A, B or C?
Experimental tests of IPO mechanisms

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Abstract

Empirical research has provided extensive evidence on the inefficiency of bookbuilding in controlling underpricing. Both academics and practitioners have investigated this phenomenon proposing innovative offering methodologies. In this paper we explore the information revelation and underpricing properties of two baseline models, uniform auctions and bookbuilding, and two newly proposed mechanisms, Ausubel auction and Competitive IPO. Our findings confirm the empirical weaknesses of bookbuilding and provide hints that standard auctions may stimulate less bidding. However, (a) the Competitive IPO features increase competition both among banks and among investors resulting in more information revelation and less underpricing than standard bookbuilding; and (b) the Ausubel auction yields superior price discovery and underpricing outcomes than uniform clock auction and bookbuilding. Our experimental results provide novel insights to the ongoing debate on optimal equity offering mechanisms, suggesting that the solution to current issuing methodologies shortcomings may require the development of a "hybrid" procedure blending properties of existing and new mechanisms.

1 Introduction

After the 2008 standstill in the IPO market following the financial crisis, IPO filings have started to grow again[1] reviving the long-standing interest in the efficiency of equity offerings methodologies and in the behavior of market participants (Jenkinson 2009). The large underpricing associated with the traditional book-built issuances alongside the existence of potential conflict of interests have spurred a vigorous discussion about the optimal design of Initial Public Offerings (IPO). While, several contributions have highlighted the theoretical advantages (Ausubel,2002a, Biais et al., 2002; Bennouri and Falconieri, 2006) and empirical superiority of auction-like mechanisms (Derrien and Womack, 2003;Vandemaele, 2003; Degeorge et al., 2010), book-building is still the most common methodology as documented, among others, by Sherman (2005), Jagannathan and Sherman (2006) and Ljungqvist (2007). These authors suggest that auctions may have not replaced bookbuilding because the most common auction structure (uniform price) carries significant undersubscription risks and doesn't provide incentives to fully reveal information. However, several studies (Derrien and Womack, 2003; Vandemaele, 2009; Degeorge et. al., 2010) show that carefully designed auction procedures can mitigate those problems and provide superior outcomes. The lack of consensus on the superiority of any of these pure offering mechanism allows to conjecture that the solution to bookbuilding shortcomings may require the development of a "hybrid" procedure that blends the properties of existing and newly designed mechanisms, as argued by Jagannathan,Jirnyi and Sherman (2010) Vandemaele (2003) and in line with findings in Derrien and Womack (2003)

In this paper we try and contribute to the literature by testing the price discovery, information revelation and underpricing properties of standard bookbuilding and uniform auctions thus exploring their alleged shortcomings. We achieve this goal by testing these offering methodologies against two innovative models - competitive IPO and Ausubel auction - that introduce features aimed at overcoming the bookbuilding and uniform price auction flaws. Competitive IPO is a recently developed empirical mechanism introduced by the investment bank Dresdner Kleinwort Wasserstein (DKW) as the offering mechanism for the 2004 Pages Jaunes (PJ) IPO which offers the desirable property of decoupling pricing and allocation roles with the goal of improving IPO efficiency (Jenkinson and Jones, 2009). Pioneering applications of this methodology have yielded promising results but the limited number of issues has not allowed

[1] See quarterly SEC Filings data at www.secfilings.com

yet for any formal study testing its properties. On the other hand, Ausubel (2002, 2004) theoretical model proposes an innovative price-discriminatory multi-unit auction which has received considerable attention as a viable alternative to existing IPO offering methodologies for it blends two desirable properties: simplicity and optimal information revelation. Ausubel (2002) indicates that such a dynamic auction model should generate efficient results while at the same time mitigating the well known overbidding and winner's curse problems of standard auction. Yet, while dynamic and Ausubel auctions have been tested in a general multi-unit environment (Engelmann and Grimm, 2009), there is no evidence both in experimental and real-world applications on the outcomes of these mechanism for share offerings.

Although these alternatives provide theoretically superior outcomes, both issuers and intermediaries may be reluctant to adopt them, or modify existing procedures borrowing from these models, given the limited evidence on their realizations and therefore the risk of yielding a weak or unexpected market response.[2] This lack of predictability contributes to explain the the renewed interest in alternative issuing methodologies (WSJ, 2009; Ritter, 2009, Degeorge et al. 2010). In this paper we tackle this issue by providing experimental evidence on the behavior of market participants under these two innovative offering formats and their baseline bookbuilding and uniform price auction formats. This approach is reliable whenever no or limited field data are available (Offerman and Potters, 2006; List, 2006; Holt, 2005; Smith, 1982; Wilde, 1980). In our experiments we test the offering outcomes against the two baseline control mechanisms, bookbuilding and uniform-price clock auction to isolate the differential performance, measured by underpricing, and simultaneously investigate the price revelation process thus shedding further light on the potential applications and expected drawbacks of these alternatives to traditional bookbuilding.

Results show that both competitive IPO and Ausubel auctions yield extremely satisfactory results in information revelation, price discovery and in mitigating underpricing (defined as the difference between the share value and the offer price). Competitive IPO outperforms bookbuilding in information revelation: on average, investors disclose 20% more of the share-value information (139% more for experienced players) in competitive IPO than in bookbuilding. Similarly, Ausubel auction minimize the information rent

[2]The need for accurate ex-ante testing of novel issuing mechanisms is highlighted by Wilhelm (2005), pag. 13: "Reshaping current practices will also require considerable courage among senior managers of issuing firms [...] I am not persuaded that applications of auction theory to electricity markets or auction-based advertising systems, for example, shed a great deal of light on the optimal implementation of theory in IPO markets."

without generating a significant winner's curse. When looking at price discovery, the Ausubel auction mechanism does not meaningfully outperform a baseline uniform-price format with an almost zero average difference between the share value and the offer price for both formats. Finally, both Competitive IPO and Ausubel auction yield a level of underpricing of less than one price tick while in bookbuilding the underpricing is seven times larger.

Our results deliver novel experimental evidence which is useful in the ongoing quest for more efficient equity issuing methodologies.

The paper proceeds as follows. Section 1 reviews IPO literature, section 2 discusses the competitive IPO, the theoretical background of the Ausubel auction and formulates research hypotheses. Section 3 develops the experimental design. Results of the experiments are reported in Section 4. Section 6 discusses the implications and concludes.

2 Offering mechanisms and empirical evidence

In general, an efficient IPO should minimize the amount of "money left on the table" by issuers, spur more competition among advisors and allocate shares efficiently (Loughran and Ritter, 2002). Market regulators worldwide have adopted different approaches to fulfill these goals, resulting in three families of IPO mechanisms; bookbuilding, auction-like and fixed price (Ritter, 2003). Several studies attempt to control whether the differential adoption of a specific mechanism generates superior results (i.e. less underpricing). Derrien and Womack (2003), focusing on the French market, show a robust superiority of auction-like mechanism in controlling underpricing in both hot and cold IPO markets. They also suggest though, that the choice of less efficient mechanisms like bookbuilding could be driven by the desire of targeting different type of investors. Kutsuna and Smith (2004) provide support for bookbuilding in the Japanese market where, though, the alternative auction mechanism was severely flawed by its mechanism design which imposed a very small upper limit on quantities, leaving investors with limited incentives to devote resources to properly reveal their demand schedules. Kandel et al. (1999) provide evidence on the Israeli market where auctions have been adopted as the offering mechanism between 1993 and 1996. Their results show that under a uniform-price auction mechanism, underpricing is significantly limited both in the first day and ten-day windows. Degeorge et al (2010) empirically show that auctioned IPOs yield superior price discovery allowing institutional investors to extract informational rents.

Yet, despite evidence that the level of underpricing associated with bookbuilding mechanisms is large and significant, this methodology is steadily increasing its market share, as documented by Sherman (2005), Jagannathan and Sherman (2006) and Ljungqvist (2007).

This puzzling evidence is addressed by several studies which argue that bookbuilding can be used for "signalling" purposes (Allen and Faulhaber, 1989; Jenkinson and Ljungqvist, 2001; Degeorge et al., 2007; Wilhelm, 2005), for reducing issuing costs to large issuers (Kutsuna and Smith, 2004), or because the information revealed by large institutional investors during the bookbuilding process is valuable to lead underwriters, thus offering an incentive to adopt bookbuilding as an offering mechanism (Cornelli and Goldreich, 2001, Fernando et al., 2007). Sherman (2005) and Wilhelm (2005) also argue that auctions have not ousted bookbuilding because of the complexity of the auction processes which impose excess caution on retail investors and therefore inefficient price revelation. The argument is that intermediaries provide an "asymmetric information protection" role to investors which auctions do not offer, since reliance on intermediaries in auction processes is limited. Therefore auctions, while being effectively considered more efficient in allocating shares, leave too much uncertainty to the investors with regards to the "real" value of the offering company. These arguments though, are not supported by the results in Vandemaele (2003) on the French market where issuers can choose between different offering mechanisms. The author conclusively shows that when companies have the option of choosing between auction-like and bookbuilding-like (fixed-price) procedures, companies with higher valuation uncertainty are more likely to opt for auction-like procedures. However, the likelihood of choosing an auction mechanism decreases, the higher the bank's reputation, indicating that if issuers are advised by a low-reputation bank, an auction mechanism can allow a more efficient price discovery and can elicit more information revelation from the market. Jagannathan, Jiryi and Sherman (2009) provide similar results showing that optimal mechanisms might be contingent on market conditions and the issuer's quality.

This lack of consensus on the optimal issuing mechanisms has fostered both theoretical research and practitioners' reactions. Biais et al. (2002) develop an optimal mechanism, which attempts to solve the retail investor rationing problem and "winner's curse" while maximizing capital raised by issuers. The model shows striking similarities with auction-like procedures in France and the UK which offer indirect evidence of the model's efficiency. Bennouri and Falconieri (2006) provide insights on the ongoing debate on the superiority of discriminatory vs nondiscriminatory auctions focusing on the IPO market. They show that auction-based share offerings with uniform price/quantity are endogenously superior to price discriminating approaches, when assuming that financial intermediaries and issuing companies form a stable long-term coalition. This structure offers opposite results to those obtained by Bias et al. (2002) supporting the idea that uniform auctions could be an optimal mechanism offering also limited winner's curse and overbidding problems.

Ausubel (2002a, 2004) proposes an innovative price-discriminatory multi-unit auction which offers strong theoretical properties that could generate efficient IPOs. The essential feature of the Ausubel model is that the price paid for marginal units is not connected with the price paid for infra-marginal units, hence bidders do not have incentives to bid less than their valuations for marginal units in an attempt to decrease the price of infra-marginal units. This last methodology has received considerable attention for it shows two desirable auction properties: simplicity and optimal information revelation. Renewed attention has been devoted by practitioners to auction mechanisms, due to the recent Google and Pages Jaunes offerings, which went public through non-traditional mechanisms. Google chose a modified Dutch auction, retaining a degree of control over bids, while Pages Jaunes, the French telephone directories business, has employed a pioneering method (which lately has been named "competitive IPO") designed by its financial advisor, which combines traditional bookbuilding and auctions in two independent steps.

The theoretical work of Ausubel and the mechanic adopted by Pages Jaunes, are especially noteworthy in that they offer potentially viable solutions to some of the major problems highlighted in optimal IPO literature and by practitioners although with two opposite approaches. Competitive IPO is based on an auction mechanism assumed to improve the efficiency of the offering price by stimulating increased competition among underwriters. Imposing a "no-fee" threat[3] on the financial advisor alongside with increased competition should generate more informative price-schedules. The aftermarket price of the offering should then be much closer to the offering price. This approach would satisfy the need for more efficient pricing mechanisms while not depriving market investors of the valuable role of intermediaries as information providers.[4]

[3]If the final price is below the price range, the underwriters' fees are not paid.

[4]The introduction of competitive IPO was not welcomed by most investment banks, with some hurrying to state that "it's a cretinous waste of time", or that the new method puts pressure on the analysts affiliated with the participating banks and covering the issuing company (Wilson, 2005). Yet, the size and success of the offerings have rapidly mitigated criticisms.

On the other hand, the Ausubel mechanism conjectures that a mechanism based on discriminatory price would protect less-informed investors because they would bid and effectively obtain exactly the quantities they feel comfortable with at the desired price. Incentives for opportunistic bidding by any investor would be neutralized by the very structure of the auction which theoretically offers consistent efficient pricing. By being administered by an investment bank, the information provision role could be granted thus introducing more confidence in bidders.

These two mechanisms thus seem to offer viable, effective solutions to the share issue problem. Unfortunately, given the novelty of the contributions and the caution of companies and investors in leaving the beaten-track, no or limited evidence is available on the behavior of market participants under these two mechanisms . The five IPOs conducted through a Competitive IPO mechanism have offered significantly lower underpricing and higher aftermarket price stability with an average price jump of 3.54% and 1.38% for the first-day the first-week respectively, while the comparable numbers for European IPOs the same year were 29.5% and 25.4%. However, the offerings were clustered in just 18 months and mostly on one industry (telecommunication) which doesn't allow to rule out a significant small sample bias. On the other hand, several papers (Engelmann and Grimm, 2009; Kagel et al., 2001, Kagel and Levin, 2001; Manelli et al., 2001) test the predictions of the Ausubel mechanism but no evidence exists in a IPO environment. Furthermore, the only recent significant cases of auction-based IPO have been Google, which adopted a modified Dutch-auction approach,[5] and few companies adopting standard uniform price clock-auctions (Hensel, 2009; Degeorge et al., 2010). Despite hints of good results offered by recent alternative mechanisms, the limited empirical evidence calls for further testing.

3 Competitive IPO and Ausubel auction mechanics

3.1 Competitive IPO

Pages Jaunes went public in July 2004 using for the first time the "competitive IPO" approach developed by Dresdner Kleinwort Wasserstein.[6] After that, this pioneering

[5] John Miller, Carnegie Mellon University Professor of Economic Theory, named the Google IPO a: "$3billion experiment[al]" testing ground for mainstream auctions theory.

[6] Jenkinson and Jones (2009) provide a detailed analysis of the PJ offering, the developments in the following IPOs and the issues raised by the UK Financial Service Authority.

methodology was applied again between 2005 and 2006 in five additional IPOs[7]. The new approach is meant to eliminate the drawbacks of traditional IPOs caused by the presence of conflicts of interests in banks, limited competition among banks and weak monitoring of the issuing process by the issuer.

The novelty of the competitive IPO lies in three aspects: first, the preparation of IPO is decoupled from execution; second, banks are informed of their role only close to the IPO (two weeks); and third, a no-fee clause applies throughout the process. The issuing process begins with the appointment of a financial advisor by the issuing company who prepares the offering but is not allowed to execute it. The aim is that since the financial advisor does not participate in the profits from share allocations, he cannot be involved in potential conflicts of interests. Bringing in the financial advisor, in this case, could be thought of as acquiring the financial expertise generally missing in new issuers and offering the market a truly independent judgment on the value of the company. Once appointed, the financial advisor organizes a beauty contest among would-be underwriting banks and short-lists several banks as potential syndicate members based on the proposals submitted by the participants. The proposals contain the banks' views on market sentiment, potential demand, offering structure, valuation and other relevant offering details. A short list of banks is selected and their roles in the syndicate (bookrunner or non-book position) are assigned only after a pre-marketing stage. Each bank receives a previously disclosed list of investors to contact and has to send to the advisor reports on a daily basis. After collecting investors' feedback the banks would submit price range proposals to the advisor. The advisor elaborates the offers setting the price range and a syndicate composition expected to maximize efficiency. The issuer takes the decision about the final price range and appoints banks with the mid price-ranges as bookrunners, and others as Joint-Lead Managers.[8] Eventually, the going-public process proceeds in the usual way, with roadshows followed by the final book-building. In order to maintain the banks' selling effort, fees are split in two; a base fee and an incentive fee. The base fee is paid only in the case where the final price falls within or above the price range. Half of the incentive fee is paid automatically if the price is in the upper tier of the price range.

[7] Dealogic and Jenkinson and Jones (2009) records that after the 2004 PJ offering four companies selected this mechanism in 2005: Inmarsat (UK, Telecom), Telenet (Belgium, Telecom), EFG (Switzerland, Banking), Eutelsat (France, Telecom)On ecompany adopted a similar mechanism in 2006: HoggRobinson (UK, Travel services).

[8] For the issuer, price accuracy is of key importance, and, thus, the bookrunner's positions are assigned taking the average values submitted to minimize post-IPO price volatility

3.1.1 The Effect of the Competition on the Underwriters and Investors

The key component of this IPO methodology is the introduction of an additional agent the financial advisor (FA) in the issuing process.[9] The FA's role is to provide expertise and perform thorough monitoring of the entire process. Not being involved in shares allocation implies that the FA is not exposed to usual conflicts of interest and, therefore, the FA's incentives are aligned with those of the issuer and these two actors can be considered as one agent, or the "expert issuer".

Two other features of competitive IPO eliminate (or at least significantly mitigate) the conflict of interest between the issuer and the underwriter: the late and selective appointment of bookrunner(s) and the threat of not getting the fees. However it is the combination of these characteristics that creates efficient competition: on one hand investment banks are encouraged to submit aggressive bids to avoid exclusion from the offering. On the other hand, the no fee threat guarantees that bids are also realistic enough price-estimates set in order to minimize the risk of losing the fees. Indeed, if there were only a "late appointment" component without the "no-fees" punishment, the banks would propose overoptimistic price ranges in order to win the mandate and later on to set the price below the price range without adding any additional efficiency to the placement process. On the other hand, having the fee threat in place – but no competition – would guarantee the selected underwriters' efforts to get the final price inside the range, but would delete the incentive to push the price range up. As a result, the final price would be set far from the highest level possible. Having both components in place puts in line the incentives of the issuer and its underwriter in maximizing the proceeds from going public.

With this methodology the issuer and the FA should obtain optimal incentives alignment for both underwriters and issuers. Yet, very little information is available about the investors' behavior (in particular, institutional investors'), which is aimed at driving the price as much towards the bottom end as possible. Some questions then arise: will investors' behavior be different in competitive IPO? Will the new pricing structure be able to elicit more information from them?

We conjecture that competition among banks could, as a side-effect, spur competition between investors. This idea comes from the observation that orders submitted directly to bookrunners are treated more favorably compared with orders made to other syndicate members. Although the analysis of allocations is highly problematic due to

[9]DKW in PJ's case.

the proprietary character of the data, two studies exploring the detailed allocations of leading European banks provide empirical evidence for the above statement. Cornelli and Goldreich (2001) find that investors who submitted the orders to the bookrunner, all else being equal, obtained 35 per cent extra allocations. In the dataset of Jenkinson and Jones (2004) the effect of submission to the bookrunner is even more pronounced, with 55 per cent increase in allocations for all IPOs (68 per cent for hot IPOs, 25 per cent for non-hot IPOs). Big investors benefit from "their" bank being appointed as the bookrunner, and therefore, they may be willing to submit higher valuations of the issue to "help" their bank to win. Investors, therefore, may become involved in the competition against other banks' investors.

We thus state the following two hypotheses:

HYPOTHESIS 1: *Investors will reveal more information about the share value in IPO with competitive stage than in traditional bookbuilt IPO.*

HYPOTHESIS 2: *The underpricing will be lower in IPO with competitive stage than in traditional bookbuilt IPO.*

3.2 Ausubel Auction and Its Application to IPO Markets

An efficient Ascending-Bid auction for Multiple Objects (commonly referred to as the Ausubel auction) combines two essential rules of effective auction design in the challenge to create the dynamic version of multi-unit Vickrey auction. Classical auction theory requires that the price paid by the winner should ideally depend on other participants' bids while being independent from her own valuation (Vickrey, 1961). Auctions designed following this recommendation would give the appropriate incentives to participants to fully reveal their information as in sealed-bid second price auctions. A second rule states that open format auctions are preferable to closed format ones (Milgrom and Weber, 1982) because they maximize the information about the opponents' behavior available to participants, and, consequently, induce more aggressive bidding. This is particularly the case for the environment with a common-value constituent in the bidders' valuations.

The Ausubel (2004) auction is based on the uniform-price clock auction (or ascending-bid clock auction) and can be summarized as follows.

Let M be the number of shares to be allocated among n bidders. Each bidder can bid for at most λ_i , $0 < \lambda_i \leq M$. Let the bidder's utility be $U_i(x_i) - (y_i)$, where x_i

denotes the number of shares assigned to bidder i and y_i her payment. The value of $U_i(x_i)$ is supposed to be the integral of a marginal value $u_i(\cdot)$,

$$U_i(x_i) = \int_0^{x_i} u_i(q)\, dq \tag{1}$$

The model is developed as a dynamic game in discrete time. It is assumed that the marginal values are weakly diminishing and integer. If each bidder's marginal utility is public knowledge, then we speak of a game of complete information, otherwise it is a game of incomplete information. For simplicity, two constraints are imposed on bidding strategies. First, the bids must not be increasing in price. Second, the bidders should not bid for smaller quantities than they have already clinched.

The auction starts at time t at a price p_0, the price increases at each subsequent time. At each price the bidders place their bids $x_i(p)$, after that the aggregate demand is calculated. If it exceeds the supply M, the auction proceeds, otherwise the auction stops and the bidders are awarded the final quantities x_i^*. For determining the payment the following "clinching rule" applies: the cumulative clinch for bidder i is calculated at each time as

$$C_i(p) = \max\left\{0, M - \sum_{j \neq i} x_j(p)\right\} \tag{2}$$

In its turn, the payment of bidder i is calculated as Stieltjes integral:

$$y_i = \int_{p^0}^{p^*} p dC_i(pq) \tag{3}$$

where p^* is the final price.

Differently from multi-unit Vickrey auctions, the Ausubel auction shows the desirable property of being simple in its operating rules for a general public, therefore allowing to expect a successful implementation.[10]

Theoretically, the design proposed by Ausubel removes the incentives for demand reduction present in the uniform-price auctions. As the price of each marginal unit is not connected with the price paid for inframarginal units, bidders do not have incentives to bid less than their valuations for marginal unit in an attempt to decrease the price of inframarginal units. Second, the rules of the auction should be simple enough to allow effective implementation. This is in contrast to the multi-unit Vickrey auction, which seems to be difficult to put into practice due to its sophisticated rules (Kagel

[10] Appendix A reports a simple numerical example.

and Levine, 2001). Another useful characteristic is the preservation of privacy of the winners' valuations. Some academics advocate that the participants will be reluctant to reveal their valuations, if in certain situations this information can be used against them (e.g. in subsequent auctions). Therefore, the bidders favour ascending-bid formats over sealed-bid second-price ones as long as in the former auctions the participants are not revealing their demand curves above the winning price.

In the private-value setting, sincere bidding is one of the equilibria while in the interdependent-value case it is proved to be unique equilibrium for the limited set of environments. The suitable framework for analyzing IPO markets is common values as long as the shares' value is the same for all investors and is equal to the secondary market price. Unfortunately, this case is not covered by the above theorem. Thus, for the Ausubel auction experiments, the baseline case will not be a theoretical prediction but the standard uniform-price clock auction, which differs from the Ausubel model in the payment rule only.

Accordingly, we define the following hypotheses:

Hypothesis 3. *The final prices in the Ausubel auction on average will be higher than the final prices in the uniform-price clock auction.*

Hypothesis 4. *The underpricing will be lower in the Ausubel auction than in uniform- price clock auction.*

4 Experimental Design

The experiment consists of two sub-experiments, "competitive IPO vs bookbuilding" and "the Ausubel vs uniform-price clock auction", set in almost identical environments. We have decided to introduce separate benchmark treatment for each mechanism in order to isolate the impact of the newly introduced features. While having one baseline for both competitive IPO and the Ausubel auction would still give us the possibility to analyze the underpricing, it would leave the questions open about the mechanisms through which these outcomes were achieved. Bringing in benchmarks which absolutely match the IPO methods under investigation but exclude the novel characteristics, makes feasible a direct evaluation of information revelation of the two methodologies. Accordingly, we introduce Bookbuilding (Treatment B), which differ from Competitive IPO (Treatment C) by the absence of multiple banks and "the auction stage", and Uniform-price clock auction (Treatment U) which differ from the Ausubel auction (Treatment

A) in that it doesn't provide a "clinching rule".

Below we present the common structure and organization of sub-experiments and then resume with specific characteristics for each treatment.

4.1 Experiment Participants, Incentives and Rounds Structure

The experiments were conducted in the Bocconi University Computational Lab with subjects randomly selected after public advertisement from undergraduate, graduate and Ph.D. students. Each subject was allowed to participate in one session only. The final pool of players totaled 100 different subjects: 60 for "bookbuilding-competitive IPO" (both bookbuilding and Competitive IPO had 3 sessions each with 12 subjects in the first session and 9 in the two consecutive sessions) and 40 for the auctions experiment (4 sessions with 5 participants for both treatments) [11]. Each session consisted of 24 experimental rounds - mimicking 24 distinct IPOs - and lasted 60–80 minutes.[12] Therefore, we collected data from 336 experimental IPOs (72 each for bookbuilding and Competitive IPO; 96 each for the Ausubel and uniform auction). All subjects were paid a show-up fee of 5 euros. In addition, at the end of each session, experimental accounts accrued were exchanged in money at a previously specified rate. Participants average payoffs for the experimental account only, ranged between 12 and 20 euro. The experimental software was developed in z-Tree (Zurich Toolbox for Readymade Economic Experiments)[13] and run on networked computers controlled by the authors, mimicking the real-world information-swapping platform.

[11] In Competitive IPO-Bookbuilding experiments it was necessary to have at least nine subjects in order to have several groups with several members in each group. We run the very first round with 12 just to have more data to control for potential flaws in the experiment design. In Auction experiments, consistently with standard experimental literature, fewer participants suffice therefore we opted for five-subject sessions and added an additional session.

[12] Before each session we run a tutorial by reading publicly instructions, allowing Q&A and running a test session (Dry round) to check the understanding of the rules. Furthermore, Q&A time was allowed at the end of each experimental round to control for any potential misunderstanding. Results of the dry rounds for the Ausubel auction are reported in Appendix A, Table A1.

[13] See Fischbacher (2007) for an introduction to z-Tree experimental software.

4.2 Experimental Setup

The experimental setting is designed to reflect the essential features of new issues markets: high degree of uncertainty and experienced established group of large investors. The information structure adopted in our experiments follows that frequently used in experimental auction studies (Kagel and Levin 1986, 1999). We assume that shares have a "true value" V (which could be interpreted as secondary market price) drawn from a uniform distribution with support $[a; b]$.[14] Subjects are not informed about the realization of V, but each subject i receives a private signal S_i about the value V, which is independently drawn from a uniform distribution defined on $[V - e; V + e]$. The parameter e is common knowledge to all subjects. Subjects do not know the signals of other subjects. Different signals simulate either pessimistic (signal below the true value) or optimistic valuation of the issue by various investors. We set the support for the true value to be $[10; 110]$ ($[10; 50]$ for auctions experiments[15]) and the support for investor signals to be $[V - 5; V + 5]$. The large width of the true value distribution support was chosen in order to obtain signals inside the true value range $[10; 110]$ with probability close to one.

The repetitive character of the game and stable groups of subjects, which remain the same throughout the sessions, mimic real-life institutional investors on new issues markets who interact continuously and represent an established community.

4.2.1 Competitive IPO and Bookbuilding Treatments

As argued in the previous section, competitive IPO by construction eliminates the conflict of interests between the issuing company and the investment bank/FA, therefore, we will consider these two agents as one aggregated agent. Since we want to observe the investors' behavior with minimal noise, as suggested in Kagel (1997) the issuer-underwriter role is performed by a computerized profit-maximizing algorithm, while the experimental subjects are assigned the role of investors.

We used a "between-person" experimental design with two distinct treatments; Treatment C (denoting competitive IPO) and Treatment B (denoting bookbuilding). In both treatments all subjects are endowed with a fixed amount of experimental currency (forints) to which the profits/losses were added/subtracted respectively. In treatment

[14] We abstract from possible interactions between primary and secondary markets and consider the true value exogenous.

[15] This choice of parameters will be further discussed in detail below.

C, subjects are divided in several groups (clients of different banks), in treatment B there is only one group.

The experimental treatment is developed to capture the crucial characteristics of the competitive IPO (Jenkinson and Jones 2009) and at the same time to be parsimonious enough for experimentation. An issuing company (Issuer) has an objective to distribute N shares maximizing the proceeds from going public. Issuer conducts a competition among M banks for the position as a Bookrunner. In the course of the competition each competing bank must gather opinions about the value of the shares from the stable group of their clients (institutional investors) who repetitively participate in IPOs. Investors are endowed with equal capital and can demand a fixed number of shares or no shares. Institutional investors possess information about the value of the issue, and their aim is to maximize the profit equal to the difference between the price of the issue and its true value multiplied by the number of shares allotted.[16] Each investor is in a long-term relationship with a single bank. This assumption is adopted for simplicity, removing it would complicate the experiment without affecting results significantly. For investors, being in a long-term relationship with the bank that is appointed as Bookrunner implies preferential treatment of their orders, i.e. ceteris paribus, the Bookrunner's customers obtain more shares than non-clients. Based on the information obtained from their investors, each bank builds an indicative price range. The bank with the highest price range becomes Bookrunner. All the investors are invited to submit price orders within the price range. The Bookrunner sets the final price and allocates the shares. Finally, we develop a bookbuilding-like procedure without the competition among banks as a benchmark for hypotheses testing and differential comparison of the results.

Competitive IPO (Treatment C) Each session of the treatment consists of 24 periods, each period being interpreted as an IPO. As mentioned before, groups consisting of three subjects are stable throughout the session. In each period 30 shares will be put on for the distribution. Each subject can submit fixed bid q for 10 shares, however, she can obtain less than this amount. The IPO mechanic is shaped carefully following the procedure proposed by DKW and reported in detail in Jenkinson and Jones (2009). Each period (IPO) proceeds as follows.

- In Step 1, the true value V is realized and subjects are given private signals S_i

[16] For the sake of simplicity, we do not model the retail investors' participation.

- In Step 2, subjects submit their valuations v'_{ij} (j stands for the group). The middle price range is built automatically for each group j:

$$\overline{v'_{ij}} = \frac{1}{3}\sum_i v'_{ij} \tag{4}$$

$$\left[\overline{v'_{ij}} - 2; \overline{v'_{ij}} + 2\right]; \tag{5}$$

where

$j \in \{1,2,3,4\}$ for session 1 and $j \in \{1,2,3\}$ for sessions $2,3$.

- In Step 3, subjects learn the winning (i.e. the highest) price range and submit price bids p_i to buy 10 shares, the price must be inside the price range or zero, if a subject decides not to acquire shares.

- In Step 4, the issue price p^* is set and shares are allocated by the following rules (designed with the help of investment banking practitioners):

  i) if the total demand is less or equal 30, p^* is set at the lowest submitted price; all the bids are satisfied;

  ii) if the total demand is higher than 30 but less than 60, p^* is set at the full subscription level; the shares are allocated to the bidders who submitted prices higher or equal to the final price by the following rule: the clients of Bookrunner are assigned $a \cdot k \cdot q$; others $k \cdot q$, where $a = const, a>1$, q is the bidden quantity, and k is the rationing coefficient defined as

$$k = \frac{Q}{a\sum_b q + \sum_{nb} q} \tag{6}$$

where $\sum_b q$ is the sum of winning bids by the clients of Bookrunner, $\sum_{nb} q$ - by other winning subjects, and Q is the total amount of IPO

iii) if the total demand is 60 or more, p^* price is set at twice the full subscription level (60 shares), those bidders who bid higher or equal to p^* receive shares by the rule described above.

- In Step 5, the payoff of subject i is calculated as $(V - p^*)q_i$, where q_i is the quantity assigned to subject i.

Bookbuilding (Treatment B) Following evidence on common market practice (Jenkinson and Ljungqvist 2001), boobkuilding treatment is analogous to Treatment C with some exceptions. First, there are no groups (all the subjects are clients of one bank) and therefore in Step 4 in (ii) and (iii) all winning bidders are treated in the same manner i.e. they obtain shares pro rata. Each winning subject gets kq shares, where: $k = \frac{Q}{\sum q}$, Q is the total amount of IPO, and $\sum q$ is the sum of winning bids submitted. Second, having left the setup in this treatment as it is, we would give no incentives to subjects to submit higher than minimum valuations at the stage of building the price range. Indeed, by reporting very low valuations, subjects bring the price range down without facing any negative consequences of getting small allocations because by bidding at the higher end of the price range at the next stage they can secure the allocations. In practice, this would not be the case because investors know that if their valuations are significantly lower than the issuer's estimated value, IPO is suspended. We introduce a similar condition in this treatment: if the average bid submitted is less than tolerance level (which we define at $0.7V$, consistently with market anecdotal common practice), IPO is cancelled.

It is worth noting that the experimental design assigns shares pro-rata to winning bidders. Such a feature may reduce the compatibility with an information extraction process à la Benveniste and Spindt (1989).[17] In their seminal contribution the authors argued that the bookrunner can reward investors for the information provided in the process by underpricing the offering and preferentially allocating shares, as empirically confirmed by Cornelli and Goldreich (2001). As such, allocation should be increasing with information revelation. This should drive underpricing down to an equilibrium level. The large and persistent underpricing observed in empirical evidence (Ritter 2009) suggests that the bargaining process results in excessive underpricing and exceedingly discretionary allocation (Jagannathan and Sherman 2005, Degeorge 2010) which motivates the quest for improved offering methodologies. Our experimental approach allows to disentangle the allocation effect from the pricing effect. However, this comes at a cost as we reckon that we may fail to fully capture the long term interaction between the bank and the preferential investors as we do not discriminate "within"

[17] We thank an anonymous referee for highlighting this implication.

the winning bidders. However, as in Cornelli and Goldreich (2001), it is unclear the extent to which privileged investors do actually compete between themselves for higher marginal allocations by providing additional information revelation.

4.2.2 The Ausubel Auction and Uniform Clock Auction

In testing auction procedures we adopt the same "between-person" experimental design with two distinct treatments: Treatment A, the Ausubel auction, and Treatment U, the baseline uniform-price clock auction treatment.

In the beginning of each treatment all subjects receive equal endowments of 500 units of experimental currency. Profits (losses) accrued in each session are then added (subtracted) from the endowment. For each experimental round (i.e., a fictional IPO) 15 identical items representing the complete share offering are auctioned among participants. Before each auction the participants obtain their estimates. Auction starts at a floor price of 10, and the price is augmented automatically by one with a pre-specified delay. Subjects enter their bids (quantity of units they want to buy at the current price) with several constraints on bids: a maximum of 10 units can be demanded; the bids must be non-increasing in quantity; for the Ausubel auction, players should bid a number of units greater than or equal to the number of units already clinched. In case demand falls too sharply (below the supply), the final price is set at the current price minus one, and equal proportions of the bids are allocated to the participants.

These auction rules apply to both treatments, while the difference between auction formats lies in the payment rule. In a uniform-price clock auction all the winners pay the final price multiplied the quantity of items they are allotted; in the Ausubel auction the payment is calculated applying the clinching rule described in detail in Section 2. Throughout the auction the subjects could see on the screen their estimate, current price, the window where they could enter bids, and in the Ausubel auction also the number of items clinched at different prices.

5 Experimental Results

In Subsection 4.1 we examine underpricing for the entire sample and for the subsample of experienced subjects for Competitive IPO-Bookbuilding and Ausubel-Uniform auction experiments. Subsections 4.2 and 4.3 look at price discovery evidence in the Competitive IPO-Bookbuilding and Ausubel-Uniform auction respectively.

5.1 Underpricing

Figure 1 provides scatter diagrams of final prices of the shares with respect to their true values under different treatments. In the Ausubel auction, the units can be purchased at the prices different from final, and thus we proxy the unique final price by the total revenues divided by the total number of units auctioned, where total revenues is the amount paid by all participants for all units. In order to allow visual comparison of the treatments, we plot the results using the same scale.

INSERT FIGURE 1 HERE

Diagrams immediately reveal a large difference in the levels of underpricing in the Competitive IPO-Bookbuilding pair, and the unexpected similarity of the small magnitude of underpricing in the Ausubel-Uniform auction setup. The top panel clearly demonstrates that the magnitude as well as the dispersion of underpricing is significantly lower in treatment C than in treatment B. In Bookbuilding the price tends to move farther from the true value as the latter increases.[18] This encouraging result supports evidence provided by Fernando, Krishnamurty and Spindt (2004) that shows that high-priced IPO experience larger underpricing consistently with Benveniste and Spindt (1989),[19] and Stoughton and Zechner (1998) theoretical predictions.

In the bottom panel the scatter diagrams of the two auctions could easily be confused – the Ausubel "clinching" rule does not result in (at least visibly) lower underpricing compared to the uniform auction.

Second, and more striking, competitive IPO and auctions, although completely different mechanisms, yield surprisingly similar results in all treatments with the vast majority of observations densely concentrated around the 45-degree line implying a close to zero underpricing. Evidence of overpricing is present under all mechanisms, but its frequency is the highest in the Uniform auction treatment with 41% of rounds being affected by a small, overpricing. This figure is 31%, 25% and 24% for the Ausubel auction, Competitive IPO, and Bookbuilding respectively. Remarkably, in Bookbuilding overpricing

[18] With the extent of underpricing being limited by the condition that the sale is cancelled in case the price is more than 30% below the true value.

[19] As previously discussed, the experimental setup assigns pro rata shares to winning bidders. The absence of a discretionary allocation rule "within" bidders may have an effect in increasing the underpricing as winners in the group do not compete for extra allocation as they get demand-based pro-rated allocations. However, as in Cornelli and Goldreich (2001), it is doubtful whether top investors do actually compete between themselves through information revelation in exchange for higher allocation.

occurs only in the lower part of the true value range (from 10 to 50) whereas in other mechanisms the overpricing is observed for the entire range.

Figure II gives a first impression about the evolution of underpricing over time. Under treatment C there is little development, however, while the underpricing magnitude stays about the same, the negative underpricing, more frequent in the beginning, disappears towards the end of sessions. The picture is quite different for Bookbuilding: in the first 5 periods underpricing stays below 10 with only one exception and bursts in the following periods with the levels raising as high as 20 and 30 in several cases. As for the negative underpricing, it occurs with approximately the same frequency as in Competitive IPO treatment but there is no evidence of learning – subjects overprice the issue during the entire experiment. Further, the magnitude of this overpricing is slightly higher compared to Bookbuilding treatment. In Ausubel and uniform auctions, in the first periods there are several cases of relatively large underpricing, which disappear later, otherwise the learning is rather limited.

INSERT FIGURE 2 HERE

For testing the underpricing hypothesis across treatments, consistently with Engelmann and Grimm (2009), we apply nonparametric Wilcoxon ranked-sign test. The null hypothesis is that the differences between the final prices and true values in two treatments have the same distribution. No distributional assumptions are required for this test. The analysis will be performed for pooled data only.

Table 1 reports the mean values and standard deviations of underpricing for all rounds (top panel) and for the last 12 rounds (bottom panel). In the last periods subjects could be considered experienced as they became familiar with the structure and had time to develop their strategies. This subsample represents a major interest, as the focus of this paper is on institutional investors who are repeated players in the new issues market.

INSERT TABLE 1 HERE

Columns C, B, A, and U provide mean underpricing for all sessions under Competitive IPO, Bookbuilding, Ausubel auction, and Uniform auction treatments respectively, the column Difference reports the means of the difference between underpricing values under the treatments specified in the parentheses.

The top panel confirms the visual observations: the difference between treatments C and B is highly significant with mean underpricing equal to 0.72 and 7.18 correspondingly, while the opposite holds for the Ausubel-Uniform auction experiment (0.95 and 0.64). Inspecting session-level data reveals that there are two sessions in the Ausubel auction and one in the uniform auction where winner's curse takes effect and results in overbidding. However, the magnitudes are insignificant (ranging from -0.32 to -0.41 for experienced subjects), and on the aggregate level the influence of winner's curse is irrelevant The last column shows that there is no significant difference between the Ausubel auction and Competitive IPO. The experienced players' subsample replicates the above results.

Both auctions and Competitive IPO demonstrate equally excellent performance, which is obtained by very different mechanisms. The next section explores these mechanisms in depth.

5.2 Competitive IPO-Bookbuilding: Price Discovery and Information Revelation

Figure 3 provides scatter diagrams of indicative bids reported to the experimental banks relative to the signals received by bidders. In Treatment C the prevailing majority of indicative bids is densely grouped around the signals while in Treatment B bids are much more dispersed. Another interesting observation, which holds true for both treatments, is that indicative bids are not only distributed below the signals but also largely and significantly above (more than 10). This phenomenon is much more pronounced in bookbuilding experiments than in competitive IPO. Bids significantly above signals could have several explanations. In Treatment B a possible rationale could be the intent of some bidders to counteract low bids by other bidders pushing the price range beyond the threshold level below which the IPO would be cancelled. This is because investors bids are responses to their own private values but IPO prices are set averaging the aggregate market demand schedule. If investors have high private values but the market response is very low, they will react increasing their own offers (yet, still below their private values) to avoid cancellation. This strategy comes at limited cost as their own offers push the price range above the cancellation threshold but do not result in binding commitments at those prices. In competitive IPO the probability of hitting the threshold is significantly smaller as the price range is conditioned only by the highest bidders i.e. investors of the Bookrunner bank. Thus, the reason behind excessive indicative bids can be interpreted as an attempt to get the bank appointed as a Bookrunner rather than mitigating the risk of low bids driving IPO cancellation. On the other hand, since the no-fee threat applies, excessive bids would impact the overall underwriters' proceeds, hence the observed behavior could stem from reasons connected to the experimental structure such as: failure to induce preferences for some subjects, attention problems, typing errors, and others. We take a closer look at these explanations when discussing individual bidding strategies.

INSERT FIGURE 3 HERE

Table 2 reports the difference between the indicative bids and the signals obtained in Treatment B and Treatment C. The last column provides the difference in the variables under consideration between two treatments. In the last row we introduce an information revelation measure to facilitate the interpretation of the results obtained.

INSERT TABLE 2 HERE

Figure 4 illustrates this metric: if a subject's bid equal her signal, information revelation is at its maximum (100%); as the difference between the bid and the signal increases, the information revelation decreases.

INSERT FIGURE 4 HERE

We assume the information revelation is 0%, when this difference reaches 10, and the information revelation turns negative when this difference grows bigger. Negative information revelation could be thought as harmful information that hinders price discovery.

Pooled data show that in both treatments on average subjects submit indicative bids below the signals, though in competitive IPO the bids are closer to the signals (-7.84, Treatment B; -5.82, Treatment C) implying that information revelation is 20% higher under Competitive IPO, and this difference is significant at the 1% level.

However, looking at separate sessions we notice that in the first session of Treatment C the difference between the indicative bid and signal is larger in absolute value than the corresponding value of the following sessions and the mean value for the overall sample. Examining the individual bidding data uncovers that this fact is due only to two subjects with average differences of -35.21 and -56.13 while for the rest of the subjects the mean is -0.63.

Graphical analysis of individual bidding information suggests dividing the main bidding patterns into several classes according to the magnitude of information revelation. More specifically, we group subjects into four different types:

Type I. For subjects attributed to this category the difference between indicative bid and signal was less than 10 in absolute value in all rounds. The cutoff value of 10 was set taking into account that private signals were drawn from the range [V-5; V+5], therefore, the bids not exceeding the signal by 10 in absolute value can be considered realistic. The subjects of this type contributed the most to the price discovery.

Type II. The difference in absolute value mainly falls below 10 (in more than 80% of rounds) and has exceeded the cutoff value at least once but less than four times. Similar to Type I these subjects played a positive part in determining the price range, submitting credible bids in the majority of rounds.

Type III. The difference exceeding 10 in absolute value occurred in more than 20% of rounds (at least in five) and the bids above the signals by more than 10 make up less than 10%. Subjects belonging to this group followed the strategy of submitting indicative bids significantly below their signals with the exception of at most two times when their bids were considerably above their signals.

Type IV. The rounds in which the difference exceeded 10 in absolute value were more than 20%, the difference above 10 was in more than 10% of rounds. Further, we can identify two bidders' subcategories: (i) subjects with bids swinging from very low to very high; and (ii) bidders without large negative swings.

Figure 5 illustrates bidding strategies of representative subjects from each group.

INSERT FIGURE 5 HERE

Table 3 reports the distribution of bidding types in both treatments. The type composition varies significantly across the treatments – bidders of Type I and II (revealing more information) constitute 46.7% in the Bookbuilding experiment while in the competitive experiment their share is as high as 76.6%, and, correspondingly, bidders of the remaining two categories make up more than a half (53.3%) in Treatment B and less than a quarter (23.3%) in Treatment C. Furthermore, the most peculiar type – Type IV – makes a considerable part (23%) in Treatment B whereas there is only one person in Treatment C who belongs to this class.

INSERT TABLE 3 HERE

With regards to type IV subjects, we argue that there may exist different rationales for submitting extremely large indicative bids relative to the signals obtained conditional on the Treatment. In a Bookbuilding setting, exaggerated indicative bids could be an attempt to avoid IPO cancellation by offsetting other players' too low bids. Subjects rationally following this strategy would ideally be type 2 subjects which act as price arbitrageurs. Controlling for the other players' outstanding bids, we find two out of seven Type IV subjects which seem to show this deliberate behavior. Yet, the remaining subjects behavior is erratic, alternating too high bids with very low ones, without any identifiable pattern or reaction to the opponents' behavior in the current and previous rounds.

In competitive IPO, bidding extremely high values could also be a strategy to mitigate low bids, but in this case executed by subjects-investors of the same bank with the final goal of getting "their" bank appointed as Bookrunner. In this setup we observed only one player of Type IV, and her strategy is not in contradiction with this explanation. However, submitting too high values secures the place of Bookrunner in four out of five periods but the resulting price ranges are over-inflated, thus resulting in negative or zero profits for this player and others, which clearly provide evidence of the risks associated with such a strategy.

On the other hand, too low bids deprive the chance to get "one's favorite" bank appointed as Bookrunner, and in any case do not decrease the price range.[20] Thus, the bidding patterns of Type III are not very sensible if the purpose is profit maximization. This kind of behavior stems from the limitations of experimental methodology that gives high but not full control over subject preferences.

One can argue that subjects of Type IV for the Bookbuilding experiment and of Type III and IV for the Competitive IPO experiment are hardly to be encountered among professional investors. To address this concern we analyze results excluding subjects of Type IV for Bookbuilding and subjects of Type III and IV for competitive treatment. Table 4 presents the results of this reduced sample. Generally, results are stronger than those of the whole sample: the difference in information revelation significantly increases from 20.2% to 84.1% (Wilcoxon ranked sign test at 1% level).

INSERT TABLE 4 HERE

As predicted by standard experimental theory, we assume that subjects become more familiar with the experiment setup the more they play. Accordingly, outcomes

[20] Unless low bids serve to offset high bids, which is not the case in the experimental data retrieved.

for the last rounds are generally more robust and informative than initial ones. To control for this learning effect, we inspect separately data for the last 12 rounds. Table 5 reports the results. Previous evidence on higher information revelation in competitive IPO against Bookbuilding is reinforced: in Treatment B the gaps between indicative bids and signals increase considerably while there is a contrary tendency in Treatment C, consequently, the difference between treatments raises to 10.50 (Wilcoxon ranked sign test at 1% level).

INSERT TABLE 5 HERE

Surprisingly, subjects do not change their bidding patterns significantly across rounds, generating similar underpricing levels (Table I). This evidence is noteworthy if paired with data on information revelation which show that the latter changes considerably in the second half of experiments for both treatments: from 41.8% to 82.9% and from 21.6% to -22.1% in Treatment C and Treatment B respectively. While this fact can be explained in a Competitive IPO setting where the price range (and thus underpricing) is determined exclusively by the group of bidders with the highest valuations, in Bookbuilding each bid matters. As lower valuations inevitably imply lower price ranges the only explanation for unchanged underpricing would be that the final price inside the price range is adjusted to the underpricing-to-be. That is, the lower the average share valuation, the closer the final price will be to the top extreme of the price range.

Table 6 reports the position of the final price with respect to the middle of the price range.[21]

INSERT TABLE 6 HERE

Results show that in a competitive IPO the final price ends up being set at the lower end of the range (-1.49) which indicates that bidders push the price range as high as possible at the competitive stage and then try to underwrite at the minimum price. Differently, in Bookbuilding the final price position is slightly above the middle (0.33) and the variance is quite high. Spearman's correlation for Treatment B between the final price position and the difference between the true value and average valuation is 0.75 significant at 1% level supporting hypothesis1 and 2.

These noteworthy results provide strong support to the intuition in Jenkinson and Jones (2009) that "[...] while traditional 'bait-and-switch' might result in a disappointingly low price range for the issuer, the outcome [in competitive IPO] is an unachievably

[21] The width of the price range is 5, thus the lowest position is -2, and the highest is 2.

high price range and a final price which is in the lower part, or outside, this range", although we do not observe any price outside the range. This evidence on one hand captures the well-known inefficiencies of bookbuilding practices; on the other hand indicates a possible issue with Competitive IPO: banks may be concerned that investors infer negative signals from prices falling consistently in the lower part of the range, disregarding the fact that the price range has been maximized.

5.3 Ausubel-Uniform Auction: Price Discovery and Information Revelation

Figure 5 presents scatter diagrams of final prices and corresponding true values for the Ausubel and the uniform auctions[22]. There are no stark differences between two treatments: under both auctions the observations are densely concentrated around the 45-degree line with only few bids situated relatively far apart. Although the points are distributed quite symmetrically with respect to the 45-degree line, in Treatment A there are slightly more cases of overbidding (i.e. final prices exceed corresponding true values) than in treatment U.

The results of the formal test give us the definite answer as to the significance of the observations reported in Table 7 on the price discovery process in auction mechanisms. In the Ausubel auction, final prices are slightly above relative true values, while the situation is reversed in the uniform auction with prices slightly below true values. The difference between auction formats is small (-0.97) but significant (Wilcoxon ranked sign test at 5% level), thus, providing limited support for the hypothesis about higher final values in the Ausubel compared to the uniform auction.

INSERT FIGURE 6 HERE

Final prices exceeding true values signal the presence of the "winner's curse", judgmental failures in common value auctions with incomplete information. Even if the estimates of the true value are unbiased, under the assumption of homogenous bidding functions, the items are likely to be won by bidders with the highest signals, often resulting in negative profits for these bidders. The failure to account for this adverse selection problem is referred to as the winner's curse and is well-documented for diverse types of single-unit auctions (Kagel, 1997). Table 7 illustrates that in three out of

[22] In this section, final price in the Ausubel auction is the price at which the last item was sold.

four sessions of the Ausubel auctions, on average the final price was set above the true value, whereas in the uniform clock auctions it happened only in one session.[23] This finding, nevertheless, does not imply that the Ausubel format is more susceptible to the winner's curse, since prices different from the final prices could have been paid for some units bringing positive overall profit, as illustrated by underpricing results.

INSERT TABLE 7 HERE

Looking at the development of the price discovery over time previously reported in figure 2, we notice that in the first seven periods there were several cases of considerable over- and underbidding, which disappear in the following rounds under both treatments. Generally, the level of differences between true values and final prices remains unchanged in the last two-thirds of the rounds. This suggests that bidders have developed their strategies quite early in the experimental session and have not altered them drastically afterwards. This result is aligned with those of Engelmann and Grimm (2009) who provide similar evidence although in a two units format.

Common value auctions are complicated for developing a strategy as they demand solving two decisional problems: item estimation and competitive bidding. The risk-free strategy for bidder i in our experimental setting consists in bidding the maximum until the price has reached "the i's estimate minus 5" and results in zero profits. In the Ausubel auction, bidding the maximum amount above this threshold and then dropping the bid to zero implies a risk of "quitting" too late, winning too many units at the price above the value and vice versa – to quit too early not winning any units. Decreasing the demand after the risk-free threshold, gradually smooths the risk together with the potential profits. In the uniform-price clock auction the above risks are accentuated as, unlike other formats where there is positive probability to obtain some units at a lower price than the closing, the final price is paid for all units won, therefore, more subjects are likely to prefer the gradual decrease of demand over "all or nothing" strategy in the uniform auction than in the Ausubel auction.

A closer look at the individual bidding patterns reported in Figure 7, indicates that the subjects have used the same limited set of strategies under both treatments.

INSERT FIGURE 7 HERE

[23] However, the magnitudes of winner's curse under both treatments are small considered that all the parameters are integer, and thus the minimum difference between the true value and the price paid is one.

The examination of the graphs of individual demands suggests three main bidder types.

Type I. Bidders of this category bid maximum amount (or close to maximum: 7 and more) until the chosen price (above the risk-free threshold) and decrease the bid to zero afterwards. The players of this type make up 25% in the Ausubel auction and 10% in the uniform-price clock auction.

Type II. Bidders belonging to this type bid maximum until a certain threshold as Type I and after reaching the threshold decrease the demand gradually (30% and 45% in the Ausubel and the uniform price auctions respectively).

Type III. These players start bidding with reduced demand and either drop frequently long before reaching the risk-free threshold, or continue to bid small amounts until the auction ends. This category constitutes 45% in both treatments.

Even if for both formats the bidders of Type I and II represent roughly half of the players, in the Ausubel auction, as suggested before, Type I is more common than in the uniform auctions, illustrating the participants' perception of the Ausubel auction as "less risky" compared with the uniform auction. This evidence is extremely important as it addresses directly the concerns on the lack of confidence in auction methodology by less sophisticated investors highlighted by Wilhelm (2005).

We proceed with examining the subjects' behavior to control for learning effects. Table 8 compares the data of the first and last 12 rounds. As the players become more experienced, the differences between true values and final prices shift slightly towards zero under both auction formats (Treatment A from -0.54 to -0.13 and Treatment U from 0.85 to 0.42), thus decreasing the winner's curse consequences. This small change suffices in erasing the significance of the difference between the treatments, thus rejecting the hypothesis about higher final prices in the Ausubel than in the uniform auction.

The explanation emerging from investigating the individual demands and discussions with the participants is that strong competition wipes out the attempts of strategic demand reduction in the uniform auction. Indeed, although theoretically bidders should optimally reduce their demands significantly below the true amounts (Ausubel and Schwartz, 1999), when it comes to practice, strong competition offsets demand reduction (Ausubel, 2003). The experimental parameters were set so as to create potential demand considerably exceeding the supply (3.3 times). In this environment several tries to decrease the bids early did not result in considerable effect on the final price as the remaining players continued to bid high amounts bringing the final prices to the levels similar to the Ausubel auction.

INSERT TABLE 8 HERE

6 Discussion, Limitations and Policy Implications

6.1 Competitive IPO

The recently developed "Competitive IPO" methodology introduces some features which are aimed at reducing the well-known inefficiencies in traditional bookbuilding offerings. The transactions completed so far with this structure have incorporated some or all of the following novelties: the late appointment of the bookrunner, the decoupling of the preparation of the IPO from its execution, the final price setting conditional on a price range, in addition to a contingent fee scheme for underwriters. An intuitive interpretation of this mechanism is that it should provide banks with an incentive to truthfully reveal information because strategic (downward) manipulation may result in being excluded form the offering. This offering mechanism has spurred considerable attention among academics and practitioners calling for an appropriate assessment of its properties and limitations. Yet the limited number of issuances to date, makes an empirical testing hardly meaningful. In this paper we try to fill this gap by testing the price discovery, information revelation and underpricing effects of the Competitive IPO method in a set of laboratory experiments. We obtain several noteworthy results. First, investors consistently reveal more information compared with traditional bookbuilding, and for experienced investors the difference in information revelation between the two mechanisms becomes far more pronounced. The gap between information revelation under Competitive IPO and bookbuilding increases considerably as investors become more experienced, with consistently smaller levels of underpricing. This positive result is reinforced by further inspection of experimental data which highlight the strong positive correlation between the difference between the true value and the average valuation and the final price position inside the price range. Secondly, final pricing in a Competitive IPO consistently falls at the lower end of the price-range suggesting that bidders compete for their role by submitting high price ranges but eventually try to minimize their underwriting risk by setting the lowest possible price In our experimental setup, the contingent-fee scheme provides a robust incentive to set a final price within the submitted price range and accordingly, we have negligible evidence of prices falling outside the range which would determine no fees. This result is strongly aligned with the intuition in Jenkinson and Jones (2009). However its interpretation is not straightforward. On one hand, in our experimental setting it doesn't affect pricing efficiency because final prices are set within higher price ranges determined by enhanced information revelation. On the other hand, in a real-case scenario banks and issuers may not welcome a price set at the lower end of a price range, because outside investors, with limited or no knowledge of the price discovery process, may infer a negative signal on the banks or issuer's reputation. This issue though, should arguably be offset by the positive effects generated by the competitive IPO mechanism: namely reduced underpricing and increased after market stability which would increase the banks' reputation. As such, they may attract commission business from the newly listed company and additional IPO mandates from prospective issuers.

These positive experimental results provide support to the limited experimental evidence available. However, a more widespread use of this method calls for caution for a number of reasons. First, Competitive IPO requires hiring a supplemental financial advisor whose responsibility is to monitor closely the entire process. While this is a negligible expense for large companies, for smaller scale firms this cost should be taken into account while calculating the benefits from lower underpricing. Probably, more than the size of the company going public *per se*, a trickier factor may be that size is also crucial for the ability to attract many banks to the competition. Thus, while potentially well-suited for large issues, competitive IPO could be less appealing for smaller, more volatile firms. In such a case, as shown by Vandemaele (2003) an auction setup might be more appropriate. Secondly, competitive IPO has been criticized for the possibility that competing banks may try to lure issuers by issuing over-optimistic valuations and research.[24] This risk though, would translate into inflated price-ranges requiring a downward revision before the final price setting, or in overpriced issues with considerable negative underpricing and longer term price drops. While this is a potential issue, in our experiment we show that negative underpricing is limited and reduces over time, as a result of the (negative) wealth-effect generated by excessively high bids. This evolutionary pattern of underpricing captures a learning effect by investors which, in the real-world should also discriminate underwriters' reputation. Finally, in the Competitive IPO mechanism, the preparation of the IPO is decoupled from the underwriting task providing the FA incentives to independently assess the

[24] See FSA (2005).

"true" value and then select bookrunners and underwriters based on their response to the initial call for bids. This mechanism should also minimize collusion 'between' underwriters. However, we cannot rule out the possibility that collusion 'within' the underwriters pool of each potential bookrunner may still generate flawed outcomes. This case though, should be minimized by the Competitive IPO feature of restricting or preventing IPO participation to non-bookrunner banks and their undewriters. As such, the risk of being driven out of the deal because of artificially low bidding is reduced.

6.2 Ausubel auction

The Ausubel auction is a recent theoretical development based on price discrimination which is expected to protect less-informed investors because they would bid and effectively obtain exactly the quantities they feel comfortable with at the desired price. At the same time, it allows an adequate amount of information rent by bidders thus yielding efficient expected results. Opportunistic bidding by any investor would be neutralized by the very structure of the auction which is renegotiation-proof and thus makes strategic over or underbidding exceedingly costly. This mechanism has been discussed as a viable alternative to existing offering mechanisms (Ausubel 2002,2005; Ritter, 2003; Bennouri and Falconieri, 2006). While it has been successfully implemented in the energy, radio spectrum and advertising markets, there is no application to the IPO environment. This paper provides a first, much-needed test[25] of the properties of Ausubel auctions. The experimental results against a baseline uniform price auction show that the Ausubel auction format consistently yields a strong and efficient information revelation and minimal underpricing which allows at the same time an adequate amount of information rent extraction. The price discovery process generates increasingly efficient prices indicating that the mechanism is appropriate for an IPO environment. An important result is that Ausubel auctions offerings are insignificantly affected by the winner's curse problem which could heavily hamper the implementation of such a mechanisms.

Differently from previous results on Competitive IPO and bookbuilding, Ausubel auctions insignificantly outperform the baseline uniform-price format. This result is not surprising as previous studies already showed that uniform-price clock auctions should deliver efficient outcomes for new stock offerings. In an Ausubel auction format context

[25] See supra footnote 2.

it can be interpreted as the effect of strong competition by bidders in both formats, which eliminates the effects of demand reduction in the uniform clock auction (Ausubel, 2003). Yet, the theoretical and experimental efficiency seems to be at odds with empirical evidence on the limited use of uniform auctions, in particular when looking at pure applications like online auctions. Wilhelm (2005), Sherman (2005), Jaganahttan and Sherman (2005) and Jaganahttan et al. (2010) among others, motivate this puzzling evidence by pointing at the certification and uncertainty reduction role provided by investment banks in standard bookbuilt offers. They argue that since auctions do not involve banks, investors may experience reduced confidence in true values. While this may not be easily eliminated in a classical uniform-price auction format, the Ausubel auction explicitly requires a financial intermediary as the provider of information and the manager of the auction, thus overcoming the problem with standard uniform auction IPOs and allowing to expect a better response from the market. In our experiment we provide support to this intuition by showing a much higher bidders' confidence in the Ausubel format as opposed to the uniform-price baseline model. In particular Ausubel auction participants reveal more fully their price-demand schedules suggesting that they perceive the Ausubel auction format as "less risky" than a standard uniform auction.

A possible obstacle with this mechanism is the discriminatory nature of pricing. Some commentators, have argued that the regulatory authorities do not allow price discrimination. However, some countries like Japan and Taiwan explicitly allow (or have allowed) discriminatory pricing. While the Japanese case has proven limitedly successful due to flaws in the auction design, Lin et al. (2007) show that Taiwan discriminatory auctions allowed for a significant price revelation from informed investors. Furthermore Ausubel (2002) and Griffith (2005) show that regulatory non-discrimination does not necessarily imply uniform pricing, in particular in the US. The Ausubel auction simply requires non-uniform pricing of shares conditionals on the demand schedule. Additionally, price discrimination can be achieved through different offering stages (e.g. a private stage followed by a public stage as in Jagannathan et al. 2010). Nonetheless, the legal definition of price discrimination is not straightforward and relies on regulatory and policy decisions which may well slow down or prevent the implementation of such a mechanism.

6.3 Conclusions

The extant literature on IPO issuing methodologies has addressed the puzzling persistence of book-built IPOs despite its well-known weaknesses. Both academics and practitioners agree that IPOs issuing mechanisms shall be improved. On one hand, standard bookbuilding lacks an adequate level of transparency and assigns too much discretion to underwriters despite satisfying longer term objectives such as price stabilization, better analyst coverage and valuable issuer's signalling. On the other hand, auctions have been proposed as a possible alternative but, as Jagannathan, et al. (2010) show, they can be challenging for bidders as they require identification of the optimal bidding strategies to achieve efficient outcomes. This paper aims to contribute to this debate by experimentally testing the outcomes of two recently proposed mechanisms, Competitive IPO and Ausubel auction, which try to overcome these limitations. Our results confirm the valuable expected properties of these models but convey some additional policy implications. First, most markets, allow equity issuance through bookbuilding only without offering a real menu of alternatives. This undermines efficient price discovery, optimal allocation and the maximization of capital raised, because the combination of several variables such as the issuer's size, age and cash-flow volatility, the underwriter's reputation and the investors' characteristics may require the adoption of different offering mechanisms. Second, more than introducing radically new methodologies, regulators may consider improving existing issuing methods by means of few innovations to deal with issuers and investors heterogeneity and with banks' conflict of interests while allowing proper 'learning' by investors and reputation building by intermediaries. Third, consistently with several recent contributions (e.g. Vandemaele, 2003; Jagannathan et al. 2009; Degeorge et al. 2010; Chiang et al. 2010) we reckon that the most likely solution to the current IPO puzzle lies in updating existing methodologies by incorporating features from "pure" models such as those tested in these papers. Some possible solutions include: two-stage offerings where offerings are restricted to informed, institutional investors in a first stage, followed by a standard bookbuilt offering in the second stage open to retail investors (Chiang et al. 2010; Jagannathan et al. 2010); conditional offerings where the selected issuing methodology is conditional on the issuer and market characteristics (Vandemaele, 2003; Degeorge et al. 2010). Competitive IPO and Ausubel auction may contribute to the design of these "hybrid" models as in this paper we show they provide valuable properties such as: conflict of interests reduction by the decoupling of the advisory and underwriting role, contingent fees structure, discriminatory pricing. We expect some of these features to be considered for inclusion in future issuing mechanisms.

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Appendix A. An example of the Ausubel auction

Suppose 3 bidders are bidding for 5 identical items (IPO shares). The auction starts with the price of 10, and bidders require such quantities:

	Bidder A	Bidder B	Bidder C
Price : 10	4	2	3

The total demand exceeds supply, no unit is assigned and the price moves upwards. Suppose that the bidders bid the same quantities until the price reaches 15, at which the demands are as follows:

	Bidder A	Bidder B	Bidder C
Price : 15	3	2	1
Units clinched	2	1	0

The total demand still exceeds supply, but now bidder A's opponents collectively demand 3 units when 5 units are available. If bidders cannot increase their bids, Bidder A is certain to obtain 2 units. By auction rules, Bidder A clinches (is awarded) 2 units at the price of 15. In the same way, for Bidder B : her opponents require 4 units out of 5 available, this means that Bidder B clinches 1 unit at the price of 15. Bidder C does not clinch any units. As demand still exceeds supply, the auction continues. Suppose that the next change in bidders' demands occurred at the price of 20:

	Bidder A	Bidder B	Bidder C
Price : 20	2	2	1
Units	2	2	1

The market clears, and the auction ends. From Bidder A's perspective, her rivals demand 3 units, thus, Bidder A clinches 2 units (at the price of 15). In the same manner, Bidder B obtains the second unit at the price of 20 and Bidder C gets one unit at the price of 20:

	Bidder A	Bidder B	Bidder C
Units clinched	2	2	1
Payments	30	35	20

Appendix B. Instructions to subjects

B1. Ausubel Auction

General information

You are about to participate in an experiment which consists of 24 rounds. In each of these rounds you will participate in an auction in which 15 identical units will be sold. In each auction you will be in a group of 5 bidders (including yourself) who can bid for a maximum of 10 units.

The value of the good will be determined randomly for each auction. The value can be any integer number from 10 to 50. The bidders will not know the value V, however, each of them will receive an estimate which can be equally likely any integer from the interval [V- 5; V + 5]. Each of you will know her/his estimate but not those of other bidders.

The auction rules

Each auction will be a clock auction, which means that the price will automatically increase by 1 every 5 seconds. The starting price will be 1   0. A bid is the number of units you want to buy at the current price. You can submit as many bids as you want but they must be non increasing, that is if at some price you bid for 7 units afterwards you can't bid for more than 7 units. Your bid must not be less than the number of units you have already won. If you don't submit your bid at some price, it is supposed that at this price you demand the same number of units as at previous price.

For better understanding of how the units are awarded let's consider the example.

Example

Suppose there are 5 identical items available and 3 bidders. The auction starts with the price of 10, and bidders require such quantities:

	Bidder A	Bidder B	Bidder C
Price : 10	4	2	3

The total demand is 9, thus, the price moves upwards. Suppose that the bidders bid the same quantities until the price is 15, at which the demands are as follows:

	Bidder A	Bidder B	Bidder C
Price : 15	3	2	1
Units won	2	1	0

The total demand (6) still exceeds supply, but now bidder A's opponents collectively demand 3 units when 5 units are available. If bidders can't increase their bids, Bidder A is certain to win 2 units. By auction rules, Bidder A is awarded 2 units at the price of 15. In the same way, Bidder B : her opponents require 4 units out of 5 available, it means Bidder B wins 1 unit at the price of 15. As demand still exceeds supply, the auction continues. Suppose that the next change in bidders' demands occurred at the price of 20:

	Bidder A	Bidder B	Bidder C
Price : 20	2	2	1
Units won	2	2	1

The total demand is 5, i.e. the demand equals supply. The auction stops. From Bidder A's perspective, her opponents demand 3 units, thus, Bidder A won 2 units (at the previous price of 15). In the same manner, Bidder B obtains the second unit at the price of 20 and Bidder C gets one unit at the price of 20.

Wrapping up:,

	Bidder A	Bidder B	Bidder C
Units won	2	2	1
Payments	2*15	1*15+1*20	1*20

Your profit (in points) is calculated at every round as the number of units obtained multiplied by the value V minus the total payments. In the example above, if the value V is 30, the profits are:

At the end of the experiment the sum of all your profits will be converted in euro and will be paid to you.

TEST

Suppose there are 10 identical items available and 3 bidders. Fill in the spaces.

	Bidder A	Bidder B	Bidder C
Price : 10	5	3	6
Units clinched			

	Bidder A	Bidder B	Bidder C
Price : 15	3	3	5
Units clinched			

The final price is 20, the value V is 25.

	Bidder A	Bidder B	Bidder C
Price : 20	3	3	4
Units clinched			
Payments			
Profit			

Thank you for taking part in our experiment!

DRY ROUNDS

Table A1

UNDERPRICING AND PRICE DISCOVERY IN AUSUBEL DRY ROUNDS

In this table we report the average underpricing and the average price discovery measured as the difference between true values and final prices for 12 "dry rounds" for Treatment A (Ausubel auction). These rounds have been run on the experimental subjects prior to the "live" stage to allow them to familiarize with the software and the auction mechanism. Each session was formed by three experimental rounds. After each session we discussed the results and answered questions. Results for the dry rounds have not been included in the final results.

Session	Underpricing	Price discovery
1	-0.33	8.00
2	-1.20	1.67
3	5.13	-3.33
4	0.33	0.00
Pooled	0.98	1.58

B2. Dutch Auction

General information

You are about to participate in an experiment which consists of 24 rounds. In each of these rounds you will participate in an auction in which 15 identical units will be sold. In each auction you will be in a group of 5 bidders (including yourself) who can bid for a maximum of 10 units.

The value of the good will be determined randomly for each auction. The value can be any integer number from 10 to 50. The bidders will not know the value V, however, each of them will receive an estimate which can be equally likely any integer from the interval [V- 5; V + 5]. Each of you will know her/his estimate but not those of other bidders.

The auction rules

Each auction will be a clock auction, which means that the price will automatically increase by 1 every 5 seconds. The starting price will be 10. A bid is the number of units you want to buy at the current price. You can submit as many bids as you want. The auction will finish when the total demand will be equal (or less than) 15. If the auction ends with demand equal to supply, each player gets the number of shares she asked at the last price. If the auction ends with demand less than 15, the demand at the previous price will be considered. Each player will obtain equal proportion of units requested at the previous price. For example, at the price of 20 the total demand is equal to 30: A bids for 6, B – for 14, and C for 10 but at the price of 21 it drops to 14. Then the final price is set at 20 (when the demand is 30). The fraction of units the participants will obtain is defined as the number of units available divided by the total demand, in this example, it is 15/30 = 0.5. It means that all participants will get 50% of units they bid for : A gets 3, B – 7, and C – 5.

At the end of each round you will learn the value V, and your profit (in points) will be calculated as the number of units obtained multiplied by the difference between the value V and the final price p*:

$$q \cdot (V - p^*)$$

At the end of the experiment the sum of all your profits will be converted in euro at rate 1 euro per 50 points and will be paid to you.

Thank you for taking part in our experiment!

B3. Bookbuilding

You are about to take part in an experiment which consists of 24 rounds. In each round a different private company will sell its 30 shares for the first time. The exact value V of the shares is not known, however, it is known that this value lies between 10 and 110.

You are one of 12 investors, each of you wants to buy 10 shares of each of these companies. Your advisor makes forecast of the shares value with the precision ± 5, for example, if the shares value V is 50, the advisor's estimate can be between 45 and 55.

All investors are the clients of the bank through which they will buy shares.

The sale of shares:

The value V is chosen randomly before each round.

1. You obtain the estimate of the shares and report to the bank the price you are ready to pay for the shares.

2. The bank calculates average price. The price range is set [p' - 2; p' + 2]. It means that the minimum price for which you can buy shares is p' – 2. If this minimum price is below the threshold set by the company, the sale is cancelled. There is no limit for maximum price.

3. If you decide to buy 10 shares, you enter the price (equal or higher than the minimum price) or, if you decide not to buy, you do not enter anything.

4. The final price and the winners are determined by the following rules.

a. If the demand for shares is less or equal 30, the final price p^* is a minimum price submitted, each participating investor gets 10 shares.

b. If the demand for shares is more than 30 but less than 60, the final price p^* is set at the level at which demand is equal to 40 shares. The investors whose bid price is higher or equal than p^*, obtain equal proportion of the total number of shares, e.g. if there are 6 players who entered p* or higher, all 6 players obtain 5 shares.

c. If the demand for shares is 60 shares or more, the final price p* is set at the level at which demand is equal to 60 shares. The shares are distributed as in the point b.

5. Your profit is calculated at every round as the number of shares obtained q multiplied by the difference between the value V and the price p^*:

$$q \cdot (p^* - V)$$

, that is if the price you paid is smaller than the true value of the share, you receive positive profits, otherwise – negative. At the end of the experiment the sum of all your profits will be converted in euro at rate 20 points = 1 Euro and will be paid to you.

Thank you for taking part in our experiment!

TEST

The company sells 30 shares.

1. Suppose there are 4 investors who submit following prices: 2, 4, 8, 6. What will be the price range?

a. [2; 6] b. [4; 8] c. [3; 7]

2. 3 investors have decided to participate and have submitted the prices as in the table below. What will be the final price and how many shares will each investor get?

	I4	I8	I9
Price	5	7	8
Shares			

3. 4 investors have obtained shares. How many shares will each of them get?

a. 7.5 b. 10 c. 8

4. The final price is 12 and you won 6 shares. What will be your profit if:

i. The true value is 15. Your profit is .....

ii. The true value is 10. Your profit is ......

B4. Competitive

You are about to take part in an experiment which consists of 24 rounds. In each round a different private company will sell its 30 shares for the first time. The exact value V of the shares is not known, however, it is known that this value lies between 10 and 110.

You are one of 12 investors, each of you wants to buy 10 shares of each of these companies. Your advisor makes forecast of the shares value with the precision ±5, for example, if the shares value V is 50, the advisor's estimate can be between 45 and 55. Each investor is a client of the bank through which he can purchase shares. There are 4 banks, so that each bank has a group of 3 investors as its clients. During the whole experiment investors remain the clients of the same bank.

The sale of shares:

1. The value V is chosen randomly before each round.

2. You obtain the estimate of the shares and report to your bank the price you are ready to pay for the shares.

3. Each bank calculates average price of its group of clients.

The bank with the highest average price p' becomes Bookrunner (what it means for investors – clients of this bank are explained later). The price range is set $[p\prime - 2; p\prime + 2]$. It means that the minimum price for which you can buy shares is $[p\prime - 2]$. If this minimum price is below the threshold set by the company, the sale is cancelled. There is no limit for maximum price.

4. If you decide to buy 10 shares, you enter the price (equal or higher than minimum price!) or, if you decide not to buy, you do not enter anything.

5. The final price and the winners are determined by the following rules.

a. If the demand for shares is less or equal 30, the final price p* is a minimum price submitted, each participating investor gets 10 shares.

b. If the demand for shares is more than 30 but less than 60, the final price p* is set at the level at which demand is equal to 40 shares. The investors whose bid price is higher or equal than p*, obtain shares. The clients of the bank-Bookrunner receive twice as much shares as other investors. For example, among winning 4 investors the clients A and B are of Bookrunner, and clients C and D are not. Then 30 shares will be distributed in such a way: A and B get 10 shares each, C and D 5 shares each.

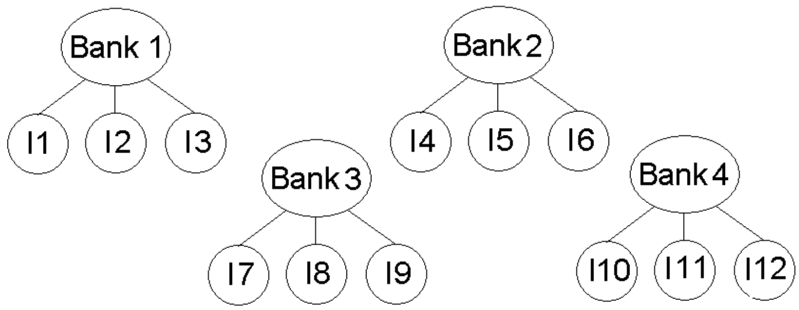
c. If the demand for shares is 60 shares or more, the final price p* is set at the level at which demand is equal to 60 shares. The shares are distributed as at point b.

6. Your profit is calculated at every round as the number of shares obtained q multiplied by the difference between the value V and the price p* : , that is if the price you paid is smaller than the value V of the share, you receive positive profits, otherwise – negative. At the end of the experiment the sum of all your profits will be converted in euro at rate of 1 euro per 20 points and will be immediately paid to you.

Thank you for taking part in our experiment!

TEST

The company sells 30 shares.



1. Which bank will be Bookrunner, if the investors submitted to their banks the following prices? (circle one):

To Bank 1 : 2, 4, 6
To Bank 2: 5, 5, 8
To Bank 3: 2, 2, 2
To Bank 4: 3, 4, 5

1 **2** **3** **4**

2. What will be the price range?

a. [2; 6] b. [4; 8] c. [3; 7]

3. 3 investors have decided to participate and have submitted the prices as in the table below. The final price is 5. Which investors will obtain the shares and how many?

	I4	I8	I9
Price	5	7	8
Shares			

4. 4 investors – I2, I4, I5, I8 - have obtained shares. Choose the correct statement.

A. All of them will get the same amount of shares – 7.5.
B. I2 and I8 will get 5 shares each, and I4 and I5 – 10 shares each

5. The final price is 12 and you won 6 shares. What will be your profit if
i. The true value is 15. Your profit is ......
ii. The true value is 10. Your profit is ....

Figure 1

FINAL PRICES AND TRUE VALUES

This figure plots scatter diagrams of the final prices relative to the true values in Competitive IPO-Bookbuilding and Ausubel-Uniform auction experiments. Optimal pricing is represented by final prices and true values being aligned on the 45 degrees line.

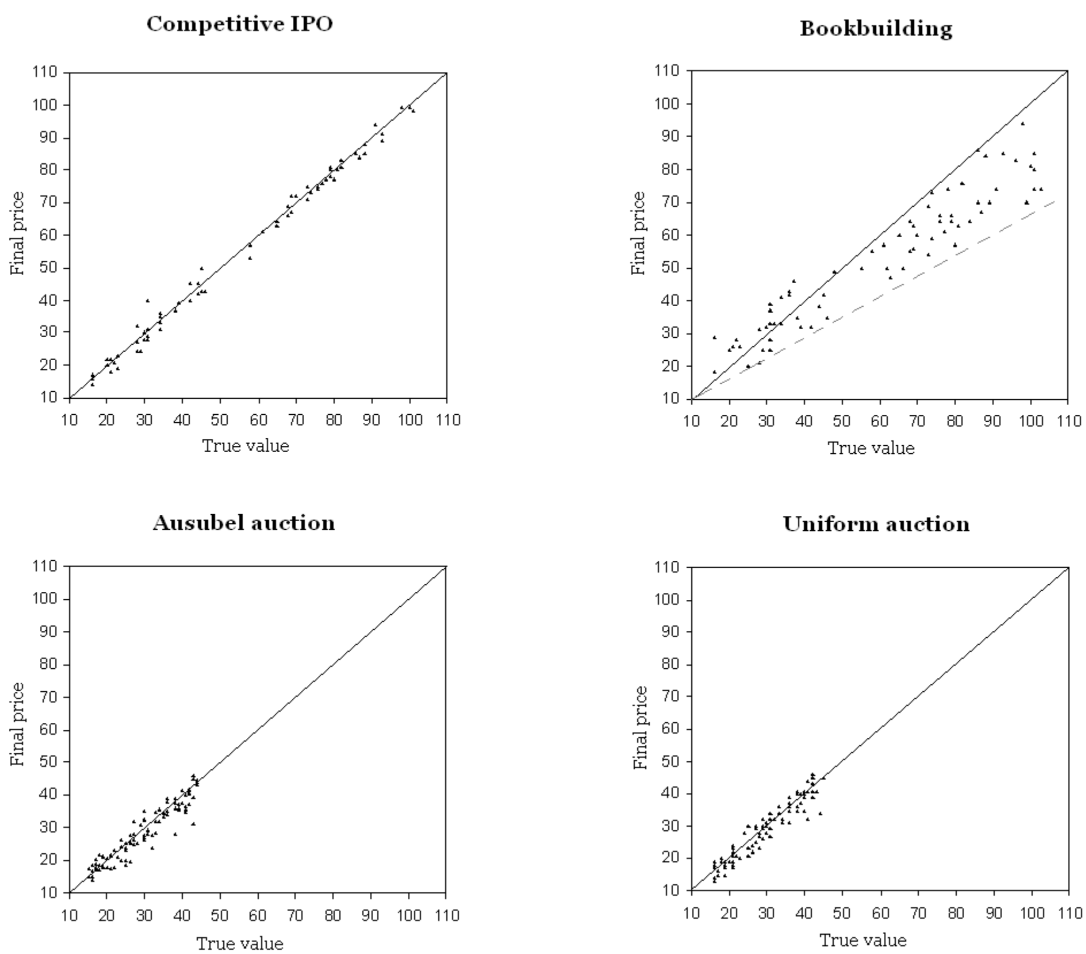


Figure 2

UNDERPRICING DEVELOPMENT: LEARNING EFFECTS

This figure plots the development of underpricing over the experimental rounds in Competitive IPO-Bookbuilding and Ausubel-Uniform auction experiments. Dots represent the realized underpricing for each experimental round. Zero underpricing is represented by the horizontal axis.

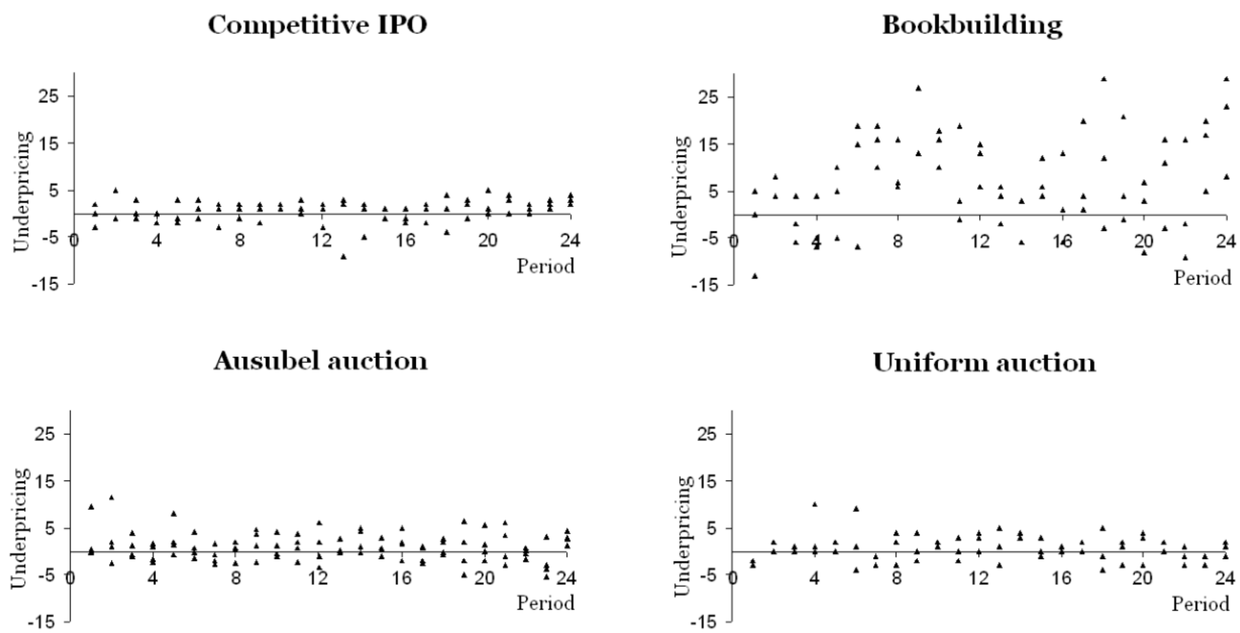


Table 1

UNDERPRICING

This Table reports the mean values and standard deviations of underpricing for all rounds (top panel) and for the last 12 rounds (bottom panel). Underpricing is calculated as the difference between the true value and the final price. A difference of zero indicates null underpricing Standard errors are in parentheses. Wilcoxon ranked sign test is calculated for pooled data. Significance at 5% and 1% level is denoted by *,** respectively

	All rounds						
Session	C	B	Difference (C minus B)	A	U	Difference (A minus U)	Difference (A minus C)
1	0.83	2.08	-1.25	0.75	1.50	-0.6	0.06
	(1.15)	(4.72)	(4.46)	(2.07)	(2.29)	(3.09)	(2.23)
2	-0.5	9.88	-10.38	-0.38	-0.33	-0.05	0.12
	(2.46)	(6.72)	(6.84)	(1.79)	(1.94)	(3.36)	(3.16)
3	1.92	9.58	-7.75	3.6	0.21	3.39	1.76
	(1.03)	(10.12)	(10.35)	(2.63)	(1.96)	(3.63)	(2.55)
4	-	-	-	-0.17	1.17	-1.33	-
	-	-	-	(1.52)	(1.76)	(2.16)	-
Pooled	0.72	7.18	-6.45**	0.95	0.64	0.35	0.65
	(1.79)	(7.82)	(7.98)	(2.25)	(2.05)	(3.30)	(2.71)

	Last 12 rounds						
Session	C	B	Difference (C minus B)	A	U	Difference (A minus U)	Difference (A minus C)
1	1.75	2.00	-0.25	0.95	1.00	0.26	-0.67
	(1.04)	(3.17)	(3.21)	(2.23)	(1.83)	(2.25)	(2.00)
2	-0.58	9.83	-10.42	-0.41	-0.42	0.01	0.25
	(3.32)	(7.33)	(6.92)	(2.22)	(2.18)	(4.03)	(4.50)
3	1.33	9.67	-8.33	2.82	-0.33	3.15	1.50
	(1.00)	(11.39)	(11.44)	(2.03)	(1.67)	(3.18)	(2.33)
4	-	-	-	-0.32	1.42	-1.73	-
	-	-	-	(1.87)	(1.65)	(2.11)	-
Pooled	0.83	7.17	-6.33**	0.77	0.42	0.42	0.36
	(1.90)	(8.15)	(8.39)	(2.22)	(1.96)	(3.08)	(3.09)

Figure 3

BIDS AND SIGNALS: BOOKBUILDING AND COMPETITIVE IPO

This figure plots the the pair-wise distribution of bids and signals for Treatment C (Competitive IPO) and B (Bookbuilding). Lower dispersion of ordered pairs (i.e. higher concentration around the 45 degrees line) indicates more efficient pricing by bidders.

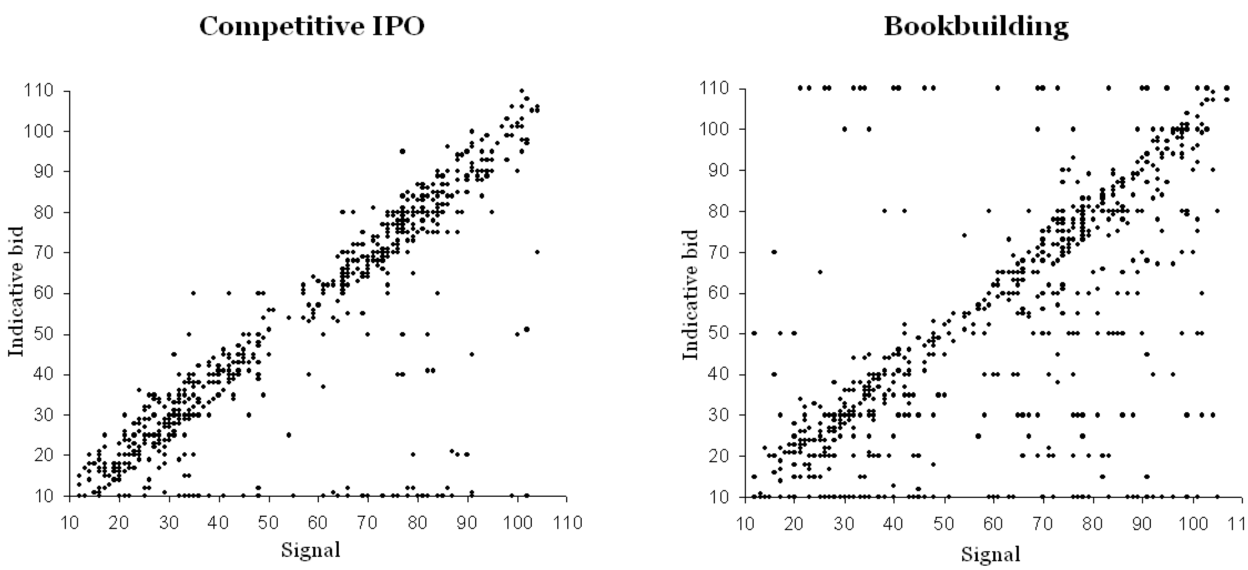


Figure 4

INFORMATION REVELATION: GRAPHICAL REPRESENTATION

Information revelation can be interpreted as the difference between the indicative bid and the signal. A zero difference implies maximum information revelation (100%). Conversely the larger the difference, the smaller the information revealed by the IPO participants through his bids.

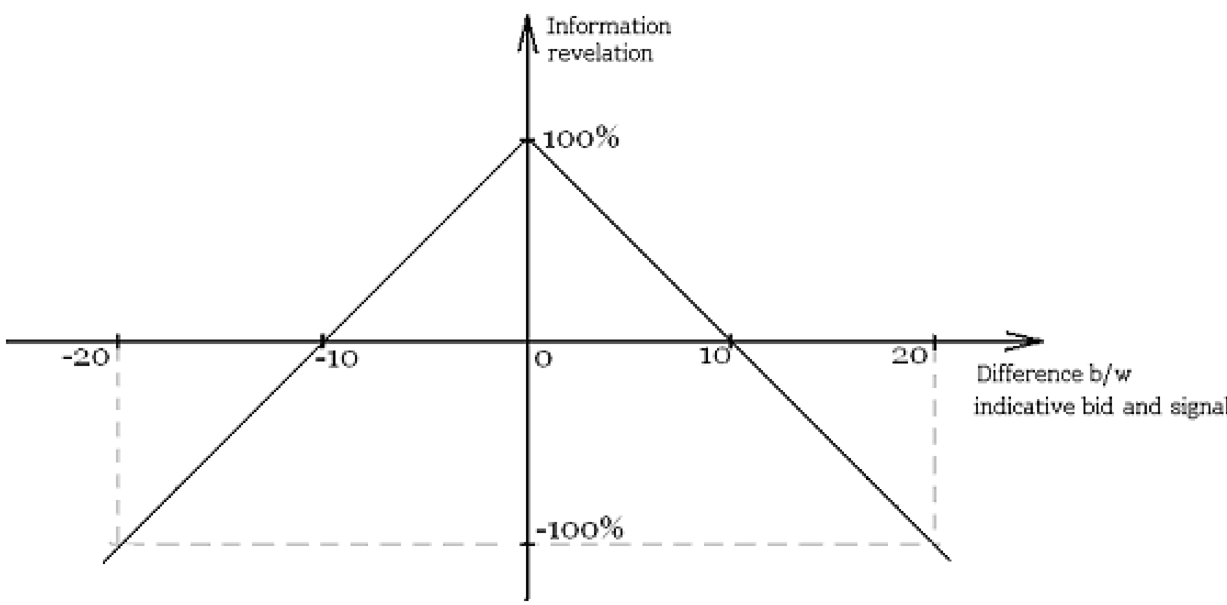


Table 2

INFORMATION REVELATION

This table reports evidence on the information revelation. Information revelation is the difference between the indicative bids and the signals obtained in Treatment B (bookbuilding) and Treatment C (Competitive IPO). Perfect Information revelation imply a difference of zero between signals and bids and 100% information revelation. The last row shows the calculated levels of information revelation. The last column provides the difference between two treatments. Standard errors are in parentheses. Wilcoxon ranked sign test is calculated for pooled data. Significance at 5% and 1% level is denoted by *,** respectively.

	All subjects		
Session (Number of Subjects)	Treatment C	Treatment B	Difference (C minus B)
1	-8.11a	-3.75a	-4.36
(n = 12)	(13.89)	(12.08)	(21.02)
2	-2.74	-12.06	9.33
(n = 9)	(6.31)	(17.32)	(16.82)
3	-5.85	-9.06	3.23
(n = 9)	(7.68)	(20.72)	(19.23)
Pooled	-5.82	-7.84	2.02**
	(9.53)	(16.55)	(18.81)
Information revelation (%)	41.8	21.6	20.2

[a] The values are due to two subjects excluding which the values would be -0.63 (4.29)

Figure 5

BOOKBUILDING AND COMPETITIVE IPO: BIDDING TYPES

This figure plots the distribution of bids according to the bidding behavior. Type identification is based on the difference between indicative bid and signal, from higher to lower information revelation.. For Type I subjects the difference between bid and signal is less than 10 in all rounds and their bids have not exceeded the cutoff more than four times; For Type II subjects the difference between bid and signal is less than 10 in 80% of the roundsand their bids have not exceeded the cutoff more than four times; For Type III subjects the difference between bid and signal is greater than 10 in more than 20% of the rounds and and their bids have not exceeded the cutoff in more than 10% of the rounds; For Type IV subjects the difference between bid and signal is greater than 10 in more than 20% of the rounds and and their bids have exceeded the cutoff in more than 10% of the rounds.

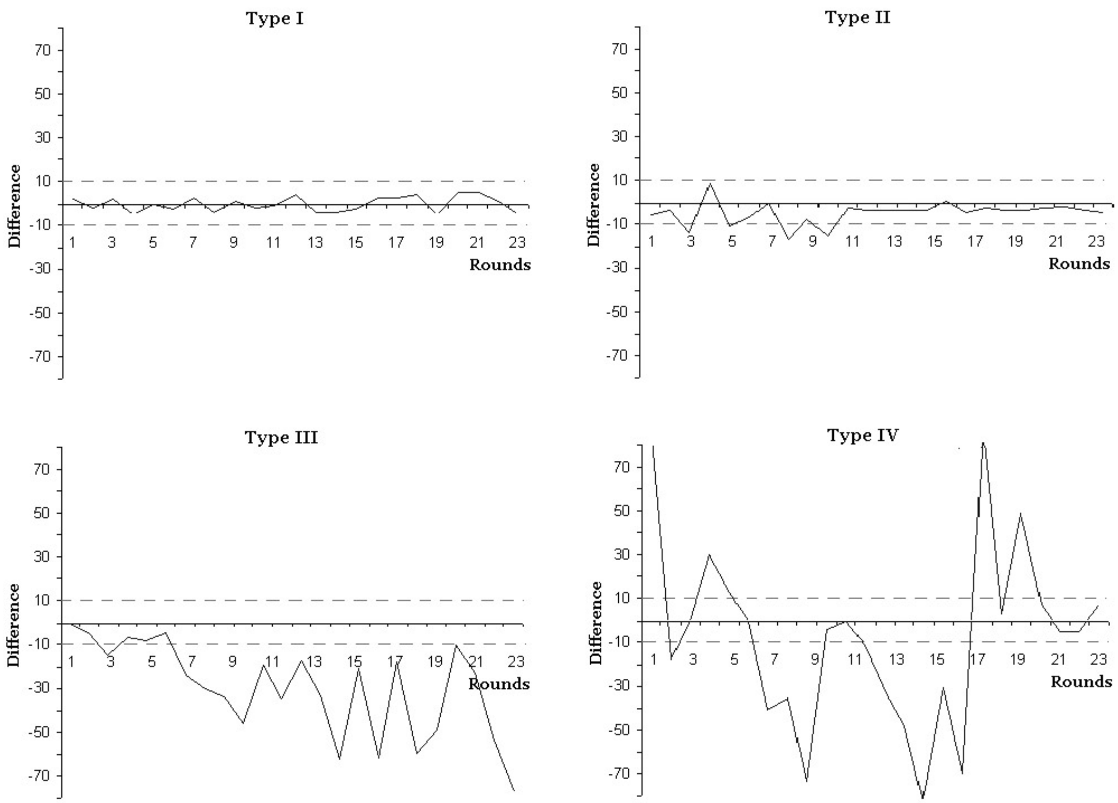


Table 3

BIDDING TYPE DISTRIBUTION (%)

This table reports the distribution of bidders according to the bidding behavior. Type identification is based on the difference between indicative bid and signal, from higher to lower information revelation.. For Type I subjects the difference between bid and signal is less than 10 in all rounds and their bids have not exceeded the cutoff more than four times; For Type II subjects the difference between bid and signal is less than 10 in 80% of the roundsand their bids have not exceeded the cutoff more than four times; For Type III subjects the difference between bid and signal is greater than 10 in more than 20% of the rounds and and their bids have not exceeded the cutoff in more than 10% of the rounds; For Type IV subjects the difference between bid and signal is greater than 10 in more than 20% of the rounds and and their bids have exceeded the cutoff in more than 10% of the rounds.

	Treatment B				Treatment C			
Type/ Session	I	II	III	IV	I	II	III	IV
1	25	33.3	16.7	25	66.7	16.7	16.7	-
2	44.4	-	33.3	22.2	11.1	44.4	33.3	11.1
3	11.1	22.2	44.4	33.3	77.8	11.1	11.1	-
Pooled	26.7	20	30	23.3	53.3	23.3	20	3.3

Table 4

INFORMATION REVELATION (REDUCED SAMPLE)

In this table we report mean differences between the indicative bid and the signal for a reduced sample including only Type I,II, and III bidders for Treatment B and I and II for treatment C. The last row show the calculated levels of information revelation. The last column provides the difference between two treatments. Standard errors are in parentheses. Wilcoxon ranked sign test is calculated for pooled data. Significance at 5% and 1% level is denoted by *,** respectively.

Subjects of Type I-III for treatment B and of Type I-II for treatment C

Session (Number of Subjects)	Treatment C	Treatment B	Difference (C minus B)
1	-0.63	-4.71	4.09
(n = 12)	(4.29)	(8.69)	(10.57)
2	-2.08	-15.68	13.65
(n = 9)	(2.68)	(17.90)	(16.87)
3	-2.10	-12.32	10.23
(n = 9)	(2.68)	(16.02)	(15.51)
Pooled	-1.45	-9.86	8.41**
	(3.74)	(14.09)	(14.01)
Information revelation (%)	85.5	1.4	84.1

Table 5

INFORMATION REVELATION: LAST 12 ROUNDS

In this table we control for learning effects in bidding patterns of bookbuilding experiments by reporting mean differences between the indicative bid and the signal for the last 12 rounds of experiments.The last row show the calculated levels of information revelation. The last column provides the difference between two treatments. Standard errors are in parentheses. Wilcoxon ranked sign test is calculated for pooled data. Significance at 5% and 1% level is denoted by *,** respectively.

All subjects

Session (Number of Subjects)	Treatment C	Treatment B	Difference (C minus B)
1	-1.48	-6.76	5.28
(n = 12)	(5.20)	(11.14)	(13.12)
2	-2.58	-16.77	14.18
(n = 9)	(3.31)	(20.41)	(18.95)
3	-1.37	-15.95	14.58
(n = 9)	(2.74)	(17.37)	(16.89)
Pooled	-1.71	-12.21	10.50**
	(3.97)	(16.28)	(16.28)
Information revelation (%)	82.9	-22.1	105

Table 6

FINAL PRICE POSITION

This table reports the position of the final price within each round's price range, compared with the middle of the price range. The last column provides the difference between two treatments. Standard errors are in parentheses. Wilcoxon ranked sign test is calculated for pooled data. Significance at 5% and 1% level is denoted by *,** respectively.

All rounds

Session (Number of Subjects)	Treatment C	Treatment B	Difference (C minus B)
1	-1.63	0.79	2.42
(n = 12)	(0.59)	(0.81)	(1.00)
2	-1.63	0.54	2.17
(n = 9)	(0.5)	(1.37)	(1.33)
3	-1.21	-0.33	0.88
(n = 9)	(0.40)	(1.42)	(1.46)
Pooled	-1.49	0.33	1.82**
	(0.59)	(1.25)	(1.35)

Figure 6

BOOKBUILDING AND COMPETITIVE IPO: BIDDING TYPES

This figure plots the the pair-wise distribution of bids and signals for Treatment A (Ausubel auction) and U (Uniform auction). Lower dispersion of ordered pairs (i.e. higher concentration around the 45 degrees line) indicates more efficient pricing by bidders.

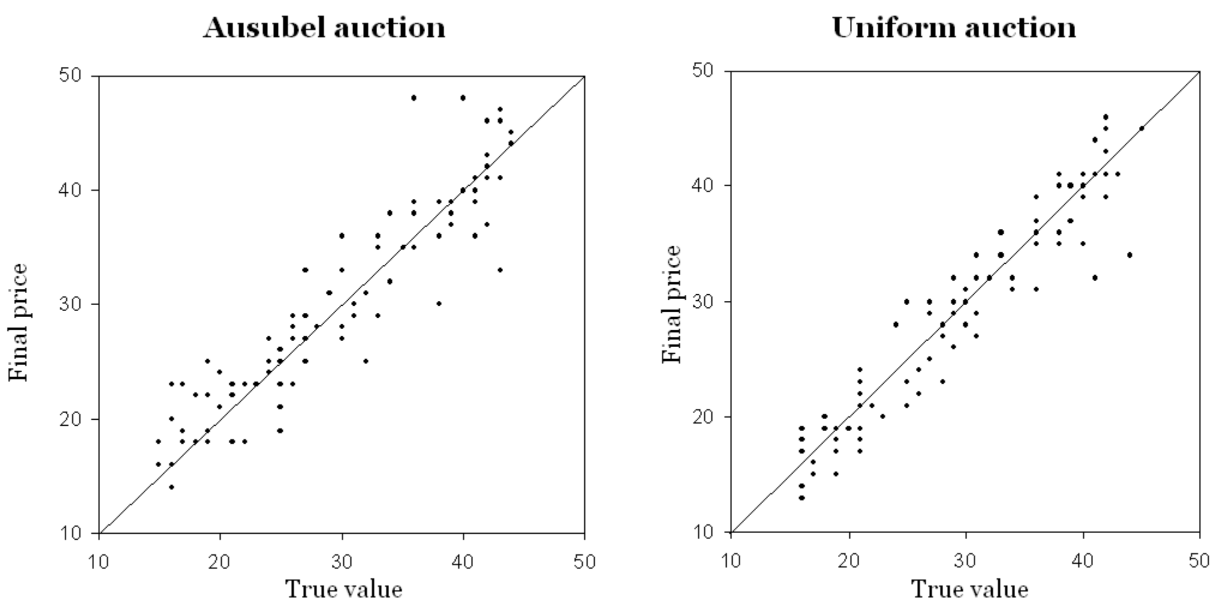


Table 7

PRICE DISCOVERY

In this table we report mean differences between true values and final prices for Treatment A (Ausubel auction) and U (uniform price auction). The last column provides the difference between two treatments. Standard errors are in parentheses. Wilcoxon ranked sign test is calculated for pooled data. Significance at 5% and 1% level is denoted by *,** respectively.

All rounds

Session	Treatment A	Treatment U	Difference (A minus U)
1	-0.54	1.50	-2.04
	(2.05)	(2.29)	(3.38)
2	-1.42	1.17	-2.58
	(2.12)	(1.76)	(1.94)
3	1.33	-0.33	1.67
	(3.50)	(1.94)	(3.58)
4	-0.71	0.21	-0.92
	(1.46)	(1.96)	(2.17)
Pooled	-0.33	0.64	-0.97*
	(2.46)	(2.05)	(3.16)

Figure 7

AUSUBEL AND UNIFORM PRICE AUCTIONS: BIDDING TYPES

This figure plots the distribution of bids according to the bidding behavior. Type identification is based on the difference between indicative bid and signal, from higher to lower information revelation. Type I bidders bid close-to or maximum amount until the chosen price above the risk-free threshold and decrease the bid to zero afterwards; Type II bidders bid maximum amount until a certain threshold as Type I and after reaching the threshold decrease the demand gradually; Type III bidders start bidding with reduced demand and either drop frequently long before reaching the risk-free threshold, or continue to bid small amounts until the auction ends.

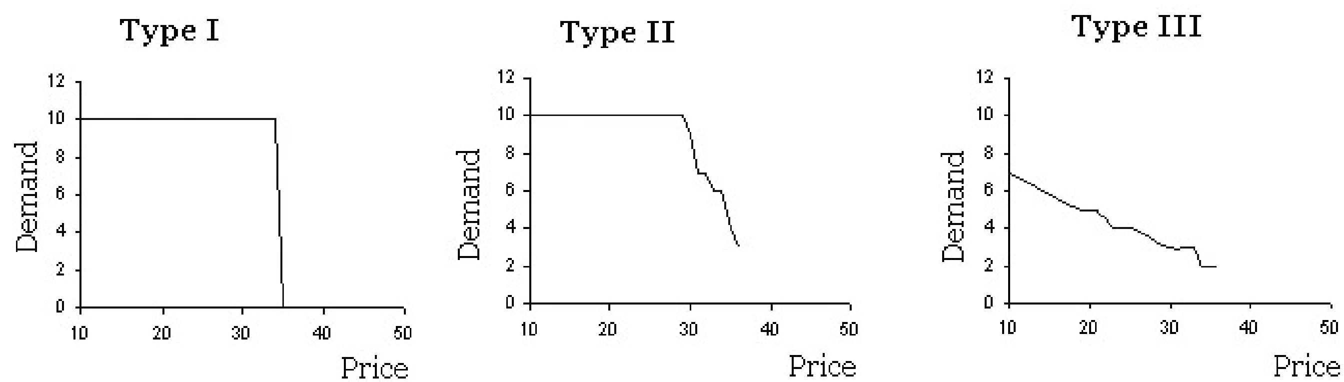


Table 8

PRICE DISCOVERY (REDUCED SAMPLES)

In this table we control for learning effects in bidding patterns of auction experiments by reporting mean differences between the true values and relative final prices for the first and last 12 rounds of experiments. The last column provides the difference between two treatments. Standard errors are in parentheses. Wilcoxon ranked sign test is calculated for pooled data. Significance at 5% and 1% level is denoted by *,** respectively.

	First 12 rounds			Last 12 rounds		
Session	Treatment A	Treatment U	Difference (U minus A)	Treatment A	Treatment U	Difference (U minus A)
1	-1.42	2.00	-3.42	0.33	1.00	0.67
	(2.25)	(2.67)	(4.25)	(2.44)	(1.83)	(2.39)
2	-1.67	0.92	-2.58	-1.17	1.42	2.58
	(2.33)	(1.93)	(2.25)	(1.86)	(1.65)	(1.63)
3	1.33	-0.25	1.58	1.33	-0.42	-1.75
	(4.67)	(1.67)	(4.72)	(2.33)	(2.18)	(2.46)
4	-0.42	0.75	-1.17	-1.00	-0.33	0.67
	(1.76)	(2.00)	(2.47)	(1.67)	(1.67)	(1.83)
Pooled	-0.54	0.85	-1.40	-0.13	0.42	0.54
	(2.79)	(2.12)	(3.81)	(2.10)	(1.96)	(2.54)