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BOOKBUILDING AND
STRATEGIC ALLOCATION

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ABSTRACT

Bookbuilding and Strategic Allocation*

Under the bookbuilding procedure, an investment banker solicits bids for shares from institutional investors prior to pricing the issue. After collecting this demand information, the investment banker prices the issue and allocates shares to the investors. We examine the books from 39 international equity issues. For each issue we consider all institutional bids and the corresponding allocations. We infer some of the criteria the investment banker uses to allocate shares. We find that the investment banker awards more shares to bidders that provide information (such as a limit price in their bids). In addition, regular investors receive more favourable allocations - especially when the issue is heavily oversubscribed. The results support the winner's curse theories and the justifications for the use of bookbuilding.

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NON-TECHNICAL SUMMARY

Equity issues have long been a puzzle to financial economists. The most striking empirical regularity is that, on average, new issues experience a substantial price rise on the first day of trading. In other words, the investment bank apparently sets the issue price too low. Several studies have provided different theoretical justifications for this phenomenon and some of them have underlined the asymmetry between informed and uninformed investors.

In this paper we exploit the fact that the mechanism used to issue equity has been changing in recent years. It is becoming increasingly common for investment banks to 'build a book' before pricing equity issues. Under the bookbuilding procedure, the investment banker solicits indications of interest from institutional investors and uses the information collected to determine the price and allocation of the offering. An indication of interest consists of a bid for a quantity of shares and frequently includes a maximum price (a limit bid) or other details. Investors can revise their bids over time. The issue price is not set according to any explicit rule, but rather at a level determined by the investment bank after observing all the indications of interest. It is generally set at a level at which demand exceeds supply. The shares are allocated to the bidders at the discretion of the investment banker.

We use a unique data set that includes the books of 39 issues, with all the bid details and the final allocation for each institutional investor. This allows us to analyse the allocation decision of the investment bank and to infer the criteria that the banker uses in the allocation decision.

When we compare bids with allocations, we find that bidders who provide information are allocated more shares than others. For example, bidders that provide price information through limit prices are awarded 17% more shares than similar bidders who submit quantity bids without price limits. Similarly, bidders who revise their bids - which can be interpreted as providing information as it arises over time - are subject to a more favourable treatment.

Moreover, we find that bidders who participate in many issues receive favourable treatment especially in the more successful, (i.e. oversubscribed) issues. Nonetheless, when we look at actual returns, we find that the informed bidders who participate infrequently are choosing the most underpriced issues and earn the highest return.

Our results suggest that indeed bookbuilding reduces the winner's curse problem by eliciting information. The investment banker gives a greater allocation to informed bidders as compensation for information. Regular bidders are compensated with higher allocations in exchange for providing

insurance to the investment banker. However, regular investors are subject to a winner's curse due to the presence of informed investors. If regular investors are treated the same way across all issues (albeit with a larger than proportional allocation), regardless of whether or not they are 'hot issues', then they will end up with low returns. The investment bank compensates them for bearing this adverse selection by providing them with more shares of the oversubscribed issues. Although the investment bank cannot accurately predict after-market returns, it can use the information contained in the oversubscription of the issue, which is positively correlated with after-market returns. Bids with a limit price are not as susceptible to adverse selection because they are informed and presumably choose attractive issues. The adverse selection faced by frequent bidders is confirmed by our result that frequent bidders, although favoured by the investment bank, earn a lower return than infrequent limit bidders, who appear to successfully pick the underpriced issues.

We also find that early limit bids are particularly favoured providing some support for the cascades theory. Very large orders are also favoured - which suggests that the bank is not concerned with disperse ownership.

Finally, we find that the investment bank also uses its discretion in order to increase its own compensation by favouring bids that were submitted directly to the bookrunner rather than to other members of the selling syndicate.

1. Introduction

Equity issues have long been a puzzle to financial economists. The most striking empirical regularity is that, on average, new issues experience a substantial price rise on the first day of trading. In other words, the investment bank apparently sets the issue price too low. Several studies have provided different theoretical justifications for this phenomenon and some of them have underlined the asymmetry between informed and uninformed investors. Empirical tests of these theories have focused on the aftermarket returns. However, it is often difficult to distinguish among the theories when looking only at aftermarket returns.

In this paper we take a different approach to testing the theories of equity issues, exploiting the fact that the mechanism used to issue equity has been changing in recent years. It is becoming increasingly common for investment banks to "build a book" before pricing equity issues. Under the bookbuilding procedure, the investment banker solicits indications of interest from institutional investors and uses the information collected to determine the price and allocation of the offering. An indication of interest consists of a bid for a quantity of shares and frequently includes a maximum price (a limit bid) or other details. Investors can revise their bids over time.[1] The issue price is not set according to any explicit rule, but rather at a level determined by the investment bank after observing all the indications of interest. It is generally set at a level at which demand exceeds supply. The shares are allocated to the bidders at the discretion of the investment banker.

We use a unique data set that includes the books of 39 issues, with all the bid details and the final allocation for each institutional investor. This allows us to analyze the allocation decision of the investment bank and to infer the criteria that the banker uses in the allocation decision. This in turn has implications for the banker's objective function. We can then see which theories are consistent with the observed allocation decision.

In particular, several theories have focused on the crucial role that informed in-

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[1]For a detailed description of the bookbuilding procedure, see Benveniste and Wilhelm (1997).

vestors play. In the winner's curse model proposed by Rock (1986), informed investors choose when to participate and impose a negative externality on uninformed investors, who obtain a disproportionate share of the overpriced issues. As a result, the banker must choose a low price in order to compensate the uninformed for the resulting adverse selection. Both Spatt and Srivastava (1991) and Benveniste and Spindt (1989) argue that bookbuilding can be seen as a mechanism designed to elicit price information from investors and reduce underpricing. In return, the investment bank has to favor the informed investors in order to induce them to reveal their private information. This can be done through a more favorable allocation of shares.

Benveniste and Spindt (1989) argue that the investment bank may also reward regular investors, who act as a form of insurance by buying shares in badly received issues. The investment banker rewards these regular investors with larger allocations of the better issues. Welch (1992) argues that the investment bank sets a low price in order to induce the early participation of informed investors, which in turn will attract a cascade of additional investors.[2]

Alternatively, allocation criteria may indicate that the investment bank is concerned with encouraging disperse ownership, as suggested by Brennan and Franks (1997), or that it may use the discretion to reward investors that have other ties with the bank.

When we compare bids with allocations, we find that bidders who provide information are allocated more shares than others. For example, bidders that provide price information through limit prices are awarded 17% more shares than similar bidders who submit quantity bids without price limits. Similarly, bidders who revise their bids—which can be interpreted as providing information as it arises over time—are subject to a more favorable treatment.

Moreover, we find that bidders who participate in many issues receive favorable treatment especially in the more successful, (i.e. oversubscribed) issues. Nonetheless,

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[2]For a overview of these theories and their empirical implications, see Jenkinson and Ljungqvist (1996) and Ibbotson, Sindelar and Ritter (1994).

when we look at actual returns, we find that the informed bidders who participate infrequently are choosing the most underpriced issues and earn the highest return.

Our results are compatible with the winner's curse theory and suggest that indeed bookbuilding reduces the winner's curse problem by eliciting information. The investment banker gives a greater allocation to informed bidders as compensation for information. Regular bidders are compensated with higher allocations in exchange for providing insurance to the investment banker. However, regular investors are subject to a winner's curse due to the presence of informed investors. If regular investors are treated the same way across all issues (albeit with a larger than proportional allocation), regardless of whether or not they are "hot issues", then they will end up with low returns. The investment bank compensates them for bearing this adverse selection by providing them with more shares of the oversubscribed issues. Although the investment bank cannot accurately predict after-market returns, it can use the information contained in the oversubscription of the issue, which is positively correlated with after-market returns. Limit bidders are not as susceptible to adverse selection because they are informed and presumably choose attractive issues. The adverse selection faced by frequent bidders is confirmed by our result that frequent bidders, although favored by the investment bank, earn a lower return than infrequent limit bidders, who appear to successfully pick the underpriced issues.

We also find that early limit bids are particularly favored providing some support for the cascades theory. Very large orders are also favored—which suggests that the bank is not concerned with disperse ownership.

Finally, we find that the investment bank also uses its discretion in order to increase its own compensation by favoring bids that were submitted directly to the bookrunner rather than to other members of the selling syndicate.

In this paper we observe the book and the entire demand for stock over an entire range of prices. Kandel, Sarig and Wohl (1999) and Biais and Faugeron-Crouzet (1998) also study equity issues in which they observe the entire demand for the shares. However, in those studies the shares are sold through an auction or an auction-like mechanism, where the allocation rule is specified in advance. In our case, the

allocation is purely discretionary, and we use these data to determine the allocation criteria used by the investment bank.[3]

While most of the paper takes bidder behavior as given, bidders will consider the allocation rule when choosing their bids. We examine bidder behavior and find that it is consistent with our results.

In the next section, we discuss the bookbuilding process, and provide some descriptive statistics. Section 3 discusses the testable implications of the theoretical literature. Section 4 contains the empirical analysis of the allocation decisions. Section 5 provides an analysis of bidder behavior and Section 6 concludes.

2.   Description of the data and the bookbuilding procedure

We consider 39 international equity issues, which took place between 1995 and 1997. Because of the high fixed cost of the procedure, bookbuilding is used primarily for large issues, usually international issues which are sold in different countries simultaneously.[4]

Of the 39 issues, 23 are IPOs and 16 are seasoned issues. Fourteen of the 39 issues are privatizations (both IPOs and later tranches). The bookbuilding procedure was used in the seasoned issues because the existing stock was illiquid or the quantity of new shares was large enough to move the market. Thus, we do not consider seasoned issues as substantially different from IPOs and we include them in our study. We also include privatizations because the bidders are primarily foreign institutions and there is no reason to believe that the criteria for allocating shares to these investors should be very different than in other issues.[5] Huang and Levich (1998) provide evidence that is consistent with proceeds maximization in privatization IPOs.

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[3]Keloharju (1998) studies allocations in the context of fixed price offerings in which bids are not used to price the issue and information extraction is not relevant. Rydqvist (1997) uses allocation data to study the use of share allocations as a form of tax-efficient compensation.

[4]US domestic issues also use bookbuilding, but in a less structured form.

[5]In privatization, shares for domestic retail customers are often sold in a separate tranche at a pre-announced discount to the general issue price.

For each issue we have data on all the bids from the potential buyers and the final allocation of shares to them.[6]

The book contains each bid submitted, including the identity of the bidder, the number of shares requested as well as a limit price if the bidder specified one. In addition, the book contains the date when the bid was entered and any subsequent revision (or cancellation) of the bid. It also records the manager who received the bid and the tranche requested.

The book distinguishes between three types of bids. A "strike bid" is a market order: an order for a specific number of shares regardless of the issue price. Bids can be denominated in shares or currency units (e.g. $5 million worth of shares).[7] A "limit bid" is a limit order: the bidder specifies the maximum price that he is willing to pay for the shares. In a "step bid" the bidder submits a demand schedule as a step function.

Table 1 shows ten bids from one of the issues. The first bidder expressed an interest in purchasing £1 million worth of shares. The bid was a strike bid — he is willing to pay any issue price. However, because the bid was expressed in currency units rather than shares, his demand for shares is lower at higher prices. In contrast, bidder 10 asked for 1000 shares regardless of the price. The only limit order in this part of the book was submitted by bidder 7 who requested 20,000 shares at a maximum price of 72. Bidder 5 submitted a step bid specifying 10,000 shares for a price of 69 or lower, but only 5000 shares for a price above 69, and an absolute price limit of 75. Bidders 4 and 9 revised their original bids.

After the deadline for submitting bids, just before the issue, the investment banker aggregates all the bid information and determines the issue price. The price is set so that total demand is larger than the number of shares offered. Figure 1 shows the oversubscription at the issue price for the issues in our sample. The median

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[6]The book does not include the retail demand. A pre-specified number of shares are reserved for retail investors, which is handled separately and is not used to price the issue.

[7]The bid may be in any currency. We have translated such amounts into the issue currency using the exchange rate at the issue date, which is the procedure followed by the investment bank.

oversubscription corresponds to a total demand of approximately three times the total supply. There are however some very heavily oversubscribed issues — up to 22 times the number of shares offered.

Once the issue price is set, the investment banker decides how to allocate the total shares among investors. As explained earlier, the investment banker does not follow an explicit rule. Table 2 shows the allocations (drawn from one of the issues in our data set) for a group of bidders each of whom submitted a bid for 20,000 shares. First of all, it is evident that the banker is not following a strict priority rule. The limit bids are awarded shares even though the strike bids have not received a 100% allocation. Similarly, the limit bid of 71 was awarded shares even though the higher limit bid of 72 still has unfilled demand. It is also noteworthy that the bidders are not being rationed equally. The awards range from 5000 shares to 12,200 shares even though all the bidders requested the same number of shares.

In fact, it is not unusual for a bidder who requested fewer shares to be awarded more shares than a larger bidder. For example, in Table 2 bidder 94 requested 20,000 shares and was awarded 5000. However in the same issue another bidder requested 10,000 shares and was awarded 6100. Also, in the example, the bidder with the higher limit price was awarded more shares than the one with the lower limit price. However, the banker often awards more shares to the bidder with the lower limit price. Moreover, some bidders are awarded no shares at all.

Figure 2 shows the demand curve for this issue. In total, just under 1.3 million shares were issued. However, even at a price of 80, the bids totalled 2.28 million shares. The choice of 71 as the issue price was not set anywhere near the point where the supply crosses the demand curve. In this case, it is set near the point where the demand curve begins its steepest descent.

In our sample of 39 issues, the issuing companies come from 20 different countries and bidders come from 61 countries. Bids are denominated in 19 different currencies, although most currency bids are in US dollars or British pounds.

The average number of final bids per issue is 295 and the median is 264 (excluding

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cancelled bids). The actual number of final bids ranges from 57 to 896. Many bids get revised; on average there are .24 revisions per initial bid and 4.6% of all initial bids were ultimately cancelled by the bidder.

There are 6236 unique bidders in the data set and on average each bidder participated in 1.84 issues. While the large majority of the bidders bid only once or a few times, more than 100 bidders took part in at least 10 issues. 80% of all final bids (excluding the cancelled bids) are strike bids, 16.6% are limit bids and 3.4% are step bids. 21.5% of all limit bids were missed (i.e. the issue price was higher then the limit bid) and 9.8% of the step bid were missed.

In Section 4 we study how the allocation of shares depends upon the characteristics of the bids. We look at each bid as a percentage of the total bids in the issue (defined as *percentage bid*) as well as each allocation as a percentage of all the shares allocated in the issue (defined as *percentage allocation*). The focus of our analysis is the *normalized rationing* defined as the ratio of percentage allocation to percentage bid. We do not focus on quantities of shares directly, as the size of each share varies across issues. Although we calculate the raw rationing - the ratio of shares allocated to bid quantity - we do not give it undue stress as it will naturally be lower for oversubscribed issues and higher for issues that are not very oversubscribed. Normalized rationing is equal to the raw rationing times the oversubscription. If shares were allocated pro rata, the normalized rationing would always equal 100% for each bidder. Any deviation in the normalized rationing from 100% represents discrimination in favor or against some bidders.

In our analysis we give equal weight to each issue, i.e., we compute the average of a variable by first taking the average within each issue and then averaging across all 39 issues.[8] Because the percentage bid must sum to one for each issue, the average percentage bid is simply the average of $\frac{1}{N_j}$ across the 39 issues where N_j is the number

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[8]In other words, if x_{ij} is a variable for bidder i in issue j, the average is given by $\frac{1}{39} \sum_j \frac{1}{N_j} \sum_i x_{ij}$. We have repeated all the analysis of this paper with equal weighting on each bid, i.e. computing the values in the following way: $\frac{1}{\sum_j N_j} \sum_j \sum_i x_{ij}$. The results are similar.

of bidders in issue j. Thus, the average percentage bid is 0.63%. Similarly, the average percentage allocation is also 0.63%.

The average rationing is 28.5%. The average normalized rationing is 71.8%. The fact that the average normalized rationing is below 100% already suggests that shares are not being distributed pro rata, but that larger bidders receive more favorable allocations. When a fixed number of shares are diverted from a small bidder to a large bidder, the normalized rationing for the large bidder increases slightly above 100%, but the normalized rationing for the small bidder decreases far below 100%. Thus, the average normalized rationing is below 100%.

Figure 3 gives an example of the distribution of percentage bids, percentage allocations and rationing for one issue in our sample.

3. Theories and testable implications

As explained in the introduction, our purpose in looking at the allocation criteria of the investment banker is to implicitly test the various theories of underpricing and in particular to understand if the presence of informed investors does indeed play an important role in equity issues.

Before actually studying the allocation criteria, we must discuss the allocation criteria that are consistent with the various theories of underpricing. In this section we review these theories and their testable implications with respect to allocations.

Several explanations of underpricing are based on the presence of asymmetric information. As mentioned above, Rock's (1986) winner's curse model argues that underpricing is due to the presence of informed investors. Since informed investors only buy underpriced issues, uninformed investors obtain more shares in overpriced issues and will only demand shares if they are underpriced on average. An empirical implication of Rock (1986) is that the winner's curse—and underpricing—could be reduced if the shares were sold only to informed investors; and that underpricing should increase with the ex-ante price uncertainty and asymmetric information surrounding an issue. Beatty and Ritter (1986) find a relationship between ex-ante uncertainty and underpricing. Similarly, Michaely and Shaw (1994) show a positive

relationship between underpricing and the degree of asymmetric information across investors. Other empirical studies use institutional investors as proxies for informed investors. The Security and Exchange Commission (1971) found that institutional investors do not receive preferential treatment in oversubscribed issues. Moreover, Weiss Hanley and Wilhelm (1995) find that there is no difference in the size of the allocations institutional investors receive in underpriced and overpriced issues. But institutional investors are not necessarily informed, or some may be more informed than others. Our data set contains only institutional investors, but it also contains details about the way they bid, which can help us to identify the informed bidders among them.

The distinction between informed and uninformed bidders as an explanation for underpricing is particularly relevant since both Benveniste and Spindt (1989) and Spatt and Srivastava (1991) argue that the main use of bookbuilding is to extract information from informed investors, giving some rents in exchange for truthful revelation. Loughran, Ritter and Rydqvist (1994) argue that if the investment bank can vary the number of shares in a discriminatory manner, allocating more shares to those bidders who provide valuable information, less underpricing is required.[9] An implication is that informed bidders receive larger allocations (relative to their bid) than uninformed bidders. The problem is to identify the informed bidders. The strength of our data is the fact that instead of relying on broad categories (such as institutional bidders vs. retail) we can infer their information from the characteristics of their bids.

In a standard auction, bids are unidimensional, so the only way to reveal information is by bidding higher or lower. In bookbuilding, investors can not only ask for larger or smaller quantities, but they can also submit such demands in the form of strike, limit or step bids. While strike bids inform the banker about the market's demand for the stock, limit bids also provide specific information about the elasticity

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[9]In fact, Loughran, Ritter and Rydqvist (1994) find that in countries where the IPO mechanism sets the price after extracting information and allows for discretional allocation the underpricing is lower.

of that demand. In fact, if all bids were strike bids, the aggregate demand would be perfectly horizontal and the book would provide no indication on how to price the issue. However, limit and step bids do provide price information.

When an informed investor submits a limit bid he reveals his information, which will be used by the investment banker to set the price. In exchange the bidder will want to receive more (underpriced) shares. If he does not reveal the information and submits a strike bid, the price will still be approximately correct (because of the information from the other limit bids) and the bidder will receive fewer shares.

Let us now consider an uninformed investor and see why he will not want to submit a limit bid. By submitting a limit (or step) bid, he incurs two types of costs. If the limit price is too low, the risk is that the investment bank will set a price for the issue higher than the limit price and the investor will obtain no shares at all. On the other side, if the limit price is too high he may influence the price up and receive overpriced shares. As an alternative to this last point, the investment bank may want to discourage frivolous bids by giving less shares to limit bids where the limit price is too high relative to the other limit bids.

As a consequence, if bookbuilding has to provide a rent in order to extract the investors' private information, we should find that limit and step bids are treated more favorably. Moreover, any other characteristic which captures information should have the same effect. Note that we do not identify a bidder as always informed, but as informed in a particular issue, as inferred from the way he bids in that issue. Also, if the investment bank discourages frivolous bids, we should observe that limit bids are discriminated against when the limit price is very high.

If instead of looking at the allocations we look directly at the investors' returns, we should find that bidders identified as informed choose the most successful issues.

A final empirical implication of the hypothesis that bookbuilding helps the investment bank extract information is that the average underpricing of these issues should be lower than the average underpricing for other issues.

The extraction of information described until now could be implemented through

an auction-like procedure, with the allocation rules set in advance. Benveniste and Spindt (1989) and Benveniste and Wilhelm (1990) argue that bookbuilding is a better method than an auction since it allows the investment bank to discriminate in the allocation of shares based on broad participation in past offerings. In other words, to give favorable treatment to frequent buyers. These frequent buyers act as insurance and buy shares in both successful and unsuccessful issues. The empirical implication of this hypothesis is that the investment banker favors regular investors who participate in many issues.

Alternatively, frequent bidders might simply be the investment bank's regular clients or friends and receive favorable treatment as a result. However, the Benveniste and Spindt (1989) hypothesis also implies that infrequent bidders are able to pick the more successful issues, while frequent bidders do not perform well because of the winner's curse (despite the discriminatory behavior of the investment bank). The alternative hypothesis does not have this implication.

Another explanation for underpricing is the need to create informational cascades (Welch, 1992): the investment banker wants to encourage early demand for shares from informed investors, since this will induce other investors to follow. As a result, early bids might receive better allocations.[10] An alternative explanation for this type of allocation could be that the investment banker may need information from early bidders to refine the process of soliciting bids over time.

Another issue is whether the issuing company has preferences about the ownership distribution of its shares. Brennan and Franks (1997) argue that managers want to avoid any large stake being assembled by a single investor. By underpricing the flotation, they can ensure that the offer is oversubscribed and that investors will be rationed. Rationing, in turns, allows managers to discriminate between applicants of different sizes and to reduce the block size of new shareholders. Alternatively, the issuing company may be worried about liquidity and may want to spread ownership

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[10]For this to be true it is necessary that subsequent investors can at least partially observe previous bids. Moreover, Benveniste and Busaba (1997) argue that bookbuilding may be seen as an alternative to creating a cascade.

widely for this reason. The implication in both cases is that rationing should favor investors who demand a smaller number of shares.

Finally, the investment bank may be just interested in maximizing its own compensation. One aspect of this was already mentioned when we discussed the possibility that the bank should favor its "friends"—possibly the frequent bidders—who should be expected to earn higher returns than other investors. Another argument is that the investment banker may want to favor investors who submit their bids directly to the bookrunner, since it then earns additional selling fees.

4. Results

We now study the investment bank's allocation criteria. We assume that the pricing decision is not made to influence the distribution of the shares.[11] Once the issue price has been chosen, the total oversubscription of the issue is determined and the investment banker must decide how to allocate the shares among the bidders. Therefore, we study the share allocations given the demand at the issue price.

In the first part of the section we present tables showing the average rationing conditional upon bid characteristics. In the main part of this section, we present regression results to test for multiple characteristics, and we look for differences between IPOs and seasoned issues. Finally, we study whether the favorable treatment in terms of shares is also reflected in higher returns.

The results in this section are obtained by equally weighting each issue. We have repeated the analysis with equal weight for each bid and the results are very similar.

4.1. Introductory Statistics.   On average, the issues were underpriced by 2.4% relative to the first available post-issue market price. IPOs were underpriced 2.0% and seasoned issues were underpriced by 2.9%.[12] The relatively high underpricing for the

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[11]For example, we exclude the possibility that the investment banker would set a low price in order to ensure that a particular limit order is hit.

[12]The average for the entire sample is significantly different from zero at the 5% level, but the underpricing for the IPO and seasoned subsamples are not statistically significantly different from zero.

seasoned issues is driven by one outlying privatization. Seven out of 39 issues were overpriced and the value weighted average underpricing was 3.52%. The underpricing in this sample is much lower than the average underpricing of 10-15% which is found in many other studies. This is consistent with the hypothesis that bookbuilding extracts information and thus reduces underpricing.

Table 3 shows the average bid and allocation size and the average rationing and normalized rationing when bids are broken up according to different criteria. The first section divides the data into four quartiles based on the size of the bid. Large bidders are favored by being awarded a larger fraction of their bids than small bidders. This result holds across all four quartiles, but most strikingly for the third and fourth (i.e. largest) quartiles.

The fact that large bidders are receiving favorable treatment suggests that their large bids are not exaggerated in anticipation of excessive rationing.

In the second section of Table 3 we divide bids according to whether they are strike, limit or step bids. From the normalized rationing, we see that limit bids are favored relative to strike bids. Step bids are even more favored, but the small number of step bids makes this result less strong.

Since limit and step bids are larger than strike bids on average, and we saw that large bids are treated favorably, we have to check that we are not simply capturing a size effect. Table 4 separates large and small bids. Both among large bids and small bids, limits and step bids are favored relative to strike bids. The difference between limit and strike bids is more prominent among the large bids.

Another characteristic of bids is whether they come from investors who take part regularly in these equity issues or from investors who participate only sporadically. We split the bidders into three categories. Those who bid in 10 or more issues are defined as high frequency bidders. Medium frequency bidders are those who participated in 3 to 9 issues. Bidders that only participated in one or two issues are defined as low frequency. When sorting into these groups we include missed limit bids but not cancelled bids. Missed limit prices are certainly relevant because they

provide information to the banker. While cancelled bids are evidence of frequent contact between the investor and the banker, ultimately they do not represent bids for shares.[13]

In the third section of Table 3 we see that high frequency bidders are favored relative to medium frequency bidders who are in turn favored relative to low frequency bidders. Note that low frequency bidders submitted smaller bids than high and medium frequency bidders. When controlling for size we find that both among large bids and small bids high frequency bidders are most favored and low frequency bidders are least favored.

In Table 5, we see that the discrimination in favor of frequent bidders is robust to the bid type. Moreover, for all frequencies, limit and step bids are favored relative to strike bids.

The last distinction between bids is the time when they are submitted. In the fourth section of Table 3 we compare early and late bids. We sort the bids by the date when they were first submitted (ignoring the date of subsequent revisions) and define the first quarter as early. We find that early bids are slightly favored. Table 6 splits the data along the early/late dimension as well as bid type dimension (i.e. strike/limit/step). Among limit and step bids, early bids are favored by a substantial amount.

4.2. Allocation of shares. We now study the criteria used by the investment bank in allocating shares. From the tables we have seen that some types of bids are less rationed than others. We now check if this is indeed the case and test if the allocations are consistent with the theories discussed in section 3.

The dependent variable in the regressions is normalized rationing.[14] The independent variables capture three types of effect: the size effect, the information effect and

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[13]A bidder's frequency is held constant for all issues that he is participating in. As a result a bidder may be classified as frequent in an early issue on the basis of future issues. In other words, we are assuming that frequent bidders were regular bidders even prior to the beginning of our sample.

[14]In this way, we control for the heteroskedasticity that would arise if we used allocations or raw rationing.

the frequency effect.

For the size effect we use two types of independent variables. The first is the percentage bid. However, we saw in Table 3 that most the two largest quartiles are different from the smaller bids. Using the percentage bid would impose a linear relationship. Therefore, we also define two dummy variables: one takes value of one if the percentage bid is in the fourth (i.e. largest) quartile, while the second takes value one if the percentage bid is in the third quartile. For the information effect, we use a dummy for limit bids, a dummy for step bids and a dummy variable for early bidders, which takes value one if the bid is one of the first 25% submitted. For the frequency effect we have two dummies: one for high frequency bidders and one for medium frequency, as defined above.

We also introduce four new variables that we did not consider in Table 3. First, we include a dummy which takes a value of one if the bid has been revised. The effect of this variable could go either ways. On the one hand, a revised bid could have the opposite meaning of an early bid: if the investment bank wants to reward a bid submitted early, then it will penalize a bid which has been changed and the coefficient should be negative. On the other hand, if the information about the value of the shares changes over the period in which the book is built, then a bid revision provides additional information to the investment banker over time. Second, we include a dummy which takes value of one if the bidder's nationality is the same as the nationality of the issuing company. This variable may be positive if the issuer wants to favor domestic investors. It may also capture an information effect and it should be positive if we expect that institutions in the same country have better information. Finally, we include a dummy variable which is set to one if the manager accepting the bid is the investment bank itself (i.e. the bookrunner) or a foreign subsidiary of the bank, while it is set to zero if the manager is any other syndicate member.

In Table 7 we present the results. The difference between Regression 1 and 2 is that Regression 2 uses a dummy for each issue to capture fixed effects. It is possible that each issue has unique characteristics, not captured by the variables in the regressions.

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For example, a particular issuing company may influence the investment banker to favor a certain set of investors. The results are not qualitatively different and we use dummies to capture fixed effects in all the remaining regressions.

Regressions 2 through 4 differ only with regard to which variable is used to capture the size effect. In Regression 2 we use dummies for the top two size quartiles. In Regression 3 we use percentage bid and in Regression 4 we use both measures. We do not mprove the regressions when we use bid percentage in addition to the quartile dummies, so we retain Regression 2 as the base case for further analysis.

The values of the coefficients on the dummies can be interpreted as the extra allocation given to those bids. For example, limit bids will be allocated 17% more than similar strike bids.

The size of the bid (especially bids in the fourth quartile) has a positive and significant coefficient. The investment bank allocates proportionally more shares to those who bid for large quantities. Obtaining a disperse ownership does not seem to be a concern for the issuer. In these issues the average percentage allocation is quite small and as a consequence liquidity and the formation of large blocks are not particularly relevant in this sample. In fact, even in the largest quartile, the average percentage allocation is only approximately 2%.[15]

Similarly, limit and step bids are favored which is consistent with the information theories described above. Limit and step bids provide the investment banker with information regarding the pricing of the issue. In exchange for this information, the investment banker favors these bidders with a larger allocation of shares as predicted by Benveniste and Spindt (1989).

Bids that have other characteristics that can be associated with information are also favored. The coefficient of the dummy for revised bid is positive and significant: this suggests the hypothesis that a revision provides more information to the investment banker. Similarly, the coefficient of the dummy for the nationality of the bidder

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[15]In a study by Keloharju (1998) small orders have a relatively more favorable treatment. However, Keloharju points out that in his study of fixed-price offerings information extraction is not an objective and predicts that his result is likely to be reversed in a bookbuilding procedure.

is positive and significant, suggesting that local investors are favored—perhaps for informational reasons but possibly to satisfy the preferences of the issuer.

Frequent bidders are also favored with larger allocations. This is consistent with the Benveniste and Spindt (1989) hypothesis that frequent bidders are rewarded for providing insurance to the investment banker. An alternative explanation is that frequent investors have close relations with the banker and are being favored for this reason.

Surprisingly, the coefficient of the dummy for early bids is negative and significant suggesting that early bidders receive worse treatment.

Finally, the dummy for the bookrunner as manager is the variable with the highest effect on allocations suggesting that the investment bank strongly favors those who submit bids through its own salespeople. This should be expected, as the bookrunner retains a larger portion of the investment banking fees if its clients purchase the shares.

We perform a White test for heteroskedasticity on the regression residuals. We do not find heteroskedasticity. We also compute robust t-statistics that are very similar to the reported t-statistics.

In Regression 5 we check whether the investment banker treats less favorably limit bids which are too high to be credible. In fact, as explained above, the cost of submitting a lower limit price is the risk that the price is missed (i.e. the issue price is higher) while the cost of submitting a high limit price is that it may increase the issue price. However, if the limit price is very high (too high to be credible), then the bid would be equivalent to a strike bid. One could argue that the investment banker should try to discourage such frivoulous limit bids. This would be similar to the *mise en vente* auction for IPOs in France (see Biais and Faugeron-Crouzet (1998)).

In order to look for this effect, we estimate Regression 5 only for limit orders, including a new variable for the percentage by which the limit price exceeds the issue price i.e. $\frac{P_{Limit} - P_{Issue}}{P_{Issue}}$. However, the coefficient is not significant, perhaps because we observe few frivolous bids in equilibrium.

In Table 8 we study how these variables interact with each other. For example, if a revision provides more information, a revision with a limit or step bid may provide more information than a revision with a strike bid. Similarly, revised bids or limit and step bids from an investor of the same nationality as the issuing company may be particularly informative.

We define three new variables: LARGE includes the two highest quartiles of bids; NOTSTRIKE combines both limit and step bids; FREQUENT combines both high and medium frequency bidders. Regressions 6 to 9 study these interactions. We find indeed that revisions which are done through a limit or step bid get a more favorable treatment. In other words, the more informative types of revisions indeed obtain a more favorable treatment. Similarly, limit and step bids from bidders with the same nationality as the issuer receive more favorable treatment. However, revised bids from bidders with the same nationality as the issuer do not receive more favorable treatment.

Another interaction which is significant is the one between limit and step bids and early bidding. In Table 7 we saw that bidding early had a negative effect. However, Regression 7 shows that the only case in which bidding early does make a positive difference in allocations is when the bid is providing special information, i.e. it is a limit or step bid. This is consistent with the cascade theory. If we interpret limit bids as more informed than strike bids, then the investment banker is encouraging informed bidders to act early. This can be understood as the information being more valuable when received early or that an early bid is more likely to encourage more bidding if the early bid is perceived as informed.

One surprising result is that large bids are less favored if the bidder comes from the same country of the issuer. One possible explanation is that the issuer may be interested in having local ownership dispersed.

Notice that the interaction between bidder frequency and the other variables is never significant. This might be expected, since the favorable treatment given to frequent bidders is not due to information, but either to an insurance effect or to "friendship".

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4.3. IPOs vs. Seasoned Issues. Our data set includes both IPOs and seasoned issues. To check whether there is a substantial difference in the allocation criteria between the two, we estimate the basic regression separating IPOs and seasoned issues. Regression 10 in Table 9 displays the results.

The allocation criteria are largely similar for IPOs and seasoned offerings. Large bidders and limit and step bids are favored in both seasoned issues and IPOs.

Although one usually associates uncertainty and the need to extract price information with IPOs, these results show that the investment banker is attempting to extract information for seasoned issues as well. In the seasoned issues in our sample, bookbuilding is used specifically because of the concern that the new shares may have an effect on the market. The result that informed bidders are favored suggests that the uncertainty surrounding equity issues includes the ability of the market to absorb a large number of new shares. The fact that the largest bidders are strongly favored in seasoned issues provides further evidence that the investment banker is concerned about the effect of the increased supply in the market.

4.4. Returns. In the previous subsections we investigated whether some types of bids or bidders receive more shares (as a proportion of their bids) than others. Whenever we found this effect, we interpreted the allocation as favorable treatment. While investors who receive larger allocations can usually be considered favored, obtaining more shares is not necessarily an advantage. If the price subsequently drops, then the investor will wish he had not been awarded so many shares. A group of investors might receive larger allocations on average but will face adverse selection if the investment banker gives them larger allocations of the worse issues.

In this section, we look at whether larger allocations do indeed translate into higher returns for the investors. We start by investigating whether the criteria for the allocation of shares depend on whether the issue is successful or not.

There are two ways to consider whether or not a larger allocation is favorable for a bidder. The first way is to look at aftermarket returns. However, the investment bank does not know the aftermarket returns when deciding on the allocations. Thus, this is

an imperfect way to determine whether the investment banker is favoring some bidders by giving them the most valuable shares. The second measure is the oversubscription of the issue. The bank knows the oversubscription when allocating shares and the correlation between oversubscription and aftermarket returns is positive, although far from perfect.[16] In Table 10, Regression 11 presents the effect of oversubscription on the allocation criteria and Regression 12 presents the effects of aftermarket returns on the allocation critera.

In Regression 11 we multiply each of the bid characteristics of the basic Regression 2 by the oversubscription of the bid. One striking result is that high frequency investors are even more favored when oversubscription is high. This suggests that the investment bank is favoring them when it knows the issue is a success. One possible interpretation is that frequent bidders are the "friends" of the investment bank. Another interpretation is the one given by Benveniste and Spindt (1989): frequent bidders provide an insurance, by bidding for shares in both good and bad issues. The bank compensates them by rationing them less than everybody else. However, if this preferential treatment were the same across all issues, they would still suffer from adverse selection and obtain low returns. The investment bank has to discriminate even more in their favor when it knows that the issue is oversubscribed to provide them with positive returns and compensate them for investing in less successful issues. By allocating more shares to regular investors in the successful issues, the investment banker reduces the need to underprice the issue.

On the other hand, the coefficients of the dummy for revised bid multiplied by oversubscription and the dummy for the limit and step bids multiplied by oversubscription are not significant. This suggests that although these bids receive better allocations overall, they are not especially favored when oversubscription is high. If the underlying problem is the winner's curse, it is rational from the investment banker point of view to favor frequent bidders when oversubscription is high but not necessarily favor informed bidders in this situation. In fact, informed bidders—for example those who submit limit bids—have their own information about the value

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[16]In our sample, the correlation between aftermarket returns and oversubscription is 0.54.

of the issue. The investment banker does not have to worry about giving the limit bidder an especially favorable treatment when the issue is oversubscribed, because the limit bidder is already choosing when and how to bid based on his own private information.

In Regression 12, when we multiply each allocation criterion by aftermarket returns, the improved allocation to frequent bidders in successful issues is no longer statistically significant. This is consistent with the notion that the investment bank can not perfectly predict aftermarket returns.

We investigate this further in Table 11 where we compute the actual returns of the investors. We break up bids according to the frequency of the bidder and the type of the bid. The first number in each cell of Table 11 reports the simulated "fair returns" of investors in each category. Fair returns are the returns that would have been earned if the investment bank had rationed all bidders in proportion to their bids. The "fair returns" in the table identify the types of bidders who successfully choose the most profitable issues. The second number is the actual average return of bidders in each category. The actual returns capture the decisions of the bidders to participate as well as the effect of the allocation rule.

The last row of Table 11 shows the returns for each level of bid frequency. By looking at the fair returns we see immediately that the low frequency investors are on average choosing better issues, as their returns are higher. When we look at the actual returns we see that although high frequency bidders receive more shares especially when the issue is oversubscribed, their actual returns are not much higher than the fair returns. In contrast, the infrequent bidders, although they are more rationed in general and particularly in oversubscribed issues, have actual returns substantially higher than the fair returns. The explanation for this result is that the low frequency bidders succeeded in choosing less oversubscribed issues which turned out to have high returns. In other words, they successfully used private information.

The last column of Table 11 shows the returns for each type of bid. The fair returns show that limit and step bidders choose better issues. But actual returns of limit bids are lower than fair returns. When we break down by frequency of bidder, however, we

see that this result is due mainly to higher frequency bidders. If infrequent bidders are choosing the high return issues, then the frequent bidders face adverse selection.

This result is consistent with the winner's curse and Benveniste and Spindt (1989) theories. The frequent investors are not favored simply because they are "friends" of the investment bank: such treatment seems to be necessary in order to counteract adverse selection.

5. Bidders' Behavior

In the previous section we studied the criteria used by the investment banker to allocate shares as a function of the bids submitted. While checking whether the allocation rule is consistent with underpricing theories, we saw that certain types of bidders are favored, whom we interpreted as informed or providing an insurance. Up until now, we took the bidders' behavior as given. However, when choosing how to bid, investors take into account how their bid will be treated, i.e. the allocation rule. In this section, we look explicitly at the bidders' behavior.

We have seen that the investment banker favors bids with certain characteristics and we now check which type of bidders tend to have these characteristics. In Table 12 we see that regular customers (high frequency bidders) tend to submit their bid earlier and tend to submit larger bids.

Since bidders may exaggerate the size of their demand in anticipation of being rationed, one could argue that bidder that we have identified as being favored might simply be those who exaggerate less. However, the fact that high frequency bidders submit larger bids than low frequency investors suggests that this is not the case. Similarly, limit and step bids are rationed less despite the fact that their bids are much larger than strike bids as seen in Table 3. The results we obtained in the previous section do not seem to be driven by bidders' behavior.

A natural question to ask is what type of bidders use limit and step bids. In Table 12 we show the percentage of limit and step bids, broken down by frequency. We see that, independently of whether the bidders are regular customers or not, the percentage of limit and step bids is approximately the same (20%). Another issue

is whether bidders always bid in the same way. The answer is no: investors usually use strike bids but will sometimes use limit and step bids. For example, out of the 101 high frequency investors, only 6 used strike bids less than half the time, and only 3 always used strike bids. One possibility is that high frequency bidders only use limit bids when they have particular information. This is consistent with our implicit assumption that there are no investors who are always better informed, but only investors who have private information about specific issues. Table 11 shows that high frequency bidders indeed choose better issues when they use limit bids, as evidenced by the fair returns.

In Table 13 we break up the issue into three equal groups based on oversubscription as well as three equal groups based on after-market return. When we distinguish among investors according to their frequency, we see that high frequency bidders participate approximately in the same proportion in all type of issues. This is consistent with the hypothesis that they are providing insurance. Infrequent investors participate slightly more often in successful issues.

The percentage of limit bids is much lower when issues are oversubscribed. When we look at returns, the distribution is more even. Limit and step bids are less likely to be missed (i.e. to have a limit price below the issue price) both for issues with low levels of oversubscription and low aftermarket returns.

6. Conclusions

We have analyzed the bids and allocations of equity issues that used the bookbuilding mechanism. We have found a number of regularities in the way the investment banker rations shares to investors. The investment banker favors limit bids, step bids, revised bids and bidders from the issuer's country. We have argued that these types of bids convey more information to the investment banker. The favorable treatment is consistent with the bank extracting price information by compensating informed bidders.

Favorable allocations are also given to large bidders and those who submit their bids directly to the bookrunner. Finally, regular customers are favored, providing
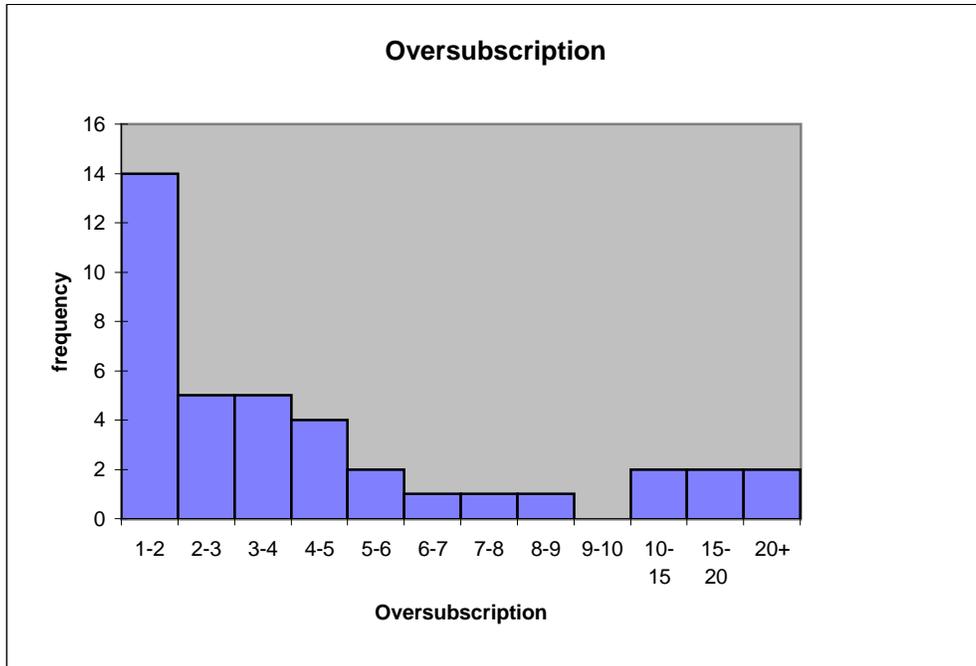
support to the Benveniste and Spindt (1989) model of bookbuilding.

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Figure 1

Figure 2

Figure 3

Rationing (issue 1)

Percentage Bid (issue 1)

Percentage Allocation (issue 1)
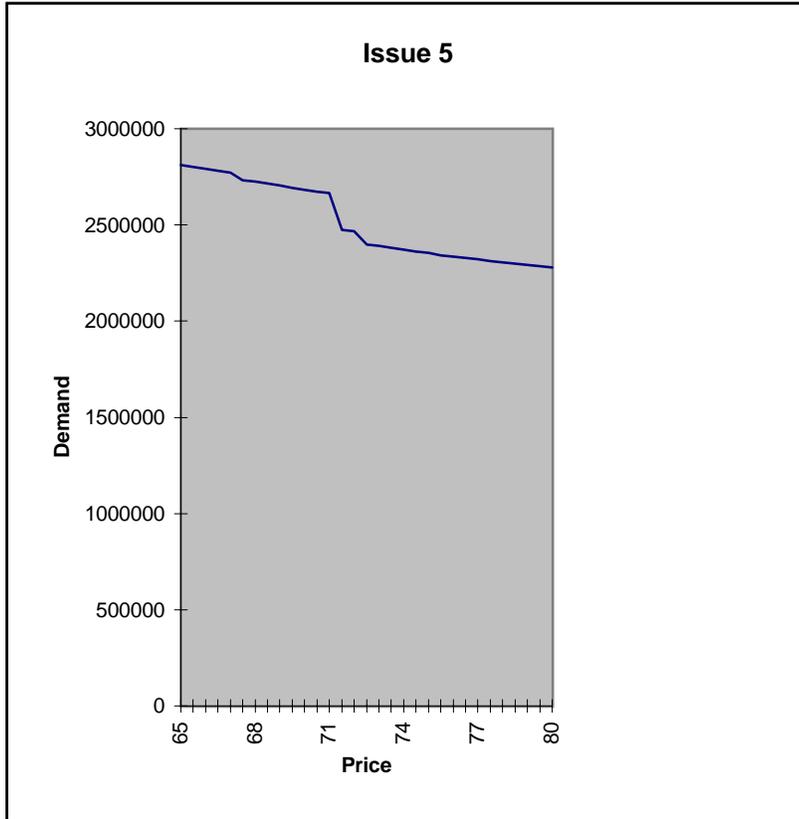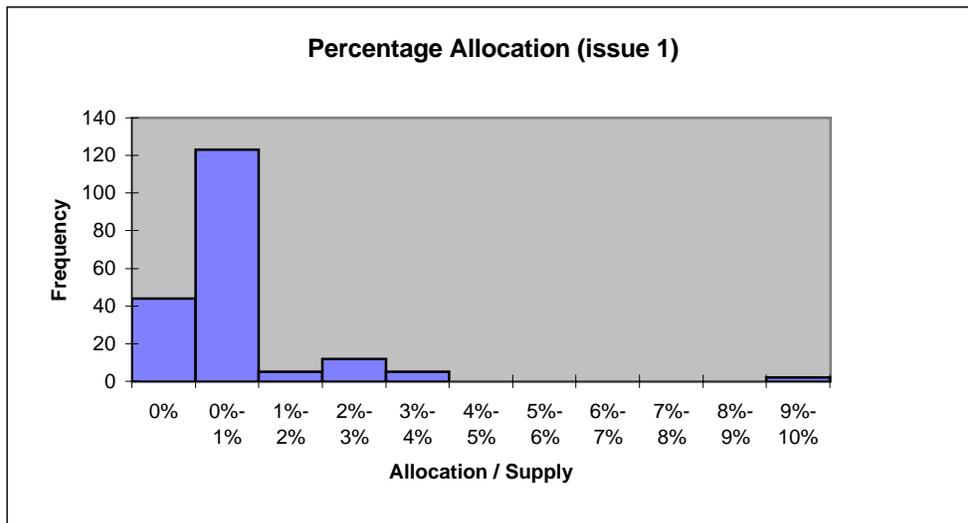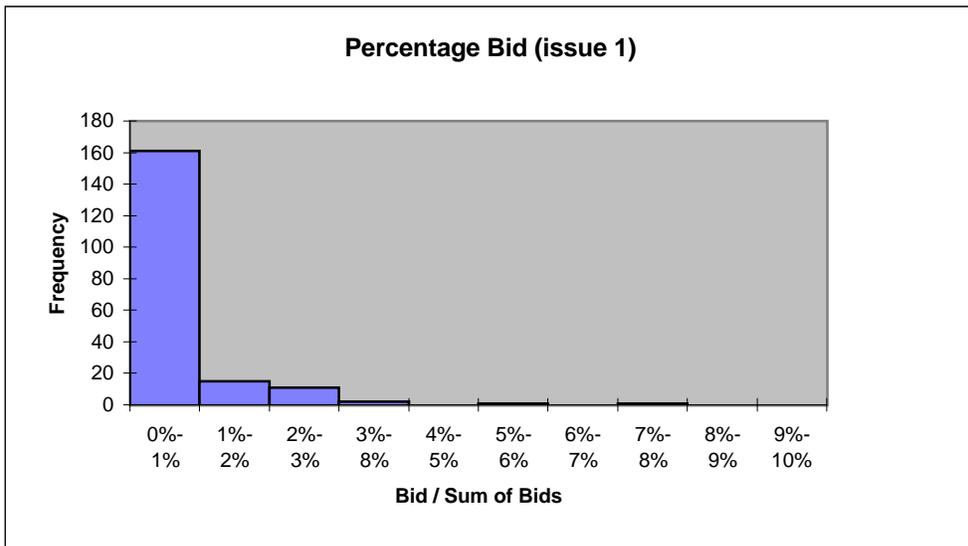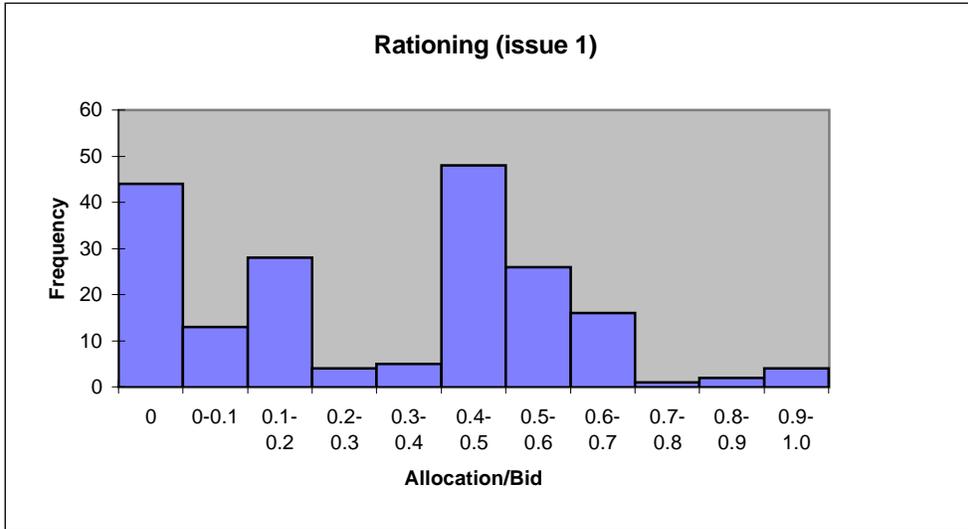
Table 1: Example of "Book"

This table is an excerpt from an actual book. Bids can be submitted in currency units or shares, bids may be revised, and limit prices may be included. Step bids indicate the quantity demanded at a number of limit prices.

Issue Id	Bidder #	Revision	Tranche	Manager	Country	Bidder Name	Bid Quantity		Bid Type	Limit Price
5	1	0	9	3	GB	aaa	1000000	GBP	Strike	
5	2	0	9	3	AU	bbb	2000000	USD	Strike	
5	3	0	9	3	GB	ccc	2100000	DEM	Strike	
5	4	0	9	3	SE	ddd	1000000	DEM	Strike	
		1					600000	DEM	Strike	
		2					100000	DEM	Strike	
5	5	0	9	4	DE	eee	see details below		Step bid	
5	6	0	9	4	DE	fff	250000	DEM	Strike	
5	7	0	9	4	DE	ggg	20000	Shares	Limit	72
5	8	0	9	3	GB	hhh	2750000	GBP	Strike	
5	9	0	9	3	GB	iii	300000	GBP	Strike	
		1					1000000	DEM	Strike	
5	10	0	9	3	FR	jjj	1000	Shares	Strike	

Step Bid Details

Issue Id	Bid Id	Step #	Price	Quantity	
5	5	1	69	10000	Shares
		2	75	5000	Shares

Table 2: Allocation Examples

This table displays actual allocations to a number of bidders who submitted identical quantities. In this example, the allocations ranged from 25% to 61% of the bid quantity. (The issue price was below both limit prices.)

Issue Id	Tranche	Bid Id	Bid Date	Bid Quantity	Bid Type	Limit Price	Allocation	Alloc/Bid
5	9	7	10th	20000	Limit	72	12200	61%
5	9	35	16th	20000	Strike		8400	42%
5	9	94	19th	20000	Limit	71	5000	25%
5	9	97	19th	20000	Strike		8000	40%
5	9	101	19th	20000	Strike		8000	40%

Table 3 : Rationing by Bid Criteria

The bids are broken up according to various criteria. For each subset of data, this table reports the average number of bids per issue, the average size of the bids as a percentage of the total of bids in the issue, the average allocation as a percentage of the total supply allocated, the average rationing measured as the ratio of allocation to bid, and the average normalized rationing defined as the ratio of percentage allocation to percentage bid.

The bids in each issue are split into quartiles based on bid size with quartile 1 being the smallest bids and quartile 4 being the largest bids. The average number of observations differs across size quartiles because of ties.   Bid type splits the bids into categories depending on whether or not the bid included a limit price (or limit prices in the case of step bids). Bid frequency is defined as high, medium or low depending on whether the bidder participated in 10 or more issues, 3 through 9 issues, or less than 3 issues in the sample. The first 25% of bids submitted for each issue are defined as early and the rest are defined as late.

	Size Quartiles				Bid Type			Bid Frequency			Timing	
	Smallest	2	3	Largest	Strike	Limit	Step	High	Medium	Low	Early	Late
N (per issue)	64.4	73.1	73.3	73.4	248.9	41.1	10.4	47.5	82.3	154.4	71.6	212.6
Percentage Bid	.044%	.141%	.370%	1.866%	.518%	.909%	1.085%	.766%	.764%	.455%	.710%	.599%
Percentage Allocation	.025%	.094%	.291%	2.004%	.483%	1.179%	1.253%	.906%	.818%	.383%	.734%	.590%
Rationing	22.9%	24.0%	28.6%	37.5%	24.7%	37.4%	39.8%	33.8%	31.1%	26.0%	29.3%	28.2%
Normalized Rationing	58.6%	58.7%	70.3%	97.6%	67.0%	97.1%	109.4%	98.8%	85.6%	60.7%	73.0%	71.3%

Table 4 : Rationing by Bid Type, Split by Size

Bids are defined as large (small) if they are above (below) the median bid size for all bids in each issue. Large and small bids are then split according to the bid type (i.e. strike, limit or step bid). For each category, this table reports the average number of bids per issue, the average size of the bids as a percentage of the total of bids in the issue, the average allocation as a percentage of the total supply allocated, the average rationing measured as the ratio of allocation to bid, and the average normalized rationing defined as the ratio of percentage allocation to percentage bid.

	Strike		Limit		Step	
	Large	Small	Large	Small	Large	Small
N (per issue)	125.4	123.5	22.9	19.2	8.19	4.9
Percentage Bid	.997%	.092%	1.369%	.111%	1.471%	.092%
Percentage Allocation	.945%	.057%	1.736%	.085%	1.677%	.089%
Rationing	28.9%	20.6%	41.2%	30.4%	43.3%	32.1%
Normalized Rationing	78.0%	55.8%	112.9%	75.6%	107.3%	99.7%

Table 5 : Rationing by Bid Frequency, Split by Bid Type

Bids are split by bid frequency where bid frequency is defined as high, medium or low depending on whether the bidder participated in 10 or more issues, 3 through 9 issues, or less than 3 issues in the sample. Bids within each frequency category are further split according to the bid type (i.e. strike, limit or step bid). For each category, this table reports the average number of bids per issue, the average size of the bids as a percentage of the total of bids in the issue, the average allocation as a percentage of the total supply allocated, the average rationing measured as the ratio of allocation to bid, and the average normalized rationing defined as the ratio of percentage allocation to percentage bid.

	High Frequency			Medium Frequency			Low Frequency		
	Strike	Limit	Step	Strike	Limit	Step	Strike	Limit	Step
N (per issue)	43.1	7.5	2.5	75.7	12.3	4.2	133.3	24.7	9.0
Percentage Bid	.640%	1.252%	.711%	.553%	1.147%	1.630%	.402%	.537%	.706%
Percentage Allocation	.717%	1.811%	.844%	.568%	1.364%	1.885%	.316%	.552%	.765%
Rationing	28.6%	40.6%	39.2%	26.3%	40.6%	42.0%	22.3%	33.2%	38.7%
Normalized Rationing	93.2%	112.3%	120.2%	80.8%	101.5%	102.3%	56.0%	85.9%	92.4%

Table 6 : Rationing by Timing, Split by Type

Bids are defined as early if they were submitted among the first 25% of all bids in each issue. Otherwise they are defined as late. Early and late bids are then split according to the bid type (i.e. strike, limit or step bid). For each category, this table reports the average number of bids per issue, the average size of the bids as a percentage of the total of bids in the issue, the average allocation as a percentage of the total supply allocated, the average rationing measured as the ratio of allocation to bid, and the average normalized rationing defined as the ratio of percentage allocation to percentage bid.

	Strike		Limit		Step	
	Early	Late	Early	Late	Early	Late
N (per issue)	62.4	186.5	11.9	30.5	4.1	8.5
Percentage Bid	.577%	.500%	1.235%	.759%	.833%	1.228%
Percentage Allocation	.558%	.460%	1.656%	.906%	.979%	1.412%
Rationing	25.3%	24.5%	38.7%	36.2%	49.1%	37.7%
Normalized Rationing	67.0%	66.9%	100.6%	92.3%	122.0%	100.4%

Table 7:   Regression of bid characteristics on normalized rationing

This table reports regression coefficients (and T-stats in parentheses) for various model specifications. The independent variable in all cases is the normalized rationing, defined as the ratio of percentage bid to percentage allocated. Regression 1 and 2 are the basic regression that includes a number of dummies for bids in the fourth and third size quartiles, limit and step bids, bids submitted early (i.e. within the first 25% of all bids in an issue), revised bids, bids submitted by bidders that bid with high and medium bid frequency (defined as participating in more than 10, and between 3 and 9 issues, respectively), bidders from the same country as the issuer as well as bids that were submitted directly to the bookrunner. Regression 2 includes dummies for each of the 39 issues.

Regressions 3 and 4 are similar to regression 1 but use bid percentage (bid size / sum of all bids in the issue) to capture the size effect. Regression 5 only considers limit bids and includes a term that is the percentage difference between the limit price and the issue price.

All regressions give equal weight to each issue.

	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5
Intercept	0.32 (17.4)	*	*	*	*
Bid percentage			4.45 (7.7)	0.69 (1.05)	
Largest size quartile	0.28 (13.8)	0.28 (13.8)		0.27 (11.6)	0.22 (8.0)
Second largest size quartle	0.08 (3.7)	0.07 (3.7)		0.07 (3.6)	0.07 (2.6)
Limit bid	0.19 (9.2)	0.17 (6.5)	0.17 (6.6)	0.16 (6.4)	
Step bid	0.27 (6.1)	0.24 (5.1)	0.26 (5.3)	0.24 (5.0)	
Early bid	-0.05 (-2.5)	-0.05 (-2.6)	-0.05 (-2.7)	-0.05 -2.6	0.05 (1.9)
Revised bid	0.10 (4.5)	0.10 (4.4)	0.13 (5.9)	0.10 (4.4)	0.15 (5.6)
High frequency	0.17 (6.7)	0.19 (7.4)	0.2 (8.06)	0.19 (7.4)	0.12 (3.4)
Medium frequency	0.10 (4.9)	0.12 (5.9)	0.13 (6.6)	0.12 (5.8)	0.07 (2.3)
Bidder nationality	0.08 (3.9)	0.05 (2.1)	0.05 (2.3)	0.05 (2.1)	0.15 (5.0)
P(limit)-P(issue) P(issue)					0.40 (1.3)
Bookrunner as manager	0.37 (20.6)	0.36 (18.9)	0.37 (19.4)	0.36 (18.9)	0.19 (6.7)
R-squared	9.4%	13.2%	12.1%	13.2%	33.8%

Table 8: Regression of bid characteristics on normalized rationing (with interaction terms)

These regressions use regression 2 (in Table 7) as a base case and add terms to capture the interaction between bid characteristics. Regression 6 captures interactions with the revision dummy, regression 7 captures interactions with early bids, regression 8 captures interactions with limit and step bids (both types of bid are included in the dummy NOTSTRIKE), and regression 8 captures interactions with bids from the same country as the issuer. FREQUENT is a dummy that is set equal to one for both medium and high frequency bidders. LARGE is a dummy that is set equal to one for the two highest size quartiles.

The dependent variable in all regressions is normalized rationing. T-stats are given in parentheses. All regressions give equal weight to each issue. Regressions include a dummy for each issue.

	Reg 6	Reg 7	Reg 8	Reg 9
Largest size quartile	0.28 (13.1)	0.28 (12.5)	0.28 (12.8)	0.31 (13.9)
Second largest size quartle	0.08 (3.8)	0.08 (3.4)	0.08 (3.7)	0.11 (4.9)
Limit bid	0.13 (4.6)	0.14 (4.9)	0.10 (2.2)	0.12 (3.9)
Step bid	0.20 (4.0)	0.22 (4.5)	0.14 (2.3)	0.18 (3.5)
Early bid	-0.02 (-1.1)	0.00 (0.0)	-0.06 (-3.0)	-0.05 (-2.1)
Revised bid	0.13 (2.6)	0.14 (5.1)	0.07 (2.5)	0.10 (3.7)
High frequency	0.19 (7.2)	0.20 (7.5)	0.20 (7.4)	0.19 (7.2)
Medium frequency	0.12 (5.6)	0.13 (5.9)	0.13 (5.7)	0.12 (5.5)
Bidder nationality	0.06 (2.2)	0.06 (2.4)	0.01 (0.2)	0.06 (1.8)
Bookrunner as manager	0.36 (19.0)	0.36 (18.9)	0.36 (19.0)	0.36 (19.0)

INTERACTION TERMS:

	Reg 6		Reg 7		Reg 8		Reg 9
LARGE x Revised	-0.02 (-0.5)	LARGE x Early	-0.00 (-0.1)	LARGE x NOTSTRIKE	-0.01 (-0.3)	LARGE x Nationality	-0.13 (-3.3)
NOTSTRIKE x Revised	0.11 (2.4)	NOTSTRIKE x Early	0.10 (2.3)	Early x NOTSTRIKE	0.08 (1.7)	NOTSTRIKE x Nationality	0.16 (3.5)
Early x Revised	-0.10 (-2.2)	Revised x Early	-0.11 (-2.5)	Revised x NOTSTRIKE	0.10 (2.2)	Early x Nationality	0.00 (0.1)
FREQUENT x Revised	-0.02 (-0.4)	FREQUENT x Early	-0.06 (-1.6)	FREQUENT x NOTSTRIKE	-0.04 (-0.9)	Revised x Nationality	0.00 (0.1)
Nationality x Revised	-0.02 (-0.5)	Nationality x Early	-0.04 (-0.8)	Nationality x NOTSTRIKE	0.14 (3.0)	FREQUENT x Nationality	-0.00 (-0.1)

| R-squared | 13.3% | 13.3% | 13.3% | 13.4% |

Table 9: Regression on normalized rationing for IPOs and seasoned issues

This regression is based on regression 2 in table 7 but all terms are multiplied by dummies identifying if the issue is an IPO or a seasoned offering. The dependent variable is the normalized rationing. T-stats are in parentheses. The regression gives each issue equal weight. The regressions includes a dummy for each issue.

Reg 10

	IPO	0.47 (8.1)		Seasoned	0.28 (4.8)
IPO x	Largest size quartile	0.21 (7.9)	Seasoned x	Largest size quartile	0.39 (12.1)
IPO x	Second largest size quartile	0.05 (2.0)	Seasoned x	Second largest size quartile	0.11 (3.7)
IPO x	Limit bid	0.16 (4.5)	Seasoned x	Limit bid	0.18 (4.5)
IPO x	Step bid	0.29 (4.5)	Seasoned x	Step bid	0.18 (2.6)
IPO x	Early bid	-0.10 (-4.0)	Seasoned x	Early bid	0.03 (0.9)
IPO x	Revised bid	0.07 (2.6)	Seasoned x	Revised bid	0.14 (3.9)
IPO x	High frequency	0.20 (6.4)	Seasoned x	High frequency	0.17 (4.2)
IPO x	Medium frequency	0.09 (3.7)	Seasoned x	Medium frequency	0.18 (5.2)
IPO x	Bidder nationality	0.03 (1.0)	Seasoned x	Bidder nationality	0.12 (3.2)
IPO x	Bookrunner as manager	0.35 (14.9)	Seasoned x	Bookrunner as manager	0.37 (11.5)

R-squared 13.6%

Table 10: Regression including terms for oversubscription and secondary market return

Regressions 11 and 12 are based on regression 2 in Table 7, but with each term also multiplied by the level of oversubscription (Reg 11) or initial return (Reg 12). Initial return is the percentage difference between the issue price and the first available post-issue secondary market price.

The dependent variable in all regressions is normalized rationing. T-stats are given in parentheses. All regressions give equal weight to each issue. Regressions include a dummy for each issue.

		Reg 11			Reg 12
	Largest size quartile	0.32 (11.6)		Largest size quartile	0.27 (12.45)
	2nd largest size quartile	0.06 (2.0)		2nd largest size quartile	0.06 (3.1)
	Limit Bid	0.13 (3.6)		Limit Bid	0.16 (6.1)
	Step bid	0.12 (1.8)		Step bid	0.27 (4.8)
	Early bid	0.03 (1.0)		Early bid	-0.06 (-2.8)
	Revised bid	0.10 (3.4)		Revised bid	0.09 (3.9)
	High frequency	0.10 (2.8)		High frequency	0.17 (6.4)
	Medium frequency	0.12 (4.3)		Medium frequency	0.12 (5.7)
	Bidder nationality	0.21 (6.8)		Bidder nationality	0.03 (1.4)
	Bookrunner as manager	0.19 (7.3)		Bookrunner as manager	0.37 (18.9)
Oversubscription x	Largest size quartile	-0.01 (-1.8)	Return x	Largest size quartile	0.70 (2.4)
Oversubscription x	2nd largest size quartile	0.01 (1.5)	Return x	2nd largest size quartile	0.40 (1.4)
Oversubscription x	Limit Bid	0.01 (1.5)	Return x	Limit Bid	0.38 (1.1)
Oversubscription x	Step bid	0.03 (1.9)	Return x	Step bid	-0.58 (-0.6)
Oversubscription x	Early bid	-0.01 (-3.5)	Return x	Early bid	0.15 (0.6)
Oversubscription x	Revised bid	0.00 (-0.7)	Return x	Revised bid	0.45 (1.5)
Oversubscription x	High frequency	0.02 (3.2)	Return x	High frequency	0.77 (1.9)
Oversubscription x	Medium frequency	-0.00 (-0.7)	Return x	Medium frequency	0.06 (0.2)
Oversubscription x	Bidder nationality	-0.03 (-8.0)	Return x	Bidder nationality	0.53 (1.6)
Oversubscription x	Bookrunner as manager	0.03 (9.3)	Return x	Bookrunner as manager	-0.82 (-2.8)
	R-squared	15.2%		R-squared	13.4%

Table 11 : Simulated and Actual Returns

The first number in each cell in this table is the simulated "fair return" earned in aggregate. The second number is the actual aggregate return earned in each category. The aggregate "fair return" assumes that all bids in a particular issue are rationed equally (i.e. based only on the oversubscription). To obtain both types of return we sum up the total profits to the category and then divide by the aggregate cost of the awarded shares.

	High Frequency	Medium Frequency	Low Frequency	All
Strike	3.16%	2.95%	3.45%	3.20%
	3.56%	2.48%	4.01%	3.28%
Limit	3.51%	3.00%	3.61%	3.38%
	3.06%	2.44%	3.67%	3.10%
Step	2.93%	4.43%	5.39%	4.99%
	2.62%	4.64%	5.44%	5.05%
All	3.27%	3.09%	3.94%	3.52%
	3.32%	2.68%	4.31%	3.52%

Table 12: Bid Characteristics by Frequency

This table displays bid characteristics of bidders broken up by bid frequency. High frequency bidders participated in 10 or more issues. Medium frequency bidders participated in 3 through 9 issues. Low frequency bidders participated in only 1 or 2 issues.   For each bid frequency, this table reports the number of bids with each characteristic. Numbers in parentheses reflect the percentage of bids with the characteristic.

	# of Bids	# of Unique Bidders	Limit and Step Bids	Early	Largest Size Quartile
All	11505	6236	2299 (20%)	2894 (25%)	2984 (26%)
High Frequency	1699	101	341 (20%)	493 (29%)	550 (32%)
Medium Frequency	3389	628	597 (18%)	964 (28%)	1029 (30%)
Low Frequency	6417	5507	1361 (21%)	1437 (22%)	1405 (22%)

Table 13: Bid Characteristics by Oversubscription and Initial Return

This table breaks up issues by oversubscription and initial returns. High, medium and low oversubscription corresponds to the issues in the top, middle and bottom thirds of oversubscription. High, medium and low return corresponds to the issues in the top, middle and bottom third of initial returns as measured by the percentage returns between the issue price and the first available post-issue market price.

For each level of oversubscription and return, the table displays the number and percentage of bids from bidders of each frequency; and the number and percentage of limit and step bids. (Percentages are in parentheses). The table also displays the number of missed limit and step bids – i.e. bids which specified limits below the issue price. (Percentages of limit and step bids that missed are in parentheses.)

	# of Bids	High Frequency	Medium Frequency	Low Frequency	Limit and Step Bids	Missed Limit and Step Bids
All	11505	1699 (15%)	3389 (29%)	6417 (56%)	2299 (20%)	426 (19%)
High Oversubscription	6135	839 (14%)	1670 (27%)	3626 (59%)	500 (8%)	118 (24%)
Medium Oversubscription	3176	539 (17%)	1049 (33%)	1588 (50%)	580 (18%)	161 (28%)
Low Oversubscription	2194	321 (15%)	670 (31%)	1203 (55%)	1219 (56%)	147 (12%)
High Return	5311	714 (13%)	1458 (27%)	3139 (59%)	1171 (22%)	235 (20%)
Medium Return	3460	603 (17%)	1069 (31%)	1788 (52%)	413 (12%)	97 (23%)
Low Return	2734	382 (14%)	862 (32%)	1490 (54%)	715 (26%)	94 (13%)