

Bookbuilding vs. Fixed Price Revisited: The Effect of Aftermarket Trading

Walid Y. Busaba^{*}

Chun Chang^{**}

Abstract

Investors who possess information about the value of an IPO can participate in the offering as well as trade strategically in the aftermarket. Both the bookbuilding and the fixed price IPO selling methods require more underpricing when aftermarket trading by informed investors is considered. Bookbuilding becomes especially costly, since the potential for profit in the aftermarket adversely affects investors' bidding behavior in the premarket. Unless the underwriter building a book can target a small enough subset of the informed investors, a fixed price strategy that allocates the issue to retail investors produces higher proceeds on average, contrary to the conventional wisdom in the literature. We therefore find a *benefit* to limiting access to the premarket and, hence, provide an efficiency rationale for the practice by American bankers of marketing IPOs to a select group of investors.

^{*} Ivey School of Business, University of Western Ontario, London, Ontario N6A 3K7, Canada; Phone (519)661-4178; wbusaba@ivey.uwo.ca.

^{**} Carlson School of Management, University of Minnesota, Minneapolis, MN 55455; Phone: (612)624-8305; cchang@csom.umn.edu.

1. Introduction

There is a growing literature, both theoretical and empirical, that studies and compares methods for marketing and pricing initial public offerings (IPOs). At the center of this literature are two commonly used methods, bookbuilding and fixed price, that differ mainly in whether or not a “price-discovery” effort is undertaken prior to setting the offer price.¹ Fixed price offerings are priced without first soliciting investor demand, with price discovery taking place mainly in the aftermarket. In contrast, bookbuilding involves road shows and one-to-one meetings with potential investors that allow the underwriter to ‘discover’ investor valuations prior to setting the offer price.

Both methods require that money be left on the table for investors in the form of underpricing. Underpricing is needed in fixed price offerings in order to compensate the uninformed retail investors for the winner’s curse they face as informed investors crowd them out of good deals (Rock, 1986). While the winner’s curse is not a concern in bookbuilding -- because the underwriter solicits investor information prior to pricing -- a discount is still required to reward investors for surrendering information (Benveniste and Spindt, 1989).

Several papers have compared in theoretical settings the underpricing required under the two methods, and the consensus finding has been that bookbuilding requires on average a lower discount (e.g., Benveniste and Wilhelm, 1990, Spatt and Srivastava, 1991, Benveniste and Busaba, 1997, and Biais and Faugeron-Crouzet, 2001). However, the models used in these papers to calculate the level of the discount are based on the assumption that the true value of the

¹ Recent papers have also considered auction formats used in some IPO markets abroad, like the French ‘mise en vente’ and variants of the Dutch auction. See Biais and Faugeron-Crouzet (2001), for example, who show that among the various IPO selling methods used, American bookbuilding and the French ‘mise en vente’ can implement the optimal direct selling mechanism. Unlike the other auction formats, bookbuilding has been widely adopted in international markets since the early Nineties. See the references in footnote 2 below, and Ljungqvist, Jenkinson, and Wilhelm (2003) and Sherman (2001) for a discussion of global trends in IPO selling methods.

offered shares is established *immediately* and *instantaneously* when public trading commences. In such models, the only way an investor benefits from possessing information is through receiving allocations of shares in IPOs. Put differently, an informed investor who does not participate at the IPO stage cannot make money by trading in the aftermarket. This assumption, however, is in sharp contrast to the fundamental premise underlying the market microstructure literature, which focuses on the trading behavior of, and the profit made by, informed investors. It also prohibits the consideration of the IPO process as a sub game within a broader context in which informed investors can choose to either participate in the premarket of an IPO, wait until the aftermarket and then trade on their information, or do both.

In this paper, we contribute to the literature by admitting the potential for profit in the aftermarket and modeling the premarket *together* with the aftermarket. In doing so, we build upon and bridge two strands of the finance literature, market microstructure and investment banking. We find that, irrespective of the method used to sell IPOs, more underpricing is needed when aftermarket trading by informed investors is considered. Bookbuilding becomes especially costly, since the potential for profit in the aftermarket adversely affects investors' bidding behavior in the premarket. We find, in this regard, that unless the underwriter building a book can successfully target a *subset* of the informed investors, a simple fixed price strategy that involves allocating the issue to retail investors produces higher proceeds on average. Establishing the possible dominance of the fixed price method *reverses* what is now an accepted 'fact' in the literature and sheds a new light on the debate in the international arena regarding the best method to market IPOs.²

² See, for example, "Going by the Book," *The Economist*, January 9, 1993, and "The Guide to Germany," *Euromoney*, April 1995. See also Benveniste and Busaba (1997).

The inability of informed investors to generate profits in the aftermarket is of paramount importance in the design of the price/allocation rule in the existing bookbuilding models. In these models, the investment banker, on behalf of the issuing firm, attempts to gather investor feedback prior to setting an offer price. To induce investors to truthfully reveal interest, the banker designs a price/allocation rule that, on the one hand, minimizes the benefits from downplaying interest and, on the other, rewards investors for truthfully revealing strong demand. The threat to cut the allocation to investors who reveal weak interest is the “stick” with which the banker “punishes” cheating investors, and the allocation of *underpriced* shares is the “carrot” offered to truth tellers.

The “stick” might not be as threatening, however, if investors who do not receive an allocation in the IPO can still profit from their hidden (misrepresented) information through trading in the aftermarket. In fact, the ability to trade in the aftermarket creates further incentive for investors to misrepresent interest during the premarket, because they can cause mispricing of the IPO and then trade in the aftermarket to exploit the mispricing. To outweigh this additional benefit and induce truth-telling during bookbuilding, the “carrot” has to be larger, therefore. In other words, bookbuilding would be more costly than previously thought if aftermarket trading were considered. We find in fact that underpricing will be needed in settings where existing models would fail to justify it (detailed illustration is offered in Section 6).

Fixed price offerings also would be more costly in this framework. Even if informed investors can be completely excluded from IPOs -- a situation that would lead to zero underpricing in Rock’s (1986) framework -- these investors can still trade strategically in the aftermarket, profiting at the expense of the uninformed investors who are allocated the IPO

shares and who may have to trade in the aftermarket for liquidity or other reasons. This necessitates ex ante that offerings be discounted.

We show that fixed price offerings require a lower discount than that needed under the bookbuilding method as modeled in the literature. Misrepresenting information during bookbuilding and then trading in the aftermarket generates a higher profit on average for the informed investors than aftermarket trading in fixed-price offerings. This is because in the first instance, informed investors can cause and then benefit from the highest possible mispricing, requiring the underwriter building a book to pay (through underpricing) for the full value of investor information. In fixed price offerings, the underwriter sets the offer price ex ante by integrating over possible investor information, and any mispricing that remains is due to the ‘absence’ rather than the misrepresentation of information. It is therefore cheaper for the firm to sell its offering through the fixed price method.

This result provides an insight into the fundamental, but still unanswered question of whether price discovery is cheaper in the primary market or the secondary market. Because we allow informed investors to trade and profit after new offerings are brought to market, the issuer’s choice of bookbuilding versus fixed price in our model comes down to a choice between paying for price discovery in the premarket versus in the aftermarket. The dominance of fixed price suggests that issuers may be paying too much for price discovery when it is conducted in the process of pricing IPOs.

We however show that there is a strategy that makes price discovery in the premarket cheaper. If investor pieces of information are sufficiently correlated, the banker building a book can target a *subset* of the informed investors that is just enough to buy the whole issue. The targeted investors can be induced to surrender their information through the promise of *larger*

allocations of *slightly* underpriced shares, as the alternative for these investors if they withhold information is to compete in the aftermarket with the rest of the informed public. If the ratio of the targeted investors to the entire informed public is small enough, underpricing under bookbuilding could drop below that required under fixed price.

This result, therefore, provides an efficiency rationale for why U.S. underwriters market IPOs to what seems to be a limited number of institutional (presumably informed) investors. Opening up the premarket to all interested informed investors could lead to more underpricing, or might simply eliminate the advantage of bookbuilding relative to fixed price. This conclusion contradicts the implication of existing bookbuilding models, according to which underpricing drops due to increased competition if the number of investors included in the premarket increases.³ Unlike the other models, ours differentiates between the total number of informed investors on the one hand, and the number of informed investors *included in the premarket* on the other. An increase in the former leads to more competition in the aftermarket and does, as a result, lead to reduced underpricing. An increase in the latter only limits the underwriter's ability to cheaply gather information through 'bribing' a few investors.

The result also sheds light on the issue we raised at the outset about treating the IPO process as a sub game. If an institutional investor has private information about an issuing firm, would the investor be better off tipping its hand to the investment banker during road shows or waiting until the stock started trading in the aftermarket? Our analysis indicates that investors who are selected for the premarket capture rents (profits in excess of information production costs) on average, while those who depend only on aftermarket trading just break even. Informed investors, therefore, are undoubtedly better off being part of a group of 'regulars' whom the

underwriter repeatedly approaches during the pricing of offerings, and this could explain the strong interest investors in general have in being included in such syndicates.

And last, the result also highlights a new dimension to the discretion needed by investment bankers in order for them to ensure the efficiency of the bookbuilding mechanism. Benveniste and Wilhelm (1990) show that successful bookbuilding requires that the underwriter have discretion over share allocations. Specifically, the banker has to be able to discriminate among investors participating in the premarket on the basis of the indications they give. Without such discretion, the banker cannot solicit reliable indications and bookbuilding loses its advantage even relative to a fixed-price strategy that suffers from the winner's curse like in Rock (1986). Our result is stronger. We allow allocations to depend on the investors' indications, but find that while bookbuilding can be conducted in this case, it still does not dominate fixed price. We show that the dominance of bookbuilding can only be established if the banker has the added discretion to limit the participation in the premarket to a select group from the informed investors at large.

The next section develops the model and describes the setting for aftermarket trading. Section 3 presents the analysis of the fixed price method and Section 4 the bookbuilding method. The outcome of the two methods is then compared, and the potential for improving the outcome of bookbuilding explored, in Section 5. Section 6 is a discussion of the results and their implications for the literature, possible extensions, and qualifications. The paper is summarized in Section 7 and proofs, where applicable, presented in the Appendix.

2. The Model

³ Physical or participation constraints keep the banker from approaching a large number of investors in these models

The Issuer

Since the focus of the paper is not on the relationship between the issuing firm and its investment bank, these two parties are treated as a single agent called the issuer. The issuer has Q shares – representing a fixed fraction of ownership -- to offer to the market and its objective is to maximize the expected proceeds. Without loss of generality, Q is normalized to 1.

The Investors

As in Rock (1986) and Benveniste and Spindt (1989), there are two types of investors: large, sophisticated investors who always participate in IPO markets, and retail investors. The large investors, representing institutions or wealthy individuals, can each buy up to W number of shares with $W \leq 1$. That is, a single investor may or may not be able to buy the entire offering. The retail investors can each buy up to w number of shares with $w < W$.⁴ Both types of investors are risk neutral and there is potentially unlimited supply of both types. The number of large investors who *choose* to become informed about a particular issuing firm is endogenous, as will be described below. The alternative case where an *exogenous* number of investors are endowed with information is treated in Section 6.

Stock Value and Investor Information

By incurring a cost c , a large investor can obtain a signal of the market value of the issuer's stock. We will refer to such an investor as an informed investor.⁵ For simplicity, the signal is either H or L with equal probability. The expected market value of the stock given the

(e.g., Benveniste and Busaba, 1997, and Sherman and Titman, 2001). Without these constraints, underpricing can be driven down to zero (e.g., Benveniste and Busaba, 1997, Corollary 1 and Footnote 7, p. 392)

⁴ We could state the wealth constraints in terms of monetary value. The analysis, however, is much simpler in this setup, without affecting the essence of our results.

signal H or L is V_H or V_L , respectively. For tractability, we assume like Rock (1986) that all informed investors observe the same signal. Identical investor signals are not necessary for our results; all that is needed is that the signals be correlated, as will be illustrated in more detail in Section 6.

There is free entry into information acquisition. The number of informed investors is determined by equating the expected gain from becoming informed to the cost of information acquisition, c . The informed investors participate in IPOs regularly and the issuer knows their identities. However, the issuer cannot prevent them from trading in the aftermarket (possibly because he may not be able to observe their trading activities).

Aftermarket Trading

We assume that the true state does not reveal itself immediately in the aftermarket unless it is already revealed in the premarket pricing process. Our results are not dependent on the specific microstructure model used, so we assume that trading in the aftermarket is carried out in the standard Kyle (1985) framework. Specifically, we assume that the retail investors who receive allocations of shares in an offering will have to sell the fraction $m + \varepsilon$ of these shares (buy if $m + \varepsilon < 0$) in the aftermarket for some exogenous reasons, where m is a nonnegative constant and ε is a random variable. For simplicity, ε is assumed to be either e or $-e$ with equal probability. Note that when $m = 0$, we have the symmetric “noise traders” in Kyle (1985). When $m + \varepsilon$ is always positive, the sellers are like those having liquidity shocks in Diamond and Dybvig (1983). Also for simplicity and in accordance with other market microstructure models, we assume that informed (large) investors do not have liquidity shocks. (Our qualitative results are,

⁵ We assume that w is small enough that the retail investors will never choose to become informed.

once again, independent of this assumption, as we argue in Section 6.) The informed investors can submit buy or sell orders to a competitive market maker who might or might not be the IPO's lead underwriter. The market maker sets the price equal to the expected value of the stock given the information conveyed in the IPO process (if bookbuilding is used) as well as by the total order flow.

We will assume $-1 < m - e < m + e < 1$. That is, liquidity trading will not exceed the total shares offered to the public.⁶

3. The Fixed Price Mechanism with Aftermarket Trading

In this section, we analyze the case in which the issuer prices the offering based on ex ante information and, to eliminate the adverse effect on pricing of informed participation (as in Rock, 1986 and Benveniste and Wilhelm, 1990), targets only retail investors. The issuer can practically restrict the participation of informed investors, even if he cannot identify them, by imposing a sufficiently small subscription limit per investor. Given there is a cost to becoming informed, the number of informed investors in equilibrium will in general be small relative to the large number of retail investors. Hence, even if the informed investors do participate in IPOs, as long as they receive sufficiently small allocations, the winner's curse they impose on the uninformed – that generates underpricing in the existing fixed price models -- will be insignificant.⁷ Without loss of generality, therefore, we assume that the issuer allocates all shares to retail investors.

⁶ We can alternatively impose the restriction that the total order flow does not exceed the total shares offered. Imposing such a restriction will be straightforward once we derive the optimal trading strategies of informed investors. The restriction essentially limits further the possible range of m and e .

⁷ A limitation of these models is that they *need* the significant participation of the informed to generate underpricing. Such models fail to allow the issuer to be strategic in its allocation rule.

Underpricing is still required in our fixed price framework, however, because the informed investors, though excluded from IPOs, can trade strategically in the aftermarket and profit at the expense of the retail investors who buy IPOs. Retail investors realize the potential for loss in the aftermarket and, as result, do not participate in IPOs unless the issues are sufficiently discounted. Therefore, to determine the offer price that retail investors are willing to accept in fixed price offerings, we need to study first the aftermarket equilibrium with informed trading.

Let n be the number of informed investors, where n is an endogenous number to be determined later. In our setting of symmetric informed investors, it is natural and reasonable to look for symmetric equilibria in which each informed investor makes the same amount of profit. Since the difference between the two possible levels of liquidity trading is $2e$, the difference in the aggregate informed trading volume between the two states L and H should also be $2e$ in order for the total order flow not to always reveal the state. Therefore, each informed investor's (symmetric) trading strategy can be written as an

α -strategy: sell $\alpha e/n$ shares if the signal is L and sell $(\alpha-2)e/n$ shares if the signal is H;

where n is the number of informed traders and α is a parameter. As we will see below, the strategy is an equilibrium for any α and the informed traders' equilibrium trading profit is independent of α . Without affecting the analysis, therefore, the possible range of α can be restricted so that total trading volume does not exceed the total shares available (as suggested in footnote 6).

Since there are n informed traders, the total informed trading volume is αe when the signal is L and $(\alpha-2)e$ when the signal is H. When $\alpha = 2, 1$ or 0 , for example, we have the following three strategies, respectively: (1) sell $2e/n$ when the signal is L and sell (or buy) nothing when the signal is H; (2) sell e/n when the signal is L and sell $-e/n$ (i.e., buy e/n) when the signal is H; (3) sell nothing when the signal is L and buy $2e/n$ when the signal is H.⁸ The order flow and pricing under an α -strategy are shown in Table 1.

Note that in Table 1, selling orders are positive and buying orders are negative. Under the α -strategy, the true state (signal) is not revealed in the two middle rows when the total order flow is $m + (\alpha - 1)e$. As a result, the market maker sets the price in these states at the prior expected value of $\frac{1}{2}(V_H+V_L)$. In the top and bottom rows, the true state is revealed and the aftermarket price fully reflects the true state.

Table 1

Probability of each scenario	The signal	Selling orders from liquidity traders	Selling order by one informed trader	Total order flow observed	Market maker's posterior of good signal	The after-market price P_1	Profit to an informed trader
0.25	H	$m - e$	$(\alpha-2)e/n$	$m +(\alpha-3)e$	1	V_H	0
0.25	H	$m + e$	$(\alpha-2)e/n$	$m +(\alpha-1)e$	0.5	$(V_H+V_L)/2$	$-(\alpha-2)e(V_H-V_L)/(2n)$
0.25	L	$m - e$	$\alpha e/n$	$m +(\alpha-1)e$	0.5	$(V_H+V_L)/2$	$\alpha e(V_H-V_L)/(2n)$
0.25	L	$m + e$	$\alpha e/n$	$m +(\alpha+1)e$	0	V_L	0

⁸ Depending on the value of α , some α -strategies may require the ability to short sell shares. Short selling is not necessary for the analysis, however, since other α -strategies which involve no short selling are also equilibria.

Lemma 1. Any α -strategy is an equilibrium strategy of the aftermarket trading game and the expected trading profit for an informed investor is given by $\pi_f = (V_H - V_L)e/(4n)$.

The expression for the informed trading profit is intuitive. There is a 50% probability that the informed trades do not reveal the true state (the middle rows of Table 1). In such cases, the market maker sets the trading price based on ex ante information at $\frac{1}{2}(V_H + V_L)$, with a mispricing of $\pm\frac{1}{2}(V_H - V_L)$. The expected trading profit of every informed investor is, therefore, the product of the probability that the true state is not revealed, the extent of mispricing in that case, and the share of the random retail trades the investor can capture, $\pm e/n$, being one of n similarly informed investors.

Since all equilibria yield the same profit to the informed investors, the investors will be indifferent among them. It does not matter to the analysis below which equilibrium is played.

When the retail investors buy the new shares from the issuer, they anticipate that they may have to trade in the aftermarket at a price P_1 for a possible loss. Their expected loss is the very expected trading profit of the n informed investors, $n\pi_f$. Therefore, the highest offer price the retail investors are willing to pay is the (unconditional) expected value of the stock minus $n\pi_f$. This result is stated below.

Proposition 1. Under the fixed price mechanism in which the shares are sold to retail investors, the amount of underpricing is equal to the trading profit of the informed investors, $(V_H - V_L)e/4$. Therefore, the offer price is given by

$$P_f = (V_H + V_L)/2 - (V_H - V_L)e/4. \quad (1)$$

By equating the expected profit of an informed investor, $(V_H - V_L)e/(4n)$, with the cost of collecting information, c , we can determine the equilibrium number of informed investors under the fixed price mechanism.

Corollary 1. The number of informed investors under the fixed price mechanism is

$$n_f = (V_H - V_L)e/(4c).$$

4. Bookbuilding with Aftermarket Trading

We now consider the case when the issuer decides to market its offering through the bookbuilding mechanism. To build a book, the issuer approaches informed investors in the premarket in an effort to solicit indications of interest. The outcome of the book is then publicized and the offer price and allocations are conditioned on it. The challenge, however, is to ensure that investors are truthful, since investors have the incentive to understate their interest in hopes of receiving allocations of shares at a depressed offer price. Benveniste and Spindt (1989) and Benveniste and Wilhelm (1990) model the process and show that truthtelling can be ensured by the issuer minimizing the allocation to investors revealing weak interest, and underpricing the offering when premarket demand is strong. The contribution here is that we allow for the possibility that an informed investor misrepresents his/her interest and then trades in the aftermarket to benefit from the induced mispricing. Truthtelling, therefore, requires a price/allocation mechanism in which underpricing is deep enough to outweigh the profit that “cheating” investors expect not only at the IPO stage *but also* in the aftermarket.

In line with the existing bookbuilding models, we focus on symmetric price/allocation rules in which investors who report the same information receive the same allocation (the offer price has to be uniform).⁹ Facing such rules, investors, who in our model possess the same information, report identically in equilibrium. We can, therefore, denote a (symmetric) mechanism by the allocation A_I given to the representative informed investor when the investor (and all others) report I , $I = H$ or L , and the offer price in that state, P_I .

In response to any price/allocation mechanism, informed investors as a group might either report truthfully or lie. (When it is optimal for any investor to report one way, it will be optimal for all others to report the same.) For truthtelling to prevail in equilibrium, the price/allocation rule followed by the issuer should ensure that the profit to investors is higher under truthtelling than under lying. To characterize incentive-compatible rules, we first derive the profit informed investors expect under the two possible reporting strategies.

Informed investor profits in general stem from receiving allocations of underpriced shares and from trading in the aftermarket if a portion of the offering was allocated to retail investors and the informed investors (privately) know that the shares are mispriced. Under the truthtelling equilibrium, the profit comes only from the first source – IPO allocations -- since the aftermarket price is set correctly by the market maker, who observes the outcome of the bookbuilding process. The profit expected by the representative informed investor who truthfully reports H is $A_H(V_H - P_H)$, and who truthfully reports L is $A_L(V_L - P_L)$. On the other hand, when informed investors falsely report L , the representative investor's profit from IPO allocations will be $A_L(V_H - P_L)$, and when the investors falsely report H , the investor's profit will be $A_H(V_L - P_H)$.

⁹ The analysis becomes intractable if arbitrary asymmetric rules were allowed. Although asymmetric rules are excluded, we still have to deal with asymmetry in the case of one player deviating from a symmetric equilibrium (see footnote 10, for example.) Section 5's results on targeting a subset of informed investors can be loosely viewed as allowing allocations to be asymmetric between two groups of investors (but still symmetric within each group).

Thus, without the possibility of trading in the aftermarket, ensuring truth-telling in equilibrium would require $A_H(V_H - P_H) \geq A_L(V_H - P_L)$ and $A_L(V_L - P_L) \geq A_H(V_L - P_H)$, just like in the existing literature.

When aftermarket trading is possible, however, we need to consider in addition the potential profit from trading in the aftermarket contingent on false reporting in the premarket. Computing such profits requires that we first characterize the optimal aftermarket trading strategy of investors following the misrepresentation of information. Once again, it is natural and reasonable to focus on symmetric trading strategies in which all informed traders behave the same and get the same payoff. If such strategies are equilibrium strategies, they are more likely to become a focal point and prevail.

When the true state is H and all informed investors report L, the issuer believes that $\Pr(\text{state} = H) = 0$, because he assumes, correctly when a truth-telling equilibrium is considered, that the investors are reporting truthfully. He publicizes the outcome of the book (i.e, the discovery of the state L) and prices the issue at P_L . All parties, including the market maker (who could be the underwriter) and retail investors, observe the outcome of the offering and adopt the belief that the value of the shares is V_L . Suppose that a portion δ_L of the offering is allocated to the retail investors when informed investors report L ($\delta_L = 1 - nA_L$ by definition). Informed investors can benefit in the aftermarket by buying against retail selling which, as stated in the modeling section, represents the fraction $m + \varepsilon$ ($\varepsilon = \pm e$) of the shares allocated to retail investors. The optimal (symmetric) trading strategy calls for every informed investor to place buy orders for $2e\delta_L/n$ of the offered shares. The aftermarket trading game when the informed investors falsely report L and δ_L shares are allocated to retail investors is presented in Table 2 below:

Table 2

Probability of each scenario	The true signal	Selling orders from liquidity traders	Selling order by one informed trader	Total order flow observed	Market maker's posterior probability of the signal = H	The after-market price P_1	Profit to an informed trader
0.5	H	$(m+e)\delta_L$	$-2e\delta_L/n$	$(m-e)\delta_L$	0	V_L	$2e\delta_L(V_H-V_L)/n$
0.5	H	$(m-e)\delta_L$	$-2e\delta_L/n$	$(m-3e)\delta_L$	1	V_H	0

Note that the probabilities and the analysis in Table 2 are conditioned on the true signal being H. They are therefore 0.5 for each of the two possible selling orders by liquidity traders. When the liquidity trading is $(m + e) \delta_L$, the total order flow becomes $(m - e)\delta_L$. The market maker will not infer that informed investors traded because $(m-e)\delta_L$ is possible even without informed trading. He will not change his prior belief that the true state is L and, hence, will set the trading price, P_1 , at V_L . In this case, each informed trader's profit will be $(V_H - V_L)2e\delta_L/n$. When the liquidity trading is $(m - e)\delta_L$, the total order flow will be $(m - 3e)\delta_L$ and the informed trading will be revealed. The market maker sets the price at V_H and the informed traders earn zero profit. Since $(m + e)\delta_L$ happens with probability 0.5, the expected aftermarket trading profit by an investor who observes H but reports L is $(V_H - V_L)e\delta_L/n = (1-nA_L)(V_H - V_L)e/n$.

A similar analysis can be carried out for the case following a misrepresentation of the true state L as H, in which case the informed traders *sell* in the aftermarket. Given an allocation to retail in this case of $\delta_H \equiv (1 - nA_H)$, the trading profit for an informed investor will be $(1-nA_H)(V_H - V_L)e/n$.

Lemma 2. If informed investors falsely report L (H) in the bookbuilding process and the portion δ_L (δ_H) of the offering is allocated to retail investors, a symmetric trading equilibrium exists in which each informed investor buys $2\delta_L e/n$ (sells $2\delta_H e/n$) shares in the aftermarket. The expected trading profit for an informed investor in each case is $\delta_I(V_H - V_L)e/n$, where $\delta_I \equiv 1 - nA_I$ and $I = H$ or L .

We can now state the incentive compatibility constraints that should be satisfied for any truthtelling price/allocation mechanism to be equilibrium when aftermarket trading is considered. These constraints are

$$A_H(V_H - P_H) \geq A_L(V_H - P_L) + (1 - nA_L)(V_H - V_L)e/n, \quad (2)$$

and

$$A_L(V_L - P_L) \geq A_H(V_L - P_H) + (1 - nA_H)(V_H - V_L)e/n. \quad (3)$$

Constraint (2) ensures that truthfully reporting H is at least as profitable as misrepresenting the signal as L, and Constraint (3) similarly ensures that the truthful revelation of L is a dominant strategy for the informed investors. Of course, truthtelling is a Nash equilibrium because a lie from any investor does not benefit the investor since the lie can be easily detected when everyone else is telling the truth. Constraints (2) and (3) ensure that investors *as a group* do not lie. If constraint (2) is violated, for example, lying by all investors

when the true signal is H will dominate truthtelling and, hence, truthtelling will not be equilibrium.¹⁰

The optimization problem for choosing the bookbuilding mechanism with aftermarket trading can now be stated. The issuer conducting bookbuilding chooses the truthtelling price/allocation rule that maximizes expected proceeds from the IPO. That is, the issuer chooses A_I and P_I , where $I = \{L, H\}$, that

$$\text{Maximize } (P_H + P_L)/2 \quad (4)$$

subject to (2), (3), and

$$0 \leq nA_L, nA_H \leq 1 \quad (5)$$

$$P_L \leq V_L; P_H \leq V_H. \quad (6)$$

Constraints 5 ensure that allocations can neither be negative nor in excess of the offering; Constraints 6 summarize the fact that, since the outcome of the book is publicized prior to pricing, the offer price cannot exceed the value of the stock given the reported state, L or H.

Proposition 2. Assume $nW \geq 1$ and all n informed investors are allocated shares symmetrically. There is a solution to the issuer's maximization problem, according to which $A_L = 0$ (the issue allocated to retail in state L), $A_H = 1/n$ (the issue allocated to the informed in state H), $P_L = V_L$, and $P_H = V_H - (V_H - V_L)e$. Given that the state H happens with a probability of $1/2$ ex ante, the expected value of underpricing under the bookbuilding mechanism is $(V_H - V_L)e/2$.

¹⁰ If in response to a price/allocation rule that is thought to induce truthtelling, lying by all investors dominates, no one investor has the incentive to deviate from lying. If the investor who truthfully reports H when all others report L were to be believed, the issuer would set the offer price at P_H and the allocation to the investor at A_H , according to the price/allocation rule. The investor's profit would then be the LHS of (2), which is less than what the investor receives if he lies like others, given that (2) is violated. If, on the other hand, the deviating investor were not to be believed, he would not benefit anyway.

The solution to the optimization problem is intuitive. Underpricing is needed because of the incentive compatibility constraint (2). (Constraint (3) will not bind at the optimum, as we argue below.) The RHS of (2) reflects the two sources of profit to informed investors when the investors falsely report L: allocations of underpriced shares (the first term) and aftermarket trading when shares are allocated to retail (the second term). Re-writing $V_H - P_L$ as $V_L - P_L + (V_H - V_L)$, we see that setting $P_L = V_L$ is consistent with minimizing the first term on the RHS of (2) and maximizing expected proceeds. Furthermore, allocating the entire offering to retail investors when the informed investors reveal L (i.e, setting $A_L = 0$) guarantees that the informed investors who lie do not benefit directly by receiving undervalued IPO shares. Although this allocation rule increases random retail trading $(1 - nA_L)e$, it increases aftermarket profits only partially since e is strictly less than the offer size Q ($Q = 1$). This allocation rule, therefore, minimizes the RHS of (2) and, hence, the required profit on the LHS. Allocating the entire issue to the informed investors when they reveal H, on the other hand, maximizes A_H and *minimizes* the underpricing $(V_H - P_H)$ required to satisfy (2) with equality.

Constraint (3) imposes a ceiling on underpricing $(V_H - P_H)$. If P_H is too low, investors who observe L might have the incentive to misrepresent it as H, since the profit they expect to generate in the aftermarket could outweigh the loss from buying overpriced IPO shares. Given $e < 1$, however, underpricing at the optimum will not be that high.

Underpricing in our bookbuilding model is driven (entirely) by the potential for profit in the aftermarket by informed investors (the second term on the RHS of (2)). An increase in the dispersion of possible share values, $V_H - V_L$, increases the mispricing that can be caused by investors' misrepresentation of information and, in turn, increases the extent of profit from

aftermarket trading. As a result, a larger IPO discount is needed to convince investors to surrender their informational advantage during the premarket. Required underpricing increases also with the uncertainty in retail trading, e . When this uncertainty is higher, larger informed trades can remain undetected, allowing informed investors to profit more from any mispricing they deliberately cause. Once again, a deeper discount is needed to induce truthful revelation of information in the premarket.

Notably, underpricing is not dependent on the cost of information production, c , although this cost affects the number of investors who chose to become informed in equilibrium.¹¹ (Equating an investor's expected benefit from underpricing to c leads to an equilibrium number of informed investors, n_b , of $(V_H - V_L)e/(2c)$.) This is because the same number of informed investors participates in the pre- as well as the aftermarket, so that an investor receives the same share, $1/n_b$, of the aftermarket profits as of the underpriced issue ($A_H = 1/n_b$ under the optimal bookbuilding mechanism in Proposition 2). A larger c , for example, leads to a smaller investor pool and a larger share of the aftermarket profits per investor. But it also leads to an equally larger per-investor allocation of underpriced shares, so that incentive compatibility can be preserved with the same level of underpricing per share.

5. Bookbuilding vs. Fixed Price

We turn now to the comparison of bookbuilding and fixed price in an environment that accounts for aftermarket trading. We first compare the results of the two methods as derived in Sections 4 and 5, and Proposition 3 formalizes the result that fixed price generates higher

¹¹ This contradicts the implications of Booth and Chua's (1996) and the bookbuilding model of Sherman and Titman's (2001), where information production is costly, as in our model, and underpricing is determined by an exogenous need to ensure the participation in the IPO of a certain number of informed investors. Section 6 offers a more detailed discussion of this issue.

expected proceeds. Then, we consider a variant of the bookbuilding mechanism under which the issuer premarkets only to a subset of the informed investors. We show that this variant has the potential to reduce underpricing, and state the conditions under which underpricing is reduced below that in fixed price offerings.

Comparison under the standard bookbuilding

Proposition 3: A fixed price method that allocates all shares to retail investors requires less underpricing on average than running a bookbuilding mechanism in which all informed investors are treated equally.

The reasoning behind this result is the following. Successful bookbuilding requires the issuer to pay for the full revelation of information since, otherwise, informed investors misrepresent H as L, causing the issue to be undervalued by $(V_H - V_L)$, and then benefit in the aftermarket from the induced mispricing. In comparison, the mispricing that informed investors benefit from when they trade in the shares of fixed price offerings is only partial, specifically $\frac{1}{2}(V_H - V_L)$, since the market maker prices these shares based on ex ante information, at the unconditional mean $\frac{1}{2}(V_H + V_L)$, when he cannot infer the true state from the order flow. Each informed investor, therefore, will have to be given more compensation for a full revelation of information than what the investor can get through aftermarket trading in the shares of fixed price offerings.

The dominance of the fixed price method stands in sharp contrast with the fundamentals of the existing bookbuilding models. In such models, bookbuilding is an optimal mechanism in light of the revelation principle. Any fixed price scheme can be replicated by a direct mechanism

that links the final payoffs to informed investors' information messages (Myerson 1979 and Harris and Townsend 1981).¹² However, for the revelation principle to hold, there could be no strategic actions after the messages are sent, and the final payoffs should be directly linked to the messages. In other words, there could be no strategic actions by informed investors after the premarket is conducted, and payoffs to these investors should be determined only by the price/allocation rule followed by the issuer. In our model with aftermarket trading, both conditions are violated. Investors' premarket indications become public upon the completion of the offering (as they can be inferred from the pricing and allocation of the offering), affecting the pricing of the shares in the secondary market and allowing the informed investors to then trade strategically and profit. Our model, therefore, allows strategic actions to be taken after messages are sent but before the final payoffs are realized. As such, the final payoffs of the informed investors cannot be directly made contingent on the investors' reported indications, because the payoffs also depend on aftermarket trading. This is why bookbuilding is not optimal when aftermarket trading is admitted.

Comparison under a variant of bookbuilding

There is a way, however, to reduce underpricing under bookbuilding and potentially restore dominance to the mechanism. It works as follows. By not including all n informed investors in the premarket, the issuer can compensate some informed investors by more than these investors would get from trading in the aftermarket. This can reduce the total underpricing needed for information revelation. For example, if W is large enough, the issuer can premarket, and allocate, the entire issue to one informed investor. The reward given to this investor for

¹² The only known exception is in Benveniste and Busaba (1997), where the issuer of a fixed price IPO can sell sequentially and generate a buying cascade (as in Welch, 1992). The outcome of a cascade cannot be replicated by

revealing the true state does not have to be large because if he does not report truthfully, he would have to compete with the other $n-1$ informed investors for the profit from trading in the aftermarket.

As long as the informed investors who are included in the premarket are *randomly* selected from the n informed investors, the possibility of being selected ensures that enough investors choose to become informed ex ante (i.e., n will be large enough in equilibrium). The potential competition in the aftermarket then keeps the underpricing given to those randomly selected investors low. In fact, required underpricing can fall below what informed investors expect to earn in fixed price offerings. The precise conditions will be given in Proposition 5 below.

To formalize this variant of bookbuilding, we assume that the issuer invites to the premarket t investors whom he selects randomly from the n informed investors, where this subgroup is just enough to buy the whole issue (i.e., $tW = 1$). To design the optimal bookbuilding mechanism, the issuer still solves the maximization problem (2) – (6), with one exception: t replaces n in the feasibility constraints (5). The optimal price/allocation rule, as before, minimizes the benefit from misrepresenting information and rewards truthtelling with allocations of underpriced shares. The following proposition states the optimal price/allocation rule.

Proposition 4. Suppose that $nW \geq 1$ and t of the n informed investors are randomly selected to participate in the IPO, where t satisfies $tW=1$. Then the issuer's maximization problem has a solution according to which $A_L = 0$, $A_H = W \equiv 1/t$, $P_L = V_L$, and $P_H = V_H - (V_H - V_L)e/(n_bW)$. The expected value of underpricing under this version of bookbuilding is

$$(V_H - V_L)e/(2n_b W), \quad (7)$$

where n_b is given by Corollary 2 below.

Note that the expected profit for any informed investor from producing information and standing ready to participate in the bookbuilding mechanism is the total expected underpricing divided by n_b . By equating this with the cost of information acquisition c , we have:

$$(V_H - V_L)e/(2Wn_b^2) = c.$$

Solving for n_b , we obtain the following result.

Corollary 2. Suppose that t informed investors out of all n informed investors are randomly selected for the premarket and allocated the new shares. Then the number n of investors who ex ante choose to become informed in equilibrium is $n_b = [(V_H - V_L)e/(2cW)]^{1/2}$.

The optimal price/allocation rule for this version of bookbuilding parallels that in Proposition 2 in that the offering is underpriced and allocated to the informed investors only when they report H. An important difference in the outcome of the offering, though, is that underpricing is reduced by a factor of t/n_b [or $1/(n_b W)$ since $tW = 1$] relative to that in Proposition 2. The reduction is brought about by the fact that the issuer now allocates the underpriced shares to the smaller set of t investors, who will each receive W shares if they truthfully report H, but the smaller $1/n_b$ of the aftermarket trading profit if they falsely report L.

As W gets larger (and t smaller), the per-share discount needed to satisfy the incentive compatibility constraint (2) gets smaller.

Another notable difference is the weaker correlation between the equilibrium level of underpricing and the exogenous parameters e and $(V_H - V_L)$. While an increase in any of the two parameters does increase potential aftermarket profits, it leads only to a partial increase in underpricing because the share of each investor in the additional trading profits, $1/n_b$, is less than the allocation of underpriced shares, W , the investor receives if he is chosen to participate in the premarket. A smaller increase in underpricing can, therefore, offset the additional profit the t investors expect in the aftermarket if they falsely reveal L. (It should be noted here that the fact that only t investors participate in the IPO -- and benefit from underpricing -- keeps n_b from increasing proportionally with e and $(V_H - V_L)$, as the expression of n_b in Corollary 2 shows.)

A third difference is the dependence of underpricing on the information production cost, c . As this cost increases, fewer investors choose to become informed in equilibrium (see n_b in Corollary 2), raising the profit each expects from aftermarket trading and, as a result, raising the reward each should receive to forgo such a profit. Since W is the most an issuer can allocate to an investor who participates in the premarket, the larger c implies that a larger discount is needed to induce investors to surrender their informational advantage.

Last, like in Proposition 2, underpricing in equilibrium cannot be too large since, otherwise, it could induce investors to misrepresent L as H, violating incentive compatibility constraint (3). However, since the t premarket investors receive a larger allocation (W) each in the H state, and because underpricing is lower than in Proposition 2 for any level of e , satisfying (3) is easier (can happen for a larger e) in this version of bookbuilding than when all n_b investors participate in the premarket. This is due to the fact that misrepresenting L as H entails a larger

cost in this version of bookbuilding as investors will receive a *larger* allocation of shares that are *overpriced* by more. Again, constraint (3) does not bind at the optimum.

We can now compare the two mechanisms in terms of the exogenous variables of the model. Recall that the underpricing under the fixed price mechanism is $(V_H - V_L)e/4$ and that under the bookbuilding mechanism with random selection is $(V_H - V_L)e/(2n_b W)$. The underpricing under bookbuilding is lower if and only if $n_b W > 2$ (or $n_b/t > 2$).

Proposition 5. Suppose it is possible for an issuer building a book to randomly select a subset of the informed investors to premarket to. Then, the issuer chooses bookbuilding over fixed price if and only if

$$n_b W = [(V_H - V_L)eW/(2c)]^{1/2} > 2.$$

The dominance of bookbuilding hinges on the issuer's ability to 'bribe' and solicit information from a subset of investors that is small enough relative to the entire informed investing public (at most one-half according to Proposition 5, since $W = 1/t$). A larger potential for profit in the aftermarket and/or a lower information production cost lead to a larger set of investors who choose to become informed in equilibrium. As n_b increases (and t/n_b drops), underpricing in bookbuilding assumes a lower fraction of aftermarket profits, enhancing the appeal of bookbuilding relative to fixed price (under which underpricing is identical to aftermarket profits). An increase in individual investors' budgets, W , leads to a similar end result, but by reducing the size of t relative to n_b .

6. Discussion

We have gained valuable insights from analyzing the impact on the pricing of IPOs of the aftermarket strategic behavior of informed investors. First, the ability of the informed investors to profit in the aftermarket leads to IPO underpricing in settings where other papers would suggest otherwise. For example, fixed price offerings in Rock (1986) and Benveniste and Wilhelm (1990) are underpriced to offset the winner's curse faced by the uninformed investors. The offerings in these papers are priced ex ante and sold in a market that includes both informed and uninformed investors. The informed place orders only for offerings they know are below true value, crowding the uninformed out of these offerings and leaving them stuck mostly with overpriced issues. There would be no underpricing in these papers if the offerings could be marketed strictly to uninformed investors. Our analysis shows, to the contrary, that underpricing would still be needed because the informed investors could exploit their information by trading strategically in the aftermarket against the uninformed who are allocated the IPO shares.

In bookbuilding, recall that underpricing is required to induce informed investors to truthfully reveal favorable information. The optimal price/allocation rule minimizes underpricing by minimizing the benefit from misrepresenting information. Allocation priority is given to investors with strong interest and those with weak interest are, to the extent possible, excluded from the offering lest they receive allocations of shares at depressed prices. Using the language of our model, the optimal bookbuilding rule maximizes A_H and minimizes A_L . The existing bookbuilding models assume that A_L cannot always be set to zero, because either there are no alternative outlets for the shares, like selling to retail investors for example (Benveniste and Spindt, 1989, and Benveniste and Busaba, 1997), or the alternatives that exist are not always reliable, like the random retail participation in Benvensite, Busaba, and Wilhelm (1996) or the

insufficient retail capacity in Biais and Faugeron-Crouzet (2001).¹³ Underpricing will be eliminated entirely in these models if the issuer is able to sell the whole offering to uninformed retail investors every time informed investors show weak interest. Our analysis shows, to the contrary, that even if A_L can always be set to zero, underpricing is still needed because of the informed investors' ability to profit in the aftermarket.

Another insight that we gained is about what determines underpricing in bookbuilding, information production or revelation. Sherman and Titman (2001), for example, argue in a bookbuilding model where information production is costly and pricing accuracy is critical that underpricing is determined by the need to induce investors to *produce* information rather than to *reveal* the information. In other words, a participation constraint, not an incentive compatibility constraint, binds in the pricing of IPOs. This is because the issuer in their model can increase the number of investors in the premarket to the point where the reduction in incentive-compatibility underpricing due to the addition of the last investor is just equal to the information production cost incurred by the investor.

In our model, both constraints bind at the same time: incentive compatibility determines the profit from possessing private information and this profit in turn creates an incentive ex ante for enough investors to produce information and stand ready to participate in IPOs. And when the issuer premarkets the offering to a small subset of informed investors, *only* incentive compatibility (constraint (2)) will bind in pricing, whereas the cost of information production determines the number of investors who ex ante choose to become informed. Specifically, the t investors chosen (randomly) for the premarket earn profits in excess of c , and the expectation to

¹³ Busaba (2000) admits the option to cancel an IPO during the bookbuilding process and shows that the option reduces underpricing by lowering the allocation to disinterested investors. (The option, therefore, works like an alternative outlet for the shares.) In his model, underpricing will be eliminated if the issuer withdraws every time demand by interested investors is not sufficient.

earn these rents by any informed investor creates an incentive *ex ante* for as many as n investors to become informed. Furthermore, because underpricing in our model is determined by the “cheating” investors’ profit in the aftermarket, rather than the investors’ ability to secure cheap IPO allocations, including more investors in the premarket would in fact increase not decrease the underpricing needed for incentive compatibility, as Propositions 4 and 5 imply.

This brings us to the third insight. One concern often raised in the context of the existing bookbuilding models is why the issuer (or banker) does not premarket to a large – or infinite -- number of informed investors if doing so increases competition for allocations and reduces underpricing. In response, the literature has appealed to feasibility constraints and/or prohibitive costs (e.g., Benveniste and Busaba, 1997, and Sherman and Titman, 2001). Our analysis suggests another reason, which implies that even if a large number of informed investors were readily available, the issuer would still choose to deal with a relatively small subset of these investors. The ability to limit participation in the premarket provides the issuer in our model with stronger leverage over the participating investors, allowing it to solicit information with a lower promised discount.

Our analysis, therefore, establishes an efficiency rationale for the commonly observed practice by U.S. underwriters of targeting a relatively small group of institutional (presumably informed) investors during the premarket. The key to our analysis is that the banker *randomly* chooses this group from the informed public at large. Since participating in IPOs generates rents in equilibrium, random selection ensures that many more investors choose to become informed *ex ante* (in hopes of being selected), giving the issuer the necessary leverage to solicit information cheaply from the participating investors.

Random selection is more of a specific feature of our stylized model than a necessary condition for there to be benefits to limiting access to the premarket. Our model could be extended in at least one way to illustrate that such benefits exist also when the banker targets a *select* pool of “regular” investors, which is more consistent with the observed underwriting practices in the U.S. (Benveniste and Spindt, 1989 and Benveniste and Wilhelm, 1990). One such extension is when investors' signals are correlated but not identical. In such a setting, the marginal value of an investor's signal is higher when a smaller number of signals are aggregated (see Welch, 1992 and Benveniste and Busaba, 1997), and signals that are not aggregated still have value, albeit less, on the margin. We could have an equilibrium in this framework, in which the issuer premarkets to a small pool of ‘regulars’, who each receives the marginal value of his information, while the excluded informed investors profit only through trading in the aftermarket.¹⁴ Aftermarket profits are obviously less for an investor since the premarket diminishes the marginal value of the investor's signal. In addition, the investor still has to compete in the aftermarket with a large number of investors who have correlated signals. Hence, the threat to exclude a regular from allocations is credible, and a bookbuilding mechanism like that in Proposition 4 will be optimal. As long as aftermarket profits are sufficiently large and /or information production cost small, many investors outside of the known pool of regulars choose to become informed, giving the issuer the leverage over regulars necessary to solicit information efficiently.

Another extension to our model is an environment where an *exogenous* number of investors are endowed with relevant information about the value of an issuing firm. This environment could prevail when, for example, industry analysts working for institutional

¹⁴ Devising aftermarket trading strategies and integrating them into premarket allocation rules and reporting strategies are intractable in this framework; that is why we assume identical information signals

investors are able to value a newcomer to the industry with minimal effort and/or cost. As long as the number of these analysts is finite, say equal to n , our analysis regarding the advantage of targeting a subset t of them in the premarket carries through in a straightforward manner even when the t investors are “regulars” rather than randomly chosen. Proposition 6 formalizes this result.

Proposition 6. Suppose that n investors are endowed with the same signal $I = H$ or L , where n is exogenous and $nW \geq 1$. Suppose that t of these n investors are “regulars” who are always invited to IPOs, where t satisfies $tW=1$. Then, the price/allocation rule outlined in Proposition 4 is an optimal bookbuilding mechanism that yields the underpricing level given in (7) of Proposition 4. This mechanism dominates fixed price if and only if $nW > 2$.

We now discuss two possible qualifications of our results. First, the benefit of targeting a small subset of informed investors in the premarket is reduced when the correlation between investor pieces of information is weak. At the extreme, in an environment where these pieces are *independent*, the marginal impact of each piece in price formation is constant regardless of how many pieces are aggregated (e.g. Benveniste and Spindt, 1989). This implies that investors would not be ‘punished’ much if they were deprived from IPO allocations, since they can still capture the full value of their information when they trade in the aftermarket. Incentive compatibility in this framework would require that each investor, whether part of a small or a large pool of regulars, be given the full value of his information, exactly what he expects to receive in the aftermarket. Hence, we suspect that there would be no advantage over fixed price

offerings in this framework. Our results in Propositions 5 and 6 would best apply in environments where investors' information signals are sufficiently correlated.

Second, we have assumed that the informed investors do not suffer liquidity shocks. If this is not the case, trading games will be much more complex because we have to address how the informed investors' liquidity shocks are correlated with the retail investors' and whether the informed investors can use this correlation as an additional information advantage in trading. The general effect of introducing liquidity shocks for informed investors, however, is likely to be the reduction of trading profits in both the fixed price method and bookbuilding. In terms of the comparison of the two, we do not expect a significant departure from our current results.

7. Summary and Conclusion

We have shown that the ability of informed IPO investors to trade on their information in the aftermarket exerts additional pressure on the pricing of offerings. Informed investors can profit from trading with the uninformed who are allocated IPO shares and who might need to sell in the aftermarket for liquidity reasons. Offerings have to be underpriced, therefore, to offset the losses of the uninformed investors, whether the offerings are sold via the fixed price method or bookbuilding. To be sure, the discount in bookbuilding is to convince the informed investors to surrender information and forgo the aftermarket profit potential.

Our analysis illustrates that the presence of informed investors in the primary market imposes a higher cost than previously thought on the process of going public. In fact, even if the strategic behavior of these investors can be neutralized at the IPO stage, by excluding them from fixed price offerings and by allocating to retail investors as needed in bookbuilding, underpricing will still be required because of the investors' strategic trading in the aftermarket. We have

shown, therefore, that underpricing will be present in settings where existing models fail to justify its presence.

Furthermore, we show that bookbuilding in which all informed investors are treated equally does not dominate fixed price when the effect of aftermarket trading is considered. Only if the banker building a book can premarket to a small group of informed investors will bookbuilding generate higher proceeds, on average, than fixed price. This suggests a rationale for the practice by American bankers of targeting a select group of institutions in the premarket. It also suggests that forcing the bankers to open up the premarket would lead to higher underpricing or to a stronger preference for the fixed price method.

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Appendix

Proof of Lemma 1:

The posterior probabilities and profits along the equilibrium path are all listed in Table 1. The expected trading profit is just the weighted average of the profits in the middle two rows. To show that any given α -strategy is an equilibrium strategy, we need to verify that an informed trader has no incentive to deviate from it. Suppose that the signal is L. In order to get a higher trading profit, an informed trader can increase its sell order above $\alpha e/n$. However, this, even in the case of low liquidity selling ($m-e$), will necessarily increase the total order flow above $m+(\alpha-1)e$ (the third row of Table 1). The market maker will detect the true state being L and price the share at V_L , which will make the informed trader worse off. The proof for the case when the true signal is H is similar. Q.E.D.

Proof of Proposition 1:

The expected payoff to a retail investor is the expected value of the stock, $(V_H+V_L)/2$, minus the expected loss due to possible liquidity shocks in the aftermarket, $(V_H-V_L)e/4$. Q.E.D.

Proof of Lemma 2:

The proof parallels that for Lemma 1 above. Q.E.D.

Proof of Proposition 2:

See the text. Q.E.D.

Proof of Proposition 3:

Simply compare the amounts of underpricing in Propositions 1 and 2. Q.E.D.

Proof of Proposition 4:

Since $W = 1/t > 1/n$, an increase in A_H from $1/n$ to W will relax the LHS of (2) without changing the RHS. Relaxing a constraint increases the maximized value of the objective function. P_H then is solved for when (2) is satisfied with equality. The expected value of underpricing is the difference between V_H and P_H multiplied by the probability that V_H happens, 0.5. Q.E.D.

Proof of Proposition 5:

See the text. Q.E.D.

Proof of Proposition 6:

The proof is the same as that of Proposition 5. Q.E.D.