 2: *Equilibrium M exists if and only if the following two conditions are satisfied*

$$\alpha_I \geq \frac{1}{2\gamma} \times \frac{1+\beta}{\beta}, \tag{Ia}$$

$$\alpha_I \geq \frac{1+\gamma}{2(1-\gamma)} \times \frac{1+\beta}{\beta}. \tag{Ib}$$

COROLLARY 2: *Under Assumption A, equilibrium M exists if and only if condition (Ia) is satisfied.*

Condition (Ia) is always satisfied if $\gamma\alpha_I \geq 1$, since $\beta \geq 1$ in all cases. The larger α_I is, the larger the informed trader's expected share and profit from the SO. For large α_I, the informed trader is more willing to bear the cost of selling at a loss in the secondary market in order to obtain a better price in the SO. As γ increases, detection of deviations from equilibrium trade of -1 become more likely, and defection becomes more costly and less desirable.

B. The PM Equilibrium

In this equilibrium, the optimal strategy of the informed trader is to abstain from trading in the secondary market ($Q_I^{+*} = 0$) if the information is V^+ and to submit an order $Q_I^{-*} = -1$ if the information is V^-. Hence, the observed secondary market net order flow is $Q \in \{+1, 0, -1, -2\}$. The market clearing prices and the SO issue prices conditional on the net order flow are given below:

Q	P_Q	P_Q^*
$+1$	V^+	V^+
0	$V^- + \Delta V \frac{1-2\gamma}{1-\gamma}$	$V^- + \Delta V \frac{(1-2\gamma)}{(1-2\gamma)+\beta\gamma}$
-1	$V^- + \Delta V \frac{\gamma}{1-\gamma}$	$V^- + \Delta V \frac{\gamma}{(1-2\gamma)\beta+\gamma}$
-2	V^-	V^-

The secondary market clearing price schedules and SO issue prices are monotonic in order flow only if $\gamma < 1/3$. Hence assumption A in effect rules out nonmonotonic price schedules. Proposition 3 provides the necessary conditions which determines the range of parameter values for which equilibrium PM obtains.

PROPOSITION 3: *Equilibrium PM exists if and only if the following two conditions are satisfied*:

$$\alpha_I \leq \left[1 - \frac{2\gamma(1-2\gamma)}{1-\gamma}\right] \Big/ \left[\gamma + (1-3\gamma)\left[\frac{(1-2\gamma)}{(1-2\gamma)+\beta\gamma} - \frac{\gamma}{\gamma+\beta(1-2\gamma)}\right]\right], \tag{IIa}$$

$$\alpha_I \geq \frac{\gamma^2}{1-\gamma} \Big/ \left[(1-2\gamma) - \frac{(1-3\gamma)(1-2\gamma)}{(1-2\gamma)+\beta\gamma} - \frac{\gamma^2}{\gamma+\beta(1-2\gamma)}\right]. \tag{IIb}$$

Under Assumption A, it can be shown that, if $\alpha_I \geq 1$, condition (IIa) is sufficient for the existence of the PM equilibrium.

C. The NM Equilibrium

In this equilibrium the trading strategy of the informed player is to trade $Q_I^{+*} = +1$ if the information is V^+ and $Q_I^{-*} = -1$ if the information is V^-. These are exactly the trades that would be submitted by the informed trader in the absence of a SO. The observed secondary market net order flow is then $Q \in \{+2, +1, 0, -1, -2\}$. The market clearing prices and the SO issue prices conditional on the net order flow are given below.

Q	P_Q	P_Q^*
$+2, +1$	V^+	V^+
0	$\bar{V}$	$V^- + \Delta V \frac{1}{1+\beta}$
$-1, -2$	V^-	V^-

In this equilibrium, the informed trader's secondary market trading reveals his information to the market with probability $(1 - \gamma)$, irrespective of whether the information is V^+ or V^-. The NM equilibrium exists only if the expected gains from bidding in the SO are small compared to the opportunity cost of refraining from trading on one's information in the secondary market. The following proposition formalizes the conditions under which equilibrium NM obtains.

PROPOSITION 4: *Equilibrium NM exists if and only if*

$$\alpha_I \leq \frac{\gamma(1 + \beta)}{2[\beta(1 - 2\gamma) + \gamma]}, \tag{IIIa}$$

$$\alpha_I \leq \frac{1}{(1 - \gamma)}. \tag{IIIb}$$

Under Assumption A, condition (IIIb) is always satisfied when condition (IIIa) is satisfied. It can also be verified that when the informed investor's expected SO allocation is greater than the secondary market trade size, this equilibrium never exists. These two properties are summarized in the following corollary:

COROLLARY 3: *Under assumption A,*

- *condition (IIIa) $\Rightarrow$ condition (IIIb),*
- *equilibrium NM does not exist if $\alpha_I > 0.5$.*

D. Mixed Strategy Equilibria

Unfortunately a pure strategy equilibrium does not always exist.[12] When no pure strategy equilibrium exists, one of two types of mixed equilibria will exists under Assumption A. The first type of mixed equilibrium, equilibrium MX1, exists when conditions (Ia) and (IIa) are violated.[13] Since condition (Ia) is violated, the informed investor's expected SO allocation α_I is too low to provide him with sufficient incentive to always trade -1 in the secondary market when his information is positive. However, since condition (IIa) is also violated, α_I is too large for a trader with positive information to find it optimal to always trade 0. Therefore, in equilibrium MX1, the informed trader with positive information mixes between trading $Q_I^{+*} = -1$ and $Q_I^{+*} = 0$ in the secondary market. It is worth noting how the existence of equilibrium MX1 relates to the value of parameter γ. For larger values of γ, condition (Ia) is more likely to hold and equilibrium MX1 is less likely to exist. The reason is that, for a larger γ, the positive nature of the informed trader's information is more likely to be revealed if he trades 0.

[12] For example, consider the set of parameter values $\gamma = \frac{1}{3}$, $\beta = 2$, $\alpha_I = 2.1$, for which conditions (Ia), (IIa), (IIIa) are violated while (IIb) is satisfied.

[13] Under A, at least one of the two conditions (IIa) or (IIb) must be satisfied. Hence violation of (IIa) implies that condition (IIb) is satisfied. Further if (IIa) does not hold, neither does (IIIa).

The second type of mixed equilibrium, equilibrium MX2, exists when conditions (IIb) and (IIIa) are violated.[14] Since condition (IIb) is violated, a positively informed investor's expected SO allocation α_I is too small to provide him with sufficient incentive to always trade 0 in the secondary market prior to the SO. However, since condition (IIIa) is also violated, α_I is too large for the trader with positive information to find it optimal to always trade +1. In this case, given a positive signal, the informed trader mixes between trading $Q_I^{+*} = 0$ and $Q_I^{+*} = +1$ in the secondary market.

PROPOSITION 5:

Mixed equilibrium MX1: *If conditions (Ia), (IIa), and (IIIa) are violated while condition (IIb) is satisfied, then under A, a mixed equilibrium exists in which, given a positive signal, the informed trader mixes between trades* $Q_I^{+*} = -1$ *and* $Q_I^{+*} = 0$ *with probability* ϕ.

Mixed equilibrium MX2: *If conditions (Ia), (IIb), and (IIIa) are violated while condition (IIa) is satisfied, then under A, a mixed equilibrium exists in which, given a positive signal, the informed trader mixes between trades* $Q_I^{+*} = 0$ *and* $Q_I^{+*} = +1$ *with probability* φ.

The determination of the mixing probabilities and of the secondary market clearing prices and SO issue prices are left to the Appendix.

E. Equilibrium Characteristics and Welfare Considerations

To illustrate the existence conditions, the ranges of values of parameters α_I and γ for which each equilibrium exists are graphed in Figure 2, keeping $1/\beta$, the proportion of the new issue allocated to uniformed bidders in the good state, fixed at 75%. As expected, the NM equilibrium exists only for very small values of α_I, the informed bidder's expected allocation in the seasoned offering. Manipulation equilibria of type M and MX1 exist for large α_I and γ while the PM equilibrium exists for lower values of α_I. As α_I increases, the incentive to conceal positive information and to engage in manipulative trades increases. High values of γ make detection of out of equilibrium strategies more likely in the M equilibrium. The plot also indicates that for some ranges of parameter values multiple equilibria are possible.[15]

To investigate the secondary market characteristics and the welfare of market participants, we compute the average secondary market net order flow, the issue discount, and the uninformed traders' costs of trading in the secondary market for the different equilibria. The expected secondary market net order flows under the pure strategy equilibria are,

$$E[\mathrm{NOF}|\mathrm{Eq.M}] = -1 < E[\mathrm{NOF}|\mathrm{Eq.PM}] = -1/2 < E[\mathrm{NOF}|\mathrm{Eq.NM}] = 0.$$

[14] Under A, violation of condition (IIb) implies that condition (IIa) is satisfied and condition (Ia) is violated.

[15] Specifically, for some parameter values, both equilibrium PM and NM are shown to simultaneously exist.

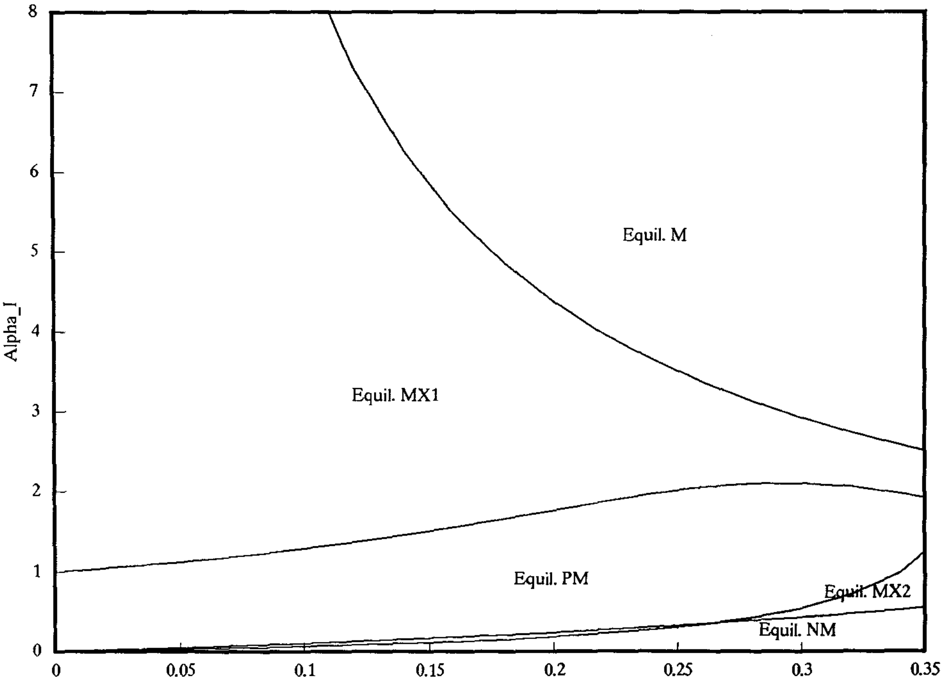

Figure 2. Existence conditions for the seasoned equity offering (SO) equilibria. This figure plots the regions of the parameter space (α_I, γ) for which the various equilibria in the SO game exist. The three pure strategy equilibria are denoted by M, PM, and NM and are, respectively, the manipulation, partial manipulation, and nonmanipulation equilibria. The two mixed equilibria are denoted by MX1 and MX2. α_I denotes the number of new shares allocated to the informed bidder when he participates in the SO. γ denotes the probability of observing an aggregate liquidity buy or sell order flow. The proportion of the offering allocated to uninformed bidders when both informed and uninformed bidders participate in the offering, $1/\beta$, is kept fixed at 0.75.

Not surprisingly, the more manipulative the equilibrium, the higher the net expected volume of secondary market selling.

Expected equilibrium SO issue discounts are computed from the price schedules derived for equilibria M, PM, and NM. The discount is defined as the expected difference between the secondary market price and the issue price, $E[P_Q - P_Q^* | \text{Eq.J}]$, where J is either M, PM, or NM.[16] Note that for the issuer, the cost of manipulation per new share issued is equal to the difference between the per share discount in the NM equilibrium, in which there is no manipulation, and the per share discount in equilibria M and PM in which manipulation occurs. The expected discounts per new share issued for each of

[16] The expected discounts for equilibria MX1 and MX2 are convex combinations of $\text{Disc}_{\text{Eq.M}}$ and $\text{Disc}_{\text{Eq.PM}}$ and of $\text{Disc}_{\text{Eq.PM}}$ and $\text{Disc}_{\text{Eq.NM}}$ respectively.

the pure strategy equilibria are

$$\text{Disc}_{\text{Eq.M}} = \Delta V \times \left[\frac{1}{2} - \frac{1}{1+\beta}\right], \tag{10}$$

$$\text{Disc}_{\text{Eq.PM}} = \frac{\Delta V}{2}[\gamma(1-2\gamma)(\beta-1)] \times \left[\frac{1}{\gamma\beta + (1-2\gamma)} + \frac{1}{\gamma + (1-2\gamma)\beta}\right], \tag{11}$$

$$\text{Disc}_{\text{Eq.NM}} = \Delta V \times \gamma\left[\frac{1}{2} - \frac{1}{1+\beta}\right]. \tag{12}$$

It is easy to verify that $\text{Disc}_{\text{Eq.M}} \geq \text{Disc}_{\text{Eq.PM}} \geq \text{Disc}_{\text{Eq.NM}}$, i.e., that the discounts decrease as the informativeness of the secondary market price increases. Further, the discounts are strictly increasing in β. Intuitively, as β increases, the share of the issue allocated to the uninformed bidders decreases and the winner's curse problem worsens.

The relationship between issue discounts and γ reflects how, in each equilibrium, changes in γ affect the informativeness of the secondary market net order flow. In the M equilibrium, since the secondary market net order flow is always uninformative, the issue discount is unaffected by changes in γ. In the NM equilibrium, the issue discount is strictly increasing in γ, since in this equilibrium, γ is the probability of observing an uninformative secondary market net order flow. In the PM equilibrium, the issue discount is nonmonotonic in γ and achieves an interior maximum for $0 \leq \gamma \leq 1/2$. Changes in γ have two offsetting effects. First, increases in γ correspond to increases in liquidity trading which provide better cover for the informed trader's trades. Second, as γ increases, fully revealing order flows become more frequent, mitigating the first effect on the winner's curse problem. For small values of γ, the first effect dominates. For large γ, the second effect dominates and the discount decreases. This is illustrated in Figure 3 which plots, for each of the three pure strategy equilibria, the magnitude of the SO issue discount in terms of ΔV for varying values γ when $1/\beta$ is fixed at 0.75.

For nondiscretionary liquidity traders, the costs of trading in the secondary market is also affected by manipulation. Let C_L denote the aggregate expected cost of secondary market trading of the uninformed liquidity traders. We have:

$$E[C_L|\text{Eq.M}] = 0, \quad E[C_L|\text{Eq.PM}] = \Delta V\frac{\gamma(1-2\gamma)}{1-\gamma}, \quad E[C_L|\text{Eq.NM}] = \Delta V\frac{\gamma}{2}.$$

Under Assumption A, $\gamma < 1/3$ and $E[C_L|\text{Eq.PM}] > E[C_L[\text{Eq.NM}]$. Hence liquidity traders prefer the M equilibrium to equilibria PM and NM and prefer the NM equilibrium to the PM equilibrium. Manipulation is thus not

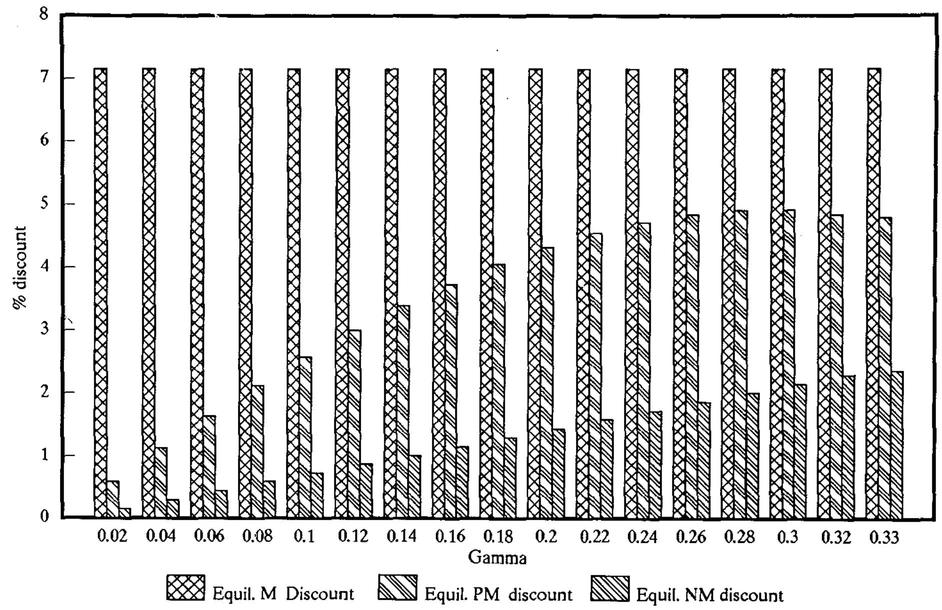

Figure 3. The seasoned equity offering (SO) equilibria issue discounts. The figure plots the issue discount as a function of γ for the three pure strategy equilibria. Equilibria M, PM, and NM are, respectively, the manipulation, partial manipulation, and nonmanipulation equilibria. γ is the probability of observing an aggregate liquidity buy or sell order flow. The discount is computed as a percentage of ΔV, the difference between the high and low values of the asset. The proportion of the offering allocated to uninformed bidders when both informed and uninformed bidders participate in the offering, $1/\beta$, is kept fixed at 0.75. The figure illustrates that the issue discount is unaffected by γ in the M equilibrium, while it is increasing in γ in the NM equilibrium. The issue discount is, however, nonmonotonic in γ in the PM equilibrium.

necessarily detrimental to nondiscretionary liquidity traders. Intuitively, the lower the informativeness of net order flow, the less severe the adverse selection problem faced by the market maker in the secondary market, and the lower the cost to liquidity traders.

V. Robustness of the Equilibria

A. Equilibrium With No Restriction on Short Selling

In this section we show that manipulation equilibria in pure strategies can exist in the absence of selling restrictions, when trades are restricted to integer quantities and the rest of the model is unchanged. Manipulation can occur only if the second market trading prior to the SO does not perfectly reveal the informed trader's information. If $Q_I^{+*} - Q_I^{-*} \geq 3$, the secondary market net order flow is perfectly revealing and manipulation cannot take place. Hence manipulation can occur only when $Q_I^{+*} - Q_I^{-*} \leq 2$. Therefore, we restrict our attention to the cases in which $Q_I^{+*} = Q_I^{-*}$, $Q_I^{+*} = Q_I^{-*} + 1$, and $Q_I^{+*} = Q_I^{-*} + 2$. In line with the earlier discussion, we refer to these three possible types of equilibria as types M, PM, and NM, respectively.[17]

We are able to show that each of the three equilibria can exist under certain parameter ranges. We are most interested in the M equilibrium under which, irrespective of the nature of his information, the informed trader submits the same market orders $Q_I^{+*} = Q_I^{-*}$. In this equilibrium, the secondary market net order flow is completely uninformative and can take the values $Q \in \{Q_I^{+*} - 1, Q_I^{+*}, Q_I^{+*} + 1\}$. The market clearing prices are then $P_{(Q_I^{+*}-1)} = P_{Q_I^{+*}} = P_{(Q_I^{+*}+1)} = \bar{V}$ and the SO issue prices are then $P^*_{(Q_I^{+*}-1)} = P^*_{Q_I^{+*}} = P^*_{(Q_I^{+*}+1)} = V^- + \Delta V/(1+\beta)$. The following proposition obtains:

PROPOSITION 6: *When trades are restricted to integer quantities, an M equilibrium with $Q_I^{+*} = Q_I^{-*} = -X$ exists for an integer $X \geq 1$ if X satisfies:*

$$\mathrm{Min}\left[\left(1 + \frac{1}{\gamma}\right), \frac{2(2-\gamma)}{1-\gamma}\right] \geq X \geq \frac{1}{\gamma} - 1, \tag{GIa}$$

and if the following condition is satisfied:

$$\mathrm{Min}\left[\left(\frac{1+\beta}{\gamma}\right), \left(\frac{1+\beta}{\gamma}\right)\left(\frac{2\gamma - \gamma^2 + 1}{2(1-\gamma)}\right)\right] \geq \alpha_I \geq \frac{1+\beta}{\gamma\beta}. \tag{GIb}$$

Conditions (GIa) and (GIb) in Proposition 6 are sufficient to guarantee that the informed trader has no incentive to deviate from the equilibrium strategy, irrespective of the nature of his information. From condition (GIa), it is easy to show that under Assumption A, an M equilibrium exists only for X = 2, X = 3, and X = 4. X = 2 is a corner solution and exists only for $\gamma = 1/3$. Existence of the M equilibrium with X = 3 requires that $1/3 > \gamma > 0.25$. For X = 4, condition (GIa) requires that $1/3 > \gamma > 0.2$. Further, there always exists values of α_I and $\beta > 1$ satisfying condition (GIb) for each γ value for which condition (GIa) is satisfied.

Sufficient conditions for the existence of equilibria of types PM and NM were also determined, though for brevity they are not reported here. A NM equilibrium can exist only for $Q_I^{+*} = 1$, $Q_I^{-*} = -1$ and will not exist for $\alpha_I > 0.5$. Hence, so long as the informed trader expects to be allocated a quantity $\alpha_I > 0.5$ in the offering, his equilibrium trading strategy conceals his information to a greater extent than his trading strategy in the absence of a SO.

The discussion above is limited to the case in which trades are restricted to integer quantities. A more general formulation would allow liquidity and informed secondary market trades to be any multiple of some small discrete trade size. In the Appendix we provide an example to show that an M-type

[17] Note that an equilibrium with $Q_I^{+*} < Q_I^{-*}$ cannot occur. In such an equilibrium the secondary market price would be decreasing in the net order flow. Hence a trader with negative information would always be better off by deviating from the equilibrium and selling more than Q_I^{-*}. Similarly, a positively informed trader would be better off selling less than the equilibrium quantity.

equilibrium can exist under a specification in which the minimum discrete trade size can be made arbitrarily small.

B. Equilibrium With More Than One Informed Trader

We now consider the case in which the number μ of informed traders can be greater than 1. We limit our analysis to the case where all informed traders are restricted to trade $Q_I^* \geq -1$ and follow symmetric strategies.[18] We show below that increasing the number of informed traders can have ambiguous effects on the issue discount. An increase in the number of informed traders could cause secondary market trading to become more informative, thereby alleviating the winner's curse problem. On the other hand, more informed bidding in the SO may result in a decrease in the share of the offering allocated to uninformed bidders when the information is positive, thereby exacerbating the winner's curse problem.

As above, let N_I be the number of shares that each informed trader can bid for in the offering. The quantity of shares that each informed trader expects to be allocated in the offering is then $\alpha_I = qN_I/(\mu N_I + N_U)$. Further, $\beta = (\mu N_I + N_U)/N_U$. The M equilibrium is now characterized by each informed trader trading -1 in the secondary market, irrespective of his information. The secondary market net order flow is then $Q \in \{-\mu - 1, -\mu, -\mu + 1\}$. Since the net order flow is uninformative, the market clearing prices will be $P_{(-\mu-1)} = P_{-\mu} = P_{(-\mu+1)} = \overline{V}$. The offer prices are then $P^*_{(-\mu-1)} = P^*_{-\mu} = P^*_{(-\mu+1)} = V^- + \Delta V/(1+\beta)$. The necessary conditions for this equilibrium are identical to conditions (Ia), (Ib) for the case with a single informed trader. However, as the number of informed traders μ increases, $\alpha_I\beta/(1+\beta)$ decreases, and the existence conditions of such an equilibrium are less likely to be satisfied. This is intuitively straightforward. The costs to a positively informed trader of maintaining the equilibrium by selling in the secondary market remains constant as μ increases, while the benefits from bidding in the SO decline since α_I declines.

The presence of more than one informed trader rules out the possibility of an NM equilibrium. The reason is that if each informed trader traded $Q_I^{+*} = +1$ on observing V^+ and traded $Q_I^{-*} = -1$, when the signal was V^-, the secondary market net order flow would be perfectly revealing. Similarly, a PM equilibrium with $Q_I^{+*} = 0$ and $Q_I^{-*} = -1$ would exist only for $\mu \leq 2$. Overall the presence of multiple informed traders makes it more likely that mixed equilibria of types MX1 and MX2 would exist rather than any of the pure strategy-type equilibria.

[18] We believe that the effect of increasing μ is similar when selling is unrestricted. In an M equilibrium increasing μ makes it less likely that the lower bound on α_I from the condition in Proposition 6 would be satisfied, though the upper bound is easier to satisfy. For a PM equilibrium, the impact of a larger number of informed traders could make the secondary market trading more informative, offsetting the increase in the costs to the issuer on account of a larger volume of informed bidding.

The effects of an increase in the number of informed traders on the extent of manipulation and costs to the issuer are in general ambiguous. To illustrate this, compare the expected issuing costs between the situations in which $\mu = 1$ and $\mu = 2$. If the equilibrium is of type M, the expected discount cost to the issuer per share from equation (10) is given by $\Delta V \times [1/2 - 1/(1 + \beta)]$. For $\mu = 2$, however, the value of β is higher and the cost to the issuer increases compared to the situation with $\mu = 1$. The increase in volume of informed bidding in the SO worsens the winner's curse problem faced by uninformed traders. Though an M equilibrium is less likely, if it does exist, then the issue costs increase as μ increases.

Increasing the number of informed traders has, however, the opposite effect under a PM equilibrium. Under this equilibrium, if $\mu = 1$, the expected issue cost per share is given from equation (11) as:

$$\frac{\Delta V}{2}[\gamma(1 - 2\gamma)(\beta - 1)] \times \left[\frac{1}{\gamma\beta + (1 - 2\gamma)} + \frac{1}{\gamma + (1 - 2\gamma)\beta}\right]. \quad (13)$$

For $\mu = 2$, however, the secondary market net order flow is much more informative. The net order flow in the secondary market will be $Q \in \{+1, 0, -1, -2, -3\}$ and will be fully revealing except for $Q = -1$, which occurs with probability γ and in which case $P_{-1} = \bar{V}$ and $P^*_{-1} = V^- + \Delta V/(1 + \beta)$. It is easily verified that the expected issue costs per share for this equilibrium will be lower than when $\mu = 1$. In this case an increase in the number of informed tends to make the secondary market trading more informative, thereby reducing the cost to the issuer. Hence, it appears that an increase in informed traders can improve as well as worsen the extent of manipulative trading and the costs issuers face.

VI. Temporary and Permanent Price Components

Assuming risk-averse market makers has been a standard feature of inventory-type models of market microstructure (see e.g., Stoll (1978)). It has been used, for example, to explain cross-sectional variations in bid-ask spreads. Attempts have been made to empirically decompose price movements into permanent and temporary components. The temporary components are presumably due to inventory-type effects (see e.g., Glosten and Harris (1988)). We show below that when the market maker is risk averse, the relative magnitudes of the temporary and permanent components of secondary market price changes are different prior to a SO than otherwise.

Let ω denote the number of shares of the traded security that the market maker is initially endowed with. The value of the market maker's initial inventory is $\omega\tilde{V}$. Let W_0 denote his terminal wealth. If the market maker does not trade, his terminal wealth is

$$\tilde{W} = W_0 + \omega\tilde{V}.$$

If the marker maker absorbs a net order flow of Q his terminal wealth is

$$\tilde{W} = W_0 + (\omega - Q)\tilde{V} + QP_Q.$$

The market maker's utility function denoted $U(\cdot)$ is assumed to be negative exponential with risk aversion parameter κ, $U(W) = -e^{-\kappa W}$, $\forall W \in \mathbb{R}$. The market maker sets his price schedule so that his expected utility is left unchanged by the trade.

As before, trading affects both secondary market prices and SO prices through the information conveyed by the net order flow. Trades also affect secondary market prices through their effect on the market maker's inventory.[19] The derivation of the price schedule set by a risk-averse market maker under these assumptions is laid out in the Appendix.

We now consider the effect of risk aversion on the secondary market prices in the context of the manipulation equilibrium, i.e., equilibrium M. In this equilibrium, the conditional probabilities of the terminal state remain unchanged upon observing any value $Q \in \{0, -1, -2\}$ of the net order flow. Therefore, taking $\omega = 0$ for notational ease, the market clearing price P_Q is set such that:

$$e^{\kappa Q P_Q} = \tfrac{1}{2}e^{\kappa Q V^-} + \tfrac{1}{2}e^{\kappa Q V^+}.$$

Hence the market clearing prices will be given by[20]

$$\begin{aligned} P_0 &= \bar{V}, \\ P_{-1} &= -\frac{1}{\kappa}\ln\frac{1}{2}\{e^{-\kappa V^-} + e^{-\kappa V^+}\}, \\ P_{-2} &= -\frac{1}{2\kappa}\ln\frac{1}{2}\{e^{-2\kappa V^-} + e^{-2\kappa V^+}\}. \end{aligned}$$

Here, irrespective of the trading volume, price adjustments are only due to inventory effects and are thus temporary. There is, therefore, no permanent price effect. By comparison, with no forthcoming SO, the prices are set as follows:

$$\begin{aligned} P_0 &= \bar{V}, \\ P_{+1} &= P_{+2} = V^+, \\ P_{-1} &= P_{-2} = V^-, \end{aligned}$$

and all price changes are permanent. The PM equilibrium yields mixed price effects, with both temporary and permanent components. This suggests that the ratio of temporary to permanent components of price changes would be higher prior to a SO than in the ordinary course of trading. Manipulation affects secondary market trading by reducing the informativeness of trades

[19] The SO price is unaffected by possible inventory effects. The issuer and the other traders see through the inventory effects and only take into account the information content of trades to set the SO price.

[20] P_0 is defined since 0 refers to the aggregate secondary market net order flow.

and increasing the volume of selling. Less informative trades reduce the permanent component of the price change per trade. Increased selling results in a buildup of the market maker's inventory, inducing temporary price drops.

VII. Policy Implications and Empirical Predictions

A. *On Curtailing Manipulative Trading—Policy Implications*

Exchanges and regulators have long manifested an interest in reducing the costs of selling equity and in preventing potentially harmful stock price manipulation. Rules such as NASD 10b–21 presumably raise the costs of manipulative trading by not allowing a manipulator to cover his short positions with stock acquired in the offering, thereby forcing him to bear the transactions costs associated with purchasing stock in the post-issue market. We now discuss the question of whether issuers benefit from regulations designed to increase the costs to manipulators. The broader issue of the social benefit of such regulations is more complex and we only note that such an analysis would have to take into account the fact that liquidity traders may not necessarily benefit from a reduction in the incidence of manipulation, as discussed in Section IV.

It might appear that one way to limit manipulative trading may be to ban short selling prior to an offering. Any such policy may, however, be counterproductive and may raise rather than lower issuing costs because not all short sales are detrimental to the issuer. In general short sales improve the informational efficiency of secondary market prices (see Diamond and Verrechia (1987)), reduce the information asymmetry, and therefore decrease the issue discount. A ban on short sales could be counterproductive since it not only curtails "manipulative" sales but also "informationally" motivated sales. NASD rule 10b–21 seems to have been sensitive to this since it only disallows short sales covered with shares purchased in a SO. The example below illustrates that a blanket ban on short sales does not necessarily benefit the issuer.

Example: Let $\alpha_I = 1$ and assume that the informed trader has a zero endowment in the asset. Hence, to submit a sell order he must be able to short. If the informed trader were able to short up to -1, it can be checked that the PM equilibrium will exist. In this case, the expected issue costs equal: $q \times \gamma \Delta V(\beta - 1)/(\beta + 1)$.

Under a ban on short sales, it can be verified that the informed trader equilibrium strategy is to not trade, irrespective of the signal he receives. Therefore, secondary market prices remain completely uninformative about the terminal value of the security. The price at which the secondary market clears is $\overline{V}$ and the SO issue price is set at $P^* = V^- + \Delta V/(1 + \beta)$. Therefore, under a ban on short sales, the expected issue cost is $q \times \Delta V(\beta - 1)/2(\beta + 1)$, which is higher than when short sales are allowed, since $\gamma < 1/2$. ■

Even milder rules such as 10b–21 that have the effect of increasing the costs to manipulators may be counterproductive and have the consequence of raising costs to issuers. We argued in Section V that an increase in the number of manipulators from 1 to 2 could be beneficial to issuers since the secondary market trading could become more informative as a result. Rules that make manipulative trading costlier could result in a reduction of the number of manipulators (particularly, if information collection were costly) and, thereby, make matters worse for issuers. In the example of section V, if the number of manipulators decreased from 2 to 1, the costs to issuers could increase rather then decrease. Hence, policies that increase the costs to manipulators are not necessarily desirable, even from the perspective of issuers.

B. Empirical Predictions

The model developed in this paper yields strong empirical predictions and is consistent with the reported empirical evidence. The main empirical predictions are:

1. There is likely to be a significant amount of overall selling just prior to the SO issue day.
2. On average, secondary market prices will drop in the days preceding the issue day, and prices will recover in the post issue market. The new shares are sold at a discount from the market's expectation of the stock value at the time of issue.[21]
3. The information content, as measured by the "liquidity parameter" or the price change per unit of trade would be smaller just prior to a SO.
4. The ratio of temporary (caused by inventory effects) to permanent components in the price movements in this period would be higher.
5. Manipulative practices are more likely and expected issue discount is higher the smaller the secondary market net order flow and the larger the new issue size.

Evidence by Smith (1977), Barclay and Litzenberger (1988), Lease *et al.* (1991), and Loderer *et al.* (1991) on pre- and post-issue-day excess returns is consistent with the predictions of the model. Smith documents in a sample of 328 seasoned offerings by NYSE and AMEX firms an average issue discount of 0.6% and an average issue day price recovery of 0.8%. Barclay and Litzenberger and Lease *et al.* document significant average negative excess returns in the two days prior to the issue date, as well as a significant issue discount and a partial post-issue-day price recovery. Further, by examining

[21] Given temporary price pressures, the issue price may not be lower than the secondary market price just prior to the offering, even if it is set at a discount from the market's expectation. From an empirical perspective, this suggests that the difference between the offer price and the preceding secondary market closing price may underestimate the issue discount. The market's expectation of the stock value could be estimated, on average, by the price (adjusted for expected returns) prevailing in the post-issue market after the temporary price pressures have subsided.

the bid and ask quotes around the offering, Lease *et al.* find evidence, consistent with prediction 1, that indicate selling pressures in the 10 days preceding the new issue (see their Table II, p. 1530). These trading patterns reverse after the offering.

Loderer *et al.* document very significant issue discounts and stock price recovery around SOs for NASDAQ firms but report insignificant issue discounts for equity offerings by NYSE firms.[22] They find, however, that 5 and 30 days post-issue cumulative excess returns are significantly positive in all markets, and substantially larger for NASDAQ than for AMEX and NYSE firms. These findings are consistent with, on average, higher levels of information asymmetry about the value of NASDAQ firms compared to AMEX and NYSE firms. Further, Loderer *et al.* report higher ratios of issue size to outstanding equity for the NASDAQ sample of SOs than for the AMEX or the NYSE samples. To the extent that this implies a larger ratio of issue size to secondary market trading volume, this evidence is also consistent with our prediction 5.

A factor that might affect our predictions 3 and 4 about the informational content of trading prior to seasoned offerings is the extent to which firms are able to time their equity offerings to be in periods with relatively lower informational asymmetry about firm value. Korajcyk, Lucas, and McDonald (1991) provide evidence that firms seem to prefer to announce new equity sales in the weeks just following the release of a quarterly earnings report rather than just before such an information release. Similarly, Choe, Masulis, and Nanda (1993) argue that the adverse selection problems associated with equity financing may be expected to vary with economic conditions. Their evidence indicates that firms are more likely to resort to equity financing following stock market rises and in periods of economic expansion and that the market reaction to equity financing is less adverse in such periods. Hence, a proper test of the predictions of our model should take such timing effects into account by comparing the informational content of trading in periods prior to seasoned offerings to periods that, for example, were similar with respect to firm information releases and general stock market conditions.

VIII. Conclusion

This paper examines the potential for manipulation arising from the interaction between secondary market trading prior to a seasoned equity

[22] However, these findings are not directly comparable with the other studies. Unlike the other papers, Loderer *et al.* do not report separately the issue discount for utilities and nonutilities even though utilities account for more than 40% of the new issues in their NYSE sample. Lease *et al.* and Baghat and Frost (1986) among others report that, in contrast to industrial offerings, utility offerings are on average sold above the pre-issue closing price and that utilities' stock do not experience negative pre-issue excess returns nor any post-issue price recovery. They note that overpricing of utility issues is consistent with the absence or very low level of information asymmetry around the offering and the savings in brokerage costs from a purchase in the offering rather than in the secondary market.

offering and the offer price-setting process. An informed trader might attempt to influence the offer price by selling heavily in the secondary market just prior to the offering, expecting to recoup his losses and make larger profits by bidding in the SO. We showed that it may be in the interest of an informed trader to trade contrary to his private information prior to a SO and that manipulation equilibria arise naturally in this setting.

Manipulation arises because of the difference between the price setting mechanisms in the secondary market and in the SO. Since the secondary market price is a function of the net order flow, an informed trader can affect secondary market prices by selling in the pre-issue market. In the offering however, shares can be acquired at a fixed issue price, independent of the quantity demanded in the SO. It is this fact that allows for the possibility of manipulation. Manipulation will occur when the informed investor expects to secure significantly more shares in the offering than the number of shares he needs to trade in the pre-issue secondary market to conceal his information.

The model highlights the dependence between the magnitude of the issue discount and the likelihood of manipulative trades. We showed that the magnitude of the issue discount required to float the SO successfully is directly related to the expected occurrence of manipulation. The model predicts a net increase in sell orders prior to the SO, leading to an increase in the inventories held by market makers and temporary price decreases. Further, since manipulative trades conceal information, the permanent component of the price change caused by a given sell order will be smaller than in the absence of a SO. Hence the ratio of temporary to permanent components of the price movements would be expected to increase prior to a SO. From a policy perspective, we show that a ban on short selling prior to seasoned offerings may raise the issue discount and may thus be costly to the issuer. Even milder regulations, such as NASD rule 10b–21, which raise the costs of manipulation, may have the unintended effect of raising the costs to issuers.

The existence of a post-issue secondary market could also affect the incidence of manipulation. Bikhchandani and Huang (1989) show that the bidding behavior of participants in a discriminatory auction is significantly affected by the existence of a post-auction resale market. Similarly the existence of a post-issue market for seasoned shares and the interrelation between pre- and post-secondary market and the offering market could significantly enhance the menu of manipulative strategies for opportunistic traders. For example, the potential for manipulation may be greater if manipulators could also trade profitably in the post-SO secondary market. Further, manipulators may bid less aggressively in the offering if they hoped to trade profitably in the post-issue market. These appear to be fruitful avenues for future research.

Appendix

Proof of Lemma 1:

(a) Existence: If the informed trader observes negative information, his equilibrium strategy yields a net order flow $Q \in \{-2, -1, 0\}$. A net order flow of $Q \geq 1$ would then reveal that the informed trader's information is positive. An order $Q_I^+ \geq 2$ from the informed trader would always result in a net order flow $Q \geq 1$ and be fully revealing. Since a trade $Q_I^+ = 1$ remains undetected with probability γ, it is optimal for the informed trader to trade $Q_I^{+*} = 1$ if his information is positive. A similar argument applies if the informed trader observes negative information. The secondary market prices follow immediately.

(b) Uniqueness: Consider any candidate equilibrium. The informed trader trades Q_I^+ if his information is positive and Q_I^- if the information is negative. Given that the terminal value of the security is either V^+ or V^-, the secondary market clearing price P_Q is such that $V^+ \geq P_Q \geq V^-$. Hence, $Q_I^+ < 0$ or $Q_I^- > 0$ cannot be optimal. Therefore, under the tie-breaking assumption, ruling out candidate equilibria with $Q^+ - Q^- \geq 3$ is sufficient for uniqueness. When $Q_I^+ - Q_I^- \geq 3$, the secondary market net order flow perfectly reveals the informed trader's information and he makes zero expected profits. It is easy to verify that there always exist deviations from any candidate equilibrium with $Q^+ - Q^- \geq 3$ which yield positive expected profits to the informed investor. This proves the uniqueness of the equilibrium $(Q_I^{+*} = 1, Q_I^{-*} = -1)$. □

Proof of Proposition 1: Equation (3) can be rewritten

$$E\left[\tilde{\alpha}_U \tilde{V}_T | Q\right] - E[\tilde{\alpha}_U | Q] \times P_Q^* = 0. \tag{14}$$

Substituting for $E[\tilde{\alpha}_U \bar{V}_T | Q] = Cov[\tilde{\alpha}_U, \tilde{V}_T | Q] + E[\tilde{\alpha}_U | Q] \times E[\tilde{V}_T | Q]$ in equation (14) yields

$$\mathrm{Cov}\left[\tilde{\alpha}_U, \tilde{V}_T | Q\right] + E[\tilde{\alpha}_U | Q] \times E\left[\tilde{V}_T | Q\right] = P_Q^* \times E[\tilde{\alpha}_U | Q]. \tag{15}$$

Solving for P_Q^* yields the desired result. □

Proof of Proposition 2: Existence of the equilibrium requires that the informed trader has no incentive to deviate from the equilibrium strategy, given his private information and the probability of detection of a deviation from equilibrium. Since a secondary market order $Q_I^{-*} = -1$ is always optimal given a negative signal, we need only consider the conditions under which, upon observing a positive signal, it is optimal for the informed trader to follow the equilibrium strategy when the other players expect him to do so. If the informed trader chooses to deviate from the equilibrium by trading $Q_I^+ = 0$ or $Q_I^+ = +1$, his deviant behavior is detected with respective probabilities γ and $(1 - \gamma)$, when the observed net order flow is $Q \geq 1$. When detected, deviant orders reveal the positive signal of the informed trader to the other players and both secondary market and offer prices are set to V^+. The payoffs, given positive information, from following the out of equilibrium strategies of trading $Q_I^+ = 0$ and $Q_I^+ = +1$ are, respectively,

$$\pi[Q_I^+ = 0 | \mathrm{Eq.M}, V^+] = \alpha_I\left(V^+ - E\left(P_Q^* | Q_I^+, \mathrm{Eq.M}\right)\right), \tag{16}$$

$$\pi[Q_I^+ = +1|\text{Eq.M}, V^+] = \left(V^+ - E\left(P_Q|Q_I^+, \text{Eq.M}\right)\right) + \alpha_I\left(V^+ - E\left(P_Q^*|Q_I^+, \text{Eq.M}\right)\right). \tag{17}$$

The conditional expected prices are computed as follow,

$$E\left(P_Q|Q_I^+, \text{Eq.M}\right) = \gamma P_{(Q_I^+ - 1)} + (1 - 2\gamma)P_{Q_I^+} + \gamma P_{(Q_I^+ + 1)}, \tag{18}$$

where the prices equal the equilibrium prices when out of equilibrium orders remain undetected, and the prices equal V^+ when a deviant strategy is detected. Using (18) and the equilibrium prices computed in Section IV.*A* (equations (6) and (7)), the expected payoffs, equations (8), (16) and (17) can be rewritten as follows,

$$\pi[Q_I^{+*} = -1|\text{Eq.M}, V^+] = -(V^+ - \overline{V}) + \alpha_I(V^+ - P^*), \tag{19}$$

$$\pi[Q_I^+ = 0|\text{Eq.M}, V^+] = \alpha_I(V^+ - P^*)[1 - \gamma], \tag{20}$$

$$\pi[Q_I^+ = +1|\text{Eq.M}, V^+] = \gamma(V^+ - \overline{V}) + \gamma\alpha_I(V^+ - P^*). \tag{21}$$

The informed trader will prefer the equilibrium strategy of trading -1 to the deviant strategies of trading 0 or $+1$ when the payoff of the equilibrium strategy is larger than the expected payoff from deviating:

$$-(V^+ - \overline{V}) + \alpha_I(V^+ - P^*) \geq \alpha_I(V^+ - P^*)[1 - \gamma], \tag{22}$$

$$-(V^+ - \overline{V}) + \alpha_I(V^+ - P^*) \geq \gamma(V^+ - \overline{V}) + \gamma\alpha_I(V^+ - P^*). \tag{23}$$

Substituting for the expected values and equilibrium prices $V^+ = V^- + \Delta V$, $\overline{V} = V^- + \Delta V/2$ and $P^* = V^- + \Delta V/(1 + \beta)$, and simplifying yields existence existence conditions (Ia) and (Ib):

$$\alpha_I \geq \frac{1}{2\gamma} \times \frac{1 + \beta}{\beta}, \tag{Ia}$$

$$\alpha_I \geq \frac{1 + \gamma}{2(1 - \gamma)} \times \frac{1 + \beta}{\beta}. \tag{Ib}$$

When $\gamma \leq \sqrt{2} - 1$ condition (Ia) implies (Ib). Hence, under *A*, (Ia) is a necessary and sufficient condition for the existence of equilibrium M. □

Proof of Propositions 3 and 4: The conditions for the existence of equilibria PM and NM can be derived in a manner similar to that of equilibrium M in proposition 2. □

Proof of Proposition 5 (*Prices, Mixing Probabilities, and Existence of Mixed Equilibria*):

(a) Mixed equilibrium MX1: Let ϕ be the probability with which a trade $Q_I^{+*} = -1$ is chosen by the informed trader; $1 - \phi$ is then the probability with which $Q_I^{+*} = 0$ is traded. The set of possible net trades therefore is $Q \in \{+1, 0, -1, -2\}$. The conditional expectation of the value of the asset on observing any of these trades, and hence the market clearing price and the

SO price are given as below:

Q	P_Q	P_Q^*
$+1$	V^+	V^+
0	$V^- + \Delta V\left[\dfrac{[\gamma\phi + (1-2\gamma)(1-\phi)]}{\gamma\phi + (1-2\gamma)(1-\phi) + \gamma}\right]$	$V^- + \Delta V\left[\dfrac{[\gamma\phi + (1-2\gamma)(1-\phi)]}{\gamma\phi + (1-2\gamma)(1-\phi) + \gamma\beta}\right]$
-1	$V^- + \Delta V\left[\dfrac{\phi(1-2\gamma) + (1-\phi)\gamma}{(1+\phi)(1-2\gamma) + (1-\phi)\gamma}\right]$	$V^- + \Delta V\left[\dfrac{\phi(1-2\gamma) + (1-\phi)\gamma}{(\beta+\phi)(1-2\gamma) + (1-\phi)\gamma}\right]$
-2	$V^- + \Delta V\dfrac{\phi}{(\phi+1)}$	$V^- \Delta V\dfrac{\phi}{(\phi+\beta)}$

ϕ must be such that in equilibrium the informed investor is indifferent between trading $Q_I^{+*} = -1$ or $Q_I^{+*} = 0$ if the information is V^+. The following equation determines ϕ:

$$-\left(V^+ - E\left[P_Q | Q_I^{+*} = -1, \mathrm{MX1}\right]\right) + \alpha_I\left(V^+ - E\left[P_Q^* | Q_I^{+*} = -1, \mathrm{MX1}\right]\right)$$
$$= \alpha_I\left(V^+ - E\left[P_Q^* | Q_I^{+*} = 0, \mathrm{MX1}\right]\right) \quad (24)$$

It can be verified that violation of condition (IIa) implies that $\alpha_I \geq 1$ and that trading $Q_I = +1$ is never optimal. To show existence of the mixed equilibrium, note that, since condition (IIa) is violated, if $\phi = 0$, then the LHS of equation (24) is greater than the RHS. Similarly, since condition (Ia) is violated, if $\phi = 1$, the RHS of equation (24) is greater than the LHS. Since both sides of (24) are continuous in ϕ, there exist some $0 < \phi < 1$ such that (24) holds.

(b) Mixed equilibrium MX2: Let φ be the probability with which a trade $Q_I^{+*} = 0$ is chosen by the informed trader; $1 - \varphi$ is then the probability with which he chooses $Q_I^{+*} = +1$. The set of possible net trades is $Q \in \{+2, +1, 0, -1, -2\}$. The market clearing price and the SO price are set as below:

Q	P_Q	P_Q^*
$+2, +1$	V^+	V^+
0	$V^- + \Delta V\left[\dfrac{(1-\varphi)\gamma + \varphi(1-2\gamma)}{(1-\varphi)\gamma + \varphi(1-2\gamma) + \gamma}\right]$	$V^- + \Delta V\left[\dfrac{(1-\varphi)\gamma + \varphi(1-2\gamma)}{(1-\varphi)\gamma + \varphi(1-2\gamma) + \gamma\beta}\right]$
-1	$V^- \Delta V\left[\dfrac{\varphi\gamma}{(1-2\gamma) + \varphi\gamma}\right]$	$V^- + \Delta V\left[\dfrac{\varphi\gamma}{(1-2\gamma)\beta + \varphi\gamma}\right]$
-2	V^-	V^-

φ must be such that the informed investor is indifferent between trading $Q_I^{+*} = 0$ or $Q_I^{+*} = +1$ if the information is V^+. φ is determined by the following equation:

$$\alpha_I\left(V^+ - E\left[P_Q^* | Q_I^{+*} = 0, \text{MX2}\right]\right) = \left(V^+ - E\left[P_Q | Q_I^{+*} = +1, \text{MX2}\right]\right) + \alpha_I\left(V^+ - E\left[P_Q^* | Q_I^{+*} = +1, \text{MX2}\right]\right). \tag{25}$$

A continuity argument similar to the one used for equilibrium MX1 can be used to show the existence of a φ solving (25). Existence of equilibrium MX2 requires that

$$\begin{aligned}
&\left(V^+ - E\left[P_Q | Q_I^{+*} = +1, \text{MX2}\right]\right) + \alpha_I\left(V^+ - E\left[P_Q^* | Q_I^{+*} = +1, \text{MX2}\right]\right) \\
&\quad = \alpha_I\left(V^+ - E\left[P_Q^* | Q_I^{+*} = 0, \text{MX2}\right]\right) > \\
&\qquad -\left(V^+ - E\left[P_Q | Q_I^{+} = -1, \text{MX2}\right]\right) \\
&\qquad + \alpha_I\left(V^+ - E\left[P_Q^* | Q_I^{+} = -1, \text{MX2}\right]\right).
\end{aligned} \tag{26}$$

To show that the inequality holds, observe that it can be rewritten as

$$\begin{aligned}
V^+ > {} & E\left[P_Q | Q_I^+ = -1, \text{MX2}\right] + \alpha_I\left(E\left[P_Q^* | Q_I^{+*} = 0, \text{MX2}\right]\right. \\
& \left. - E\left[P_Q^* | Q_I^+ = -1, \text{MX2}\right]\right).
\end{aligned}$$

This condition is satisfied when $\alpha_I \leq 1$, since

$$E\left[P_Q | Q_I^+ = -1, \text{MX2}\right] \leq \bar{V},$$

$$E\left[P_Q^* | Q_I^{+*} = 0, \text{MX2}\right] - E\left[P_Q^* | Q_i^+ = -1, \text{MX2}\right] \leq \frac{\Delta V}{2}.$$

Under Assumption A, violation of condition (IIb) implies that $\alpha_I \leq 1$. Hence the informed trader has no incentive to deviate to a move of -1. □

Proof of Proposition 6: We need to determine the existence conditions for the pure strategy M equilibrium. Let $-X$ be the equilibrium secondary market trades submitted by the informed trader, irrespective of the nature of his information, i.e., $Q_I^{+*} = Q_I^{-*} = -X$. The players' beliefs on observing out of equilibrium net order flows are specified as follows: if the net order flow is greater than what would have been observed in equilibrium, i.e., if $Q \geq -X + 2$, then the informed trader is believed to have information V^+, while if more selling is observed than expected under equilibrium, the information is believed to be V^-. Given the beliefs induced by out of equilibrium moves, we analyze the conditions under which the informed trader will not deviate from the equilibrium.

Consider first the case in which the informed trader has information V^-. In equilibrium his expected profit is $X\Delta V/2$. The informed trader will not deviate when his expected profit from deviating is smaller than the equilibrium expected profit. We need to consider all possible deviations from equilibrium. Deviations that involve submitting a smaller sell order than $-X$ are of three types: (a) $Q_I^- = -X + 1$, (b) $Q_I^- = -X + 2$ and (c) $Q_I^- = -X + Y$, where $Y \geq 3$. The conditions under which those deviations are not optimal are respectively:

$$\text{(a) } X\frac{\Delta V}{2} \geq (1-\gamma)(X-1)\frac{\Delta V}{2} + \gamma(X-1)\Delta V \Leftrightarrow X \leq \frac{1}{\gamma} + 1,$$

$$\text{(b) } X\frac{\Delta V}{2} \geq \gamma(X-2)\frac{\Delta V}{2} + (1-\gamma)(X-2)\Delta V \Leftrightarrow X \leq \frac{2(2-\gamma)}{1-\gamma},$$

$$\text{(c) } X\frac{\Delta V}{2} \geq (X-Y)\Delta V \qquad \Leftrightarrow X \leq 2Y.$$

Under Assumption A, $\gamma \leq 1/3$, and (b) implies that $X \leq 5$. Therefore, condition (c) is redundant, since $2Y \geq 6$. This yields the following necessary condition for the existence of the equilibrium:

$$\text{Min}\left[\frac{1}{\gamma} + 1, \frac{2(2-\gamma)}{1-\gamma}\right] \geq X.$$

A similar analysis of the possible deviations involving increased selling when the information is negative shows that such deviations are not optimal if $X \geq 1/\gamma - 1$. Hence, the necessary and sufficient condition for the informed trader to not deviate when his information is V^- is:

$$\text{Min}\left[\frac{1}{\gamma} + 1, \frac{2(2-\gamma)}{1-\gamma}\right] \geq X \geq \left(\frac{1}{\gamma} - 1\right). \tag{27}$$

When the information observed by the informed trader is V^+, the equilibrium expected profit is given by $-X\Delta V/2 + \alpha_I \beta \Delta V/(\beta + 1)$. The condition which ensures that the informed trader has no incentive to deviate to trades involving less selling, i.e., trades such as $Q_I^+ \geq -X + 1$, is:

$$\frac{\alpha_I \beta}{1+\beta} \geq \frac{1-\gamma}{2\gamma} + \frac{X}{2}. \tag{28}$$

Since from condition (27), $(1/\gamma + 1) \geq X$, condition (28) is always satisfied if $\alpha_I \geq (1+\beta)/\gamma\beta$. Similarly it can be shown that a sufficient condition to ensure that the informed trader, if his information is V^+ does not deviate to $Q_I^+ = -X - 1$ is $(1+\beta)/\gamma \geq \alpha_I$. Also, a sufficient condition to rule out deviations of the sort $Q_I^+ = -X - Y$, where $Y \geq 2$, is

$$\frac{2\gamma - \gamma^2 + 1}{2\gamma(1-\gamma)} \geq \frac{\alpha_I}{1+\beta}. \tag{29}$$

Hence if (27) is satisfied, combining (28) and (29) yields the sufficient condition ensuring existence of the equilibrium:

$$\text{Min}\left[\left(\frac{1+\beta}{\gamma}\right), \left(\frac{1+\beta}{\gamma}\right)\left(\frac{2\gamma - \gamma^2 + 1}{2(1-\gamma)}\right)\right] \geq \alpha_I \geq \frac{1+\beta}{\gamma\beta}. \quad \square \tag{30}$$

Example of M Equilibrium With Arbitrary Discrete Trade Size

Assume that the minimum trade size is L/N, where L is the largest possible aggregate order flow from liquidity traders and N is any positive integer. Traders can submit any multiple of this minimum trade size. Since N is arbitrary, this formulation is quite general. Assume that the liquidity trader order flow takes one of $(2N + 1)$ possible values $Q_L \in \{L, L(1 - 1/N), \ldots, 0, \ldots, -L(1 - 1/N, -L\}$, with equal probability.

The pure strategy M equilibrium is characterized, as in Proposition 6, by $Q_I^{+*} = Q_I^{-*} = -X$. The secondary market net order flow is then $Q \in \{L - X, \ldots, -L - X\}$. To determine the equilibrium existence conditions, let the players' beliefs on observing out of equilibrium trading volume be such that if the observed net order flow implies less selling than should have been observed in equilibrium, the informed trader's information is believed to be V^+. If it implies that the selling is more heavy than should have been observed in equilibrium, the informed trader's information is believed to be V^-. Hence $P_{Q>(-X+L)} = V^+$ and $P_{Q<(-X-L)} = V^-$.

Given the out of equilibrium beliefs, deviating from the equilibrium will be suboptimal if the informed trader's expected profit from deviating is lower than his expected profit in equilibrium. First consider the case in which the informed trader observes V^-. He will have no incentive to sell more than X and to submit an order $-X - \delta N/L$, where δ is any positive integer, if the following weak inequality is satisfied:

$$X\frac{\Delta V}{2} \geq \frac{(2N + 1 - \delta)}{(2N + 1)}\left[X + \frac{\delta L}{N}\right]\frac{\Delta V}{2} + \frac{\delta}{2N + 1}(0).$$

The LHS is the informed trader's expected profit if he submits the equilibrium trade of $-X$. The RHS represents the expected profit from submitting a sell order of $(-X - \delta L/N)$. With probability $\delta/(2N + 1)$, an out of equilibrium aggregate volume is observed, in which case the market clearing price becomes V^- and the informed trader makes no profits. Clearly, only deviations with $\delta \leq (2N + 1)$ could be optimal. Simplifying yields,

$$X \geq (2N + 1 - \delta)\frac{L}{N}. \tag{31}$$

In a similar fashion, it can be shown that if the information is V^-, the informed trader will have no incentive to sell less than in equilibrium and submit an order $-X + \delta L/N > -X$, if:

$$L\left(\frac{2N + 1 + \delta}{N}\right) \geq X. \tag{32}$$

Combining (31) and (32) yields the following sufficient condition (since $\delta \geq 1$):

$$L\left(2 + \frac{2}{N}\right) \geq X \geq 2L. \tag{E1}$$

Therefore, there always exists an X (such $X = 2L + (L/N)$) satisfying condition (E1).

When the informed trader's information is V^+, it is easy to show that the informed trader will not want to deviate from equilibrium if the following condition is satisfied:

$$\alpha_I\left(\frac{\beta}{\beta+1}\right) \geq 2L + \frac{L}{N} \geq \alpha_I\left(\frac{1}{\beta+1}\right). \tag{E2}$$

Hence, when condition (E2) is satisfied, a pure strategy type M equilibrium will exist in which the informed trader always submits an order of $-X$, irrespective of his private information, where X satisfies (E1).

Secondary Market Clearing Under Risk Aversion

In a competitive market, the market maker sets bid and ask schedules that leave him indifferent between trading and not trading the observed net order flow given the information conveyed by the order flow and the effect of the trade on his inventory. P_Q is chosen such that

$$E_t\left[U(\tilde{W}^t)|Q\right] = E_t\left[U(\tilde{W}^{nt})|Q\right], \tag{33}$$

where $\tilde{W}$ indicates terminal period wealth and the superscripts indicate whether or not the net order flow was absorbed. Assuming that market makers have a negative exponential utility function $U(W) = -e^{-\kappa W}$ with risk aversion parameter κ, and initial endowments of W_0 and ω in the risk free asset and the risky security respectively, the two sides of equation (32) can be rewritten as

$$\begin{aligned} E_t\left[U(\tilde{W}^t)|Q\right] &= -\theta_Q e^{-\kappa[W_0+(\omega-Q)V^+ + QP_Q]} \\ &\quad -(1-\theta_Q)e^{-\kappa[W_0+(\omega-Q)V^- + QP_Q]}, \\ E_t\left[U(\tilde{W}^{nt})|Q\right] &= -\theta_Q e^{-\kappa[W_0+\omega V^+]} - (1-\theta_Q)e^{-\kappa[W_0+\omega V^-]}. \end{aligned} \tag{35}$$

After equating the two expressions, simplifying and collecting terms we get

$$\begin{aligned} e^{\kappa Q P_Q} = &\left[\frac{\theta_Q e^{-\kappa\omega V^+}}{\theta_Q e^{-\kappa\omega V^+} + (1-\theta_Q)e^{-\kappa\omega V^-}}\right] e^{\kappa Q V^+} \\ &+ \left[\frac{(1-\theta_Q)e^{-\kappa\omega V^-}}{\theta_Q e^{-\kappa\omega V^+} + (1-\theta_Q)e^{-\kappa\omega V^-}}\right] e^{\kappa Q V^-}. \end{aligned} \tag{36}$$

Define

$$\lambda_Q = \frac{(1-\theta_Q)e^{-\kappa\omega V^-}}{\theta_Q e^{-\kappa\omega V^+} + (1-\theta_Q)e^{-\kappa\omega V^-}} = \frac{(1-\theta_Q)}{\theta_Q e^{-\kappa\omega\Delta V} + (1-\theta_Q)}. \tag{37}$$

Substituting in (36) for λ_Q, solving for P_Q and simplifying yields the following:

$$P_Q = V^- + \frac{1}{\kappa Q} \ln\left[\lambda_Q + (1 - \lambda_Q) e^{\kappa Q \Delta V} \right]. \tag{38}$$

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