An Experimental Analysis of the IPO Pricing Mechanism:
The Case of Auction Method*

YUKIHIKO FUNAKI[a], RYUICHIRO ISHIKAWA[b],
YOSHIAKI OGURA[c], JINGRU WANG[d]

Abstract

This paper investigates the inefficiencies in the IPO pricing process, specifically focusing on the overpricing issue (the IPO price exceeds the fundamental value) and compares the Book-building (BB) and Auction methods. The study builds on previous research (Funaki et al., 2024) and examines two auction models: a single-unit auction and a multi-unit auction. The experimental analysis evaluates the allocation efficiency, information elicitation, and price discovery of the Auction method, comparing the results to prior BB method experiments.

The objective is to identify an IPO approach that maximizes firm value while protecting investors. Results indicate that the Auction method can achieve relatively high levels of price discovery and allocation efficiency. Controlling the bid price increments or using multi-unit auctions instead of single-unit auctions can reduce overbidding. The paper concludes that while the Auction method offers cost benefits and is inclusive for retail investors, the BB method is better suited for protecting institutional investors and fostering long-term investment relationships.

Keywords: Initial public offerings, Auctions, Experiments
JEL classification: D9, G4

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* No conflict of interest: "This paper has no conflicts of interest to disclose."

[a] Waseda University, funaki@waseda.jp
[b] Waseda University, r.ishikawa@waseda.jp
[c] Waseda University, yogura@waseda.jp
[d] Waseda University, ouseinyo@ruri.waseda.jp

1. Introduction

1.1. Background

An initial public offering (IPO) is when a firm first goes public by issuing shares to an unspecified number of investors at some offering price. The IPO enables the issuing company to obtain diverse and flexible funding from financial markets, beyond borrowing from financial institutions.

As noted in numerous previous studies, including our earlier work "An Experimental Analysis of the IPO Pricing Mechanism: The Case of Book-building" by Funaki et al. (2024), while the IPO is an essential step for a firm to enter the financial market and achieve greater growth, there is an undeniable inefficiency in the pricing mechanism.

The so-called IPO underpricing problem, considered an indirect cost of an IPO, refers to the phenomenon where the initial offering price of a firm's shares is set below the market price on the first day of trading. This results in a significant price increase when the stock begins trading in the after-market, leading to immediate gains for IPO stockholders but potentially leaving money on the table for the issuers. Underpricing is often seen to ensure that the IPO is fully subscribed and that there is strong demand for the shares, but it can also reflect inefficiencies or conservative pricing in the IPO process.

Therefore, it is crucial to improve the IPO pricing mechanisms by evaluating the current methods and identifying the key factors that impact performance in each approach. As Sherman and Titman (2002) pointed out, when examining practice globally, it becomes evident that the Book-building (BB) and Auction methods continue to be the primary pricing methods employed for IPOs. Starting with Sherman (2005), Jagannathan and Sherman (2006), Bonini and Voloshyna (2011), and numerous related studies, research has extensively examined and compared the allocation efficiency, information elicitation, and price discovery levels of the BB and Auction methods. However, determining a clear preference between these two common methods has proven challenging. This leaves unresolved the question of why the BB method became the dominant IPO pricing approach, despite being less advantageous for issuers in terms of profitability.

1.2. Research question and objectives

Driven by the unresolved questions raised by previous theoretical and empirical studies, we are motivated to explore the causes of the underpricing problem and issue manipulations, emphasizing the value of an experimental approach that allows for observing investor behavior in a controlled environment.

In this research, we carry out an experimental analysis of the Auction method, assessing its allocation efficiency, information elicitation, and price discovery levels. We then compare these findings with our prior results on the BB method (Funaki et al., 2024). Our goal is to identify an IPO approach that both maximizes firm value and protects investors.

Note that we do not compare the IPO price with the first day closing price given the absence of an after-market stage in our experiments. Indeed, our focus will be on comparing the IPO price with the value of the stock. Henceforth, in the context of this study, the terms "underpricing" and "overpricing" will specifically pertain to the comparison between the IPO price and the value of the stock.

2. Experimental design and methodology

2.1. Experimental models and equilibria

We have two models to represent the Auction method in the IPO process: a simple single-unit auction model and a more complex multi-unit auction model, which better reflects real-world scenarios.

The baseline settings of our model are based on our prior research. In Funaki et al. (2024), we conducted a serie of experiments to test the BB method on IPOs using a direct mechanism provided by Biais and Faugeron-Crouzet (2002). This experimental model serves as a specific example of the direct mechanism, and we continue to use the same environment in this study, including the number of IPO shares, the number of investors, investors' private information, the value function of the stock and the profit function.

We consider a society with 40 unseasoned IPO shares traded and five informed institutional investors $(i = 1,2,3,4,5)$. The private signal s_i received by the institutional investor has (g) with probability $1/2$ and (b) with $1/2$ which collectively shows the stock is whether high value or low value. Also, the distribution is independent. The value of the stock v depends only on the number n of (g) signals, calculated as 100 times the number of (g) signal in this society plus 100. All investors are assumed to be rational, risk-neutral, and the value of the shares represents a common value. In this process, the five investors are provided with private signals regarding the stock value. After each investor i obtains private signal (g) or (b), they then assess the value based on their own signal and submit their bids b_i accordingly, $b_i \in [100,600]$. The allocation and price of the shares are determined by the outcomes of these bids.

Below we will give the detailed explanation of the single-unit auction, the multi-unit auction, and one of their respective Bayesian Nash equilibria.

In the single-unit common value uniform price auction, we treat the unseasoned 40 shares of IPO stock as a single unit. Therefore, the five investors each place a single bid on the entire block of shares (for simplicity, they bid on a per-share price in the experiment). The investor with the highest bid wins the auction and is allocated all 40 shares. The stock price is determined by the highest losing bid, which is equivalent to the second price.[1] If multiple investors submit the highest bid, the tie-breaking rule is to equally divide the 40 shares among the winning bidders, rather than allocating all 40 shares to one investor based on probability.[2] In this case, the stock price is set to the next highest price after the tie. If all 5 bids are identical, resulting in no losing bid, the price is set at 100, the lowest possible value of the stock. Following is the IC equilibrium we focus on in the analysis.

In the multi-unit common value uniform price auction scenario, the 40 shares are divided into 5 equal quotas of 8 shares each. Each investor places 5 bids, one for each quota, creating a multi-demand situation with a total of 25 bids. The top 5 bids are the winning ones, with the bidder who placed each winning bid receiving a quota of 8 shares. If there are multiple bids at the 5th highest level, the quotas are first allocated to the highest of these bids, each receiving 8 shares. Afterward, any remaining shares are distributed among the bidders tied at the 5th highest bid level, in proportion to the number of tied bids, consistent with the equal-split rule used in single-unit auctions. The price will be set at the highest losing bid (the 6th bid if there are no ties) or at 100 if there are no losing bids. Following is the adjusted IC equilibrium consistent with the single-unit case.[3]

Equilibrium in the single-unit auction

$$\text{If } s_i = b, \text{ then } b_i = 300;$$
$$\text{If } s_i = g, \text{ then } b_i = 400.$$

For simplicity, this equilibrium is presented as a behavioral strategy, but it can also be described using a mixed strategy. Additionally, there are many other equilibria, including both pooling and separating types, beyond the one we are focusing on.

Equilibrium in the multi-unit auction

- For (g) signals investors, bid exactly 4 bids of 600 out of $\underline{5n}$ bids in total; bid 400 for the remaining $\underline{(5n-4)}$ bids.
- For a (b) signal, bid 300 on all 5 bids.

2.2. Experimental procedures

We conducted four treatments of the Auction method. Two of these are single-unit auction

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1 Since there is no fully applicable theory for our specific settings, our model is based on the theories discussed in Kagel and Levin (2011) and aims to achieve an equilibrium with incentive compatibility (indicates that investors with different signals bid on their expected value of the stock accordingly).

2 These two rules should yield the same expected profit. The equal-split rule is used to prevent unfair outcomes, ensuring that bidders with the same bid receive an identical allocation, consistent with the characteristics of our BB method setting.

3 Simply bidding five identical bids at the expected value is no longer a Nash equilibrium, although a slightly adjusted equilibrium still holds for most of the properties we proposed. This equilibrium also indicates the crucial role of marginal bid(s).

treatments (Tr. 1b, Tr. 1b00), and the other two are multi-unit auction treatments (Tr. 5b, Tr. 5bsc). All four treatments were implemented at Waseda University, with the participants primarily consisting of undergraduate students. The details are presented in Table 1.

Treatment	**Subjects Number**	**Required Time**	**Details**
Tr. 5b	30	88 min.	After receiving their private signal, each participant submits 5 bids simultaneously.
Tr. 5bsc	36/25	80 min.	During the screening process conducted prior to the main treatment, only 25 out of 36 participants (considered as more sophisticated investors with better understanding) were selected to continue with the main treatment, which corresponds to Tr. 5b.
Tr. 1b	30	60 min.	After receiving their private signal, each participant submits 1 bid simultaneously.
Tr. 1b00	30	60 min.	The bid value is limited to multiples of 100, rather than all integers between 100 and 600. The other process is the same as in Tr. 1b.

Table 1. Detailed overview of the four treatments

3. Results

The main results from the treatments can be summarized as the follows:

Result 1. Overpricing relative to the stock's fundamental value occurs in the Auction method, consistent with the BB method.

Result 2. Tr. 5b, Tr. 5bsc and Tr. 1b00 achieve similar levels of price discovery, while the overpricing percentage in Tr. 1b is significantly higher.

Result 3. Tr. 5b and Tr. 5bsc exhibit the same relatively high allocation efficiency, whereas Tr. 1b and Tr. 1b00 achieve higher efficiency but face a major issue with exclusivity among the (g) signals investors.

Result 4. Demand reduction and bid spreading are observed in Tr. 5b and Tr. 5bsc, particularly in Tr. 5bsc.

4. Discussion and Conclusion

Although we omit the detailed introduction of our previous study, Funaki et al. (2024), we recall that our main objective is to compare the Auction method with the BB method used in IPOs. Considering that the basic characteristics of the experimental models of the two methods are set the same, we simply compare the performance including allocation efficiency, price discovery and non-exclusive levels between treatments.

Our findings show that in the BB method, investors with greater knowledge and understanding perform better. However, in the auction treatments, IPOs achieve similarly high levels of price discovery and allocation efficiency, regardless of investors' knowledge. Notably, dividing shares into multiple quotas or adjusting bid price increments can help mitigate overbidding in the Auction method.

These findings suggest that investor quality control is essential for the BB method, and offering underpricing can incentivize sophisticated institutional investors. In contrast, the Auction method doesn't require expensive screening, offering more access to retail investors, though this might impact institutional investor interests.

In conclusion, the multi-unit auction method is ideal for reducing costs and maximizing firm value, while the BB method is better suited for protecting investors and fostering long-term relationships.

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