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ALTERNATIVE IPO METHODS:

AN EXPERIMENTAL ANALYSIS

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to my parents

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INTRODUCTION

The scandals in new issues markets in the early 2000s have urged the changes in opaque initial public offering (IPO) procedures. Academia, industry, and regulatory bodies have taken the challenge and embarked on the quest to eliminate the existing inefficiencies employing different tools available to them. For example, the Securities and Exchange Commission (SEC) fines heavily for IPO malpractices[1] and toughens the IPO regulations regarding among other issues the analyst conflict of interests, spinning, and laddering[2]. While financial academic literature, having received a new impetus, concentrates mostly on searching the rationales behind underpricing and comparing the efficiency of issuing methods in place. Although at present no theory is able to explain in full the phenomenon of underpricing, the modelling of underpricing as the outcome of asymmetric information has received the strongest empirical support (Ljungqvist, 2007). Similarly, there is no consensus as to the ability of various issuing methods to control underpricing with the hot debate still going on between bookbuilding advocates and auction enthusiasts.

Practitioners, in their turn, have started experimenting with novel mechanisms. Dresdner Kleinwort Wasserstein has created a hybrid between bookbuilding and auction designed to increase the competition among investment banks. The crucial differences of the novel method from traditional bookbuilding lie in the contest among investment banks for the position of bookrunner(s) and "no-fee" threat. The banks interested in bookrunner mandates have to win in an auction, where the bids are indicative price ranges (formed on the basis of preliminary marketing and collected investors' interest). After the assignment of bookrunner positions and other

[1] CSFB, JP Morgan, Robertson Stephens were censured and fined for "taking millions of dollars from customers in inflated commissions in exchange for allocations of "hot" Initial Public Offers", see www.sec.gov.
[2] For more information see www.sec.gov.

roles in the syndicate an IPO proceeds as usually with one exception – another constraint: if the final price is set below the lower end of the established price range, the syndicate members do not obtain their fees. Several large companies have successfully employed this method: PagesJaunes, the French telephone directories; Inmarsat (the UK mobile satellite company); EFG International (Swiss private bank) and others. The average first-day jump for these companies was four times less and the first-week jump was 21 times less compared to averages of European IPOs the same year. The results achieved speak for themselves and suggest that the competitive IPO mechanism deserves attention.

Another proposal for a more efficient issuing method has come from the auction theory. Ausubel (2004) offers a dynamic version of the multi-unit Vickrey mechanism implementing key prescriptions for effective auction design. The author sustains that "this alternative design yields more efficient allocations than a uniform-price auction, and it may be especially well-suited for security issuance"[3].

The present work focuses on exploring the properties of the two alternative IPO methods experimentally. The experimental methodology is adopted since it has proven to be a useful tool when the field data is scarce or not available.

The plan of the dissertation is as follows: the first chapter provides a snapshot of the underpricing research. Section 1 starts with the description of generic IPO process and continues with highlighting the differences between the issuing methods. Section 2 proposes an overview of theoretical and empirical evidence on the performance of bookbuilding and auctions and discusses the current dominance of the former method.

[3] Ausubel (2002a)

The second chapter presents an experimental investigation of the competitive IPO. Section 2 describes the novel procedure on the example of PagesJaunes case and puts forward the research hypotheses. In Section 3 the experimental design is proposed. Then, Section 4 reports the results, and Section 5 concludes by discussing the policy implications.

The third chapter offers the experimental comparison of the Ausubel auction and the uniform price clock auction. Section 2 presents the Ausubel auction while Section 3 looks at the theoretical properties of the auction in different environments. Section 4 surveys the previous experimental studies of the Ausubel auctions. Section 5 outlines the experimental design. The results are reported in Section 6. The last section includes the summary and discussion of the results obtained. The overall conclusions are closing the dissertation.

CHAPTER 1.

EXISTING IPO MECHANISMS AND UNDERPRICING

1. IPO process and established methods of going public

Though regulations on going public procedures differ substantially across countries, and some of the institutional features such as rules regarding information disclosure prior initial public offering, allocation and participation constraints can have significant impact on the efficiency of IPO, this work focuses on a generic IPO process and thus we will abstract from any country-specific details and will consider IPO procedures and issuing methods in general.[4] In this section, we sketch the main stages of an issuing process and highlight the differences between conventional methods of going public (bookbuilding, auctions, and fixed-price offerings) with an emphasis on pricing and allocation decisions.

1.1 IPO Procedure

A typical IPO process involves several stages. First, the firm going public must choose the leading underwriter who will take the company through the intricate issuing process. Practitioners identify the expertise of the underwriter's capital market group and research coverage as the key determinants of underwriter's choice (Killian, Smith, and Smith, 2001). Then, the leading underwriter performs due diligence in order to produce a preliminary prospectus (containing information on a new issue of

[4] For detailed description of IPO procedures in Europe and in the US see Jenkinson and Ljungqvist (2001).

stock and the prospects of the issuing company) which must be submitted to the regulatory authorities. The next step is marketing of the issue: the leading underwriter and syndicate members engage in promoting the stock by issuing press releases, advertising, and organizing one-to-one meetings with important institutional investors. Having introduced the issuing company to potential investors and having collected the information on market demand, the underwriters and the issuer decide on final pricing and allocations of the shares. In the aftermarket the underwriters provide price support and analyst coverage for the new stock.

1.2 The key features of standard issuing methods

The fundamental distinctions between the issuing methods lie in the price discovery and allocation mechanisms. Setting the price of an IPO is a challenging task as prior to the listing on stock exchange the information generated by deals in the secondary market about the firm's potentials and the investors' demand is not available. Thus the ability to discover the price is one of the crucial characteristics of the going public mechanisms. Under all the methods the underwriter estimates the issuing company's value using discounted cash flow technique or peer group analysis. The way the issuing mechanisms differ is how they elicit additional information from the potential investors. In fixed-price offerings the price is set early in the process – while preparing a preliminary prospectus – and thus is not affected by the investors' feedback received during marketing stage[5]. In bookbuilding, the preliminary prospectus contains indicative price range, but the final price is determined only after a series of road shows, where institutional investors express their views on the value of the company and submit non-binding bids. In auction-like mechanisms the price is

[5] Though banks can collect the investors' feedback informally before setting the price.

the outcome of an auction. The format of auctions employed vary from country to country[6], and as known from the auction theory, the auction forms differ significantly in the ability to induce the bidders to reveal their valuations.

Closely connected to the pricing decision is the decision to whom allocate the shares. Not only the performance of IPO in the aftermarket to some extent depends on the behaviour of initial investors, but also allocation mechanism itself can play a pivotal role in the price discovery process serving as a mean of rewarding the investors providing valuable information. According to the information revelation view (Benveniste and Spindt, 1989), in bookbuilding underwriters exercise their full discretion over shares distribution to compensate investors helping to evaluate the issue with favourable allocations. In auctions, shares are allotted to the winning bidders, while in fixed price offers some form of rationing or random rule is employed to allocate shares.

In the nineties bookbuilding almost ubiquitously supplanted other two approaches and became by far the most popular issuing method. However, if most academicians agree on the inferiority of fixed-price offers relative to bookbuilding and auctions both theoretically and empirically (Benveniste and Busaba, 1997; Bias and Faugeron-Crouzet, 2002; Loughran et al., 1994; Ritter, 2003a; Derrien and Womack, 2003), the opinions as to the efficiency of bookbuilding versus auctions vary greatly. The rest of the essay focuses on these two methods.

[6] Dutch (uniform price auction, where all winners pay the same price) auction is used in Israel, Offre à Prix Minimum (an auction-like mechanism, where, however, the price is set below the market-clearing price and the shares are allocated pro rata)– in France, discriminatory auction (the winners pay the prices they bid) – in Japan.

2. Underpricing

Since the phenomenon of underpricing was brought to light in the 1970s in Logue (1973) and Ibbotson (1975), it became the most well-documented empirical regularity in IPO literature. New issues are underpriced everywhere in the world, though the magnitude varies across countries, in time, and in the methods employed to go public[7]. Ritter (2003b) documents that in the US underpricing (measured as the difference between the prices of subscription and the first trading day) has grown from around 7% in the 1980s to approximately 15% in 1990-1998, and jumped to 65% during the dot com bubble. In 2001-2005 underpricing came back to more normal levels at around 12%. The aggregate amount of money left on the table (defined as the first-day price change times the number of shares issued) from 1980 to 2001 sums up to $106,397 million. In Europe first-day returns ranged from 6.3% in Austria during the period 1984-2002 (Ausseneg, 2002) to 49% in Greece in 1987-2002 (Nounis, 2003).

During last decades many theories were put forward trying to rationalize underpricing. Jenkinson and Ljungqvist (2001) discuss in detail existing explanations, and Ljungqvist (2007) overviews the empirical evidence in support of the theories of underpricing. The models treating underpricing as a consequence of asymmetric information has found the most empirical support. These findings are complemented with the recent survey of chief financial officers (CFOs) which has shown that practitioners regard underpricing primarily as a compensation of investors for taking risk. The second most-important rationale behind underpricing named by CFOs was the desire of investment bank to incur favours from their institutional clients (Brau and Fawcett, 2006), which fits the principal-agent framework where the agent's (the

[7] For comparative evidence of IPO underpricing worldwide see Jenkinson and Ljungqvist (2001, p.38) and Ritter (2003, p. 423-424).

underwriter's) incentives are not well-aligned with those of the principal (the issuer) and the agent prefers to serve self-interests rather than to benefit the principal.

The body of empirical evidence documents that underpricing varies significantly with the issuing methods employed (Ritter, 2003b). In the countries where both bookbuilding and auctions are in use, the latter are associated with lower underpricing. Seemingly, auctions perform better in controlling underpricing, and the dominance of bookbuilding appears puzzling under these conditions. However, the smaller first-day returns of auctioned IPOs can be only the top of an iceberg, and other benefits secured by bookbuilding or different rationales can hide beneath and explain the bookbuilding popularity. The rest of the section focuses on comparing two issuing mechanisms theoretically (Subsection 3.1) and empirically (Subsection 3.2). Subsection 3.3 discusses the current dominance of bookbuilding over auctions.

2.1 Theory

Theoreticians are divided in their opinions about the efficiency of the issuing methods. In this section we offer both views (favouring bookbuilding and auctions) using representative models developed by Sherman and Biais, Bossaerts and Rochet but before doing so we will present necessary theoretical preliminaries – the information revelation and principal-agent approaches.

2.1.1 Information revelation and principal-agent models[8]

Information revelation view was proposed in Benveniste and Spindt (1989) and Benveniste and Wilhelm (1990). The idea behind this model is that certain

[8] For detailed description see Jenkinson and Ljungqvist (2001, Chapter 3.3 - 3.4).

investors possess private information about the value of the issue, and the underwriter aims at encouraging the revelation of this information by underpricing the shares and giving preferable allocations to informed investors. Sherman (2000) and Sherman and Titman (2002) modified the underlying model conjecturing that institutional investors become informed about the new issue at a cost. Therefore, in this model underpricing arises not only as a means to encourage information revelation but also as a compensation for the information production.

Baron and Holmstrom (1982) and Baron (1980) explore issuing process from the point of view of agency theory. The issuer delegates the pricing of the shares to the underwriter. As long as the incentives of the issuer and the underwriter are not perfectly aligned and the efforts are not fully observable, in non-perfectly competitive environment the underwriters can use their informational advantage (knowledge of investor demand) to extract positive rents: the investment bank reduces the effort costs of distributing the shares by underpricing the issue.

In both information revelation and principal-agent models underpricing arises as information rent to informed investors and underwriters respectively.

2.1.2 Sherman vs. Biais et al.

The comparison of bookbuilding and auctions in theoretical literature favours one method or other depending on the assumptions adopted, in particular, whether or not the conflict of interests between issuers and intermediaries is assumed. The models assuming that underwriters act in the best interests of the issuer give preference to bookbuilding arguing that it is suited the best for information elicitation due to its ability to reward investors providing valuable information. On the other hand, the auction supporters maintain that the conflict of interest is central in the

issuing process, and therefore auctions are preferable to bookbuilding because they limit the underwriter's possibilities for abuse by taking the allocation discretion away. Moreover, the auction advocates put forward that auctions proved to be efficient in discovering highly uncertain price in other settings.

Sherman (2005) adopts the no-conflict-of-interests approach. The author models bookbuilding, discriminatory, and uniform auctions in the setting characterized by endogenous accuracy of investors' information and the number of participants. The issuer – underwriter maximizes the expected proceeds (minimizes underpricing) and prefers more accurate pricing of the issue (lower aftermarket volatility). The informed investors can purchase information of varying accuracy.

Bookbuilding is modelled in the following way: a) the underwriter chooses a group of potentially informed investors and announces pricing and allocation rules; b) the investors acquire information and decide whether to report it truthfully to the underwriter; c) the underwriter sets prices and allocates shares. The author derives that in equilibrium shares will be underpriced only to informed investors reporting "good" (i.e. that the value of issue is high) information.

The environment for auctions is identical to the one of bookbuilding. Bidders first decide on whether to enter the auction and then on the level of the information accuracy to purchase. After observing the signals obtained participants place the bids. The shares are assigned to the highest bidders at the price bid – in the discriminatory auction, and at the clearing price – in the uniform price auction. In equilibrium, in the discriminatory auction there will be underpricing, and in the uniform auction – if sufficient number of bidders receive positive information, the underpricing will be zero.

Under all the three methods the expected proceeds are equal to the expected value of the shares minus the expected information costs. The difference between bookbuilding and auction solutions lies in the ability of the underwriter to control the information production and, consequently, either the expected proceeds or aftermarket volatility. In this setup bookbuilding in contrary to auctions gives the opportunity to carve the results according to the issuer's preferences. Further, with bookbuilding, the probability of undersubscription is zero because the underwriter can guarantee that the adequate number of institutional investors will want to valuate the issue.

Biais, Bossaerts, and Rochet (2002) take a different from Sherman stance and focus on deriving optimal issuing mechanism assuming agency problem. They assume that underwriter and informed investors (possessing information about retail investors' demand and the market value of the issue respectively) collude against the issuer. The issuer's objective is to maximize the proceeds. The authors derive optimal mechanism which is the price schedule decreasing in the quantity allocated to each retail investor. The intuition behind this method is that if institutional investors possess positive information about the issue, the coalition of underwriter and informed investors will desire to purchase more shares, therefore, retail investors will be allocated the smaller amount of shares and the price will be higher. This mechanism extracts some information and eliminates completely the winner's curse. However, the shares are still underpriced, and similarly to Sherman underpricing represents the informational rents to the informed agents. The optimal mechanism is similar to auction-like offre a prix minimum and offer by tender.

The assumption of the conflict of interest is central to modelling issuing process. Depending on the position taken the underwriter's discretion can be viewed either as the primary advantage or as dangerous flaw of the bookbuilding method. The

advocates of disintermediation of the issuing process sustain that the assumption that the underwriter acts in the best interests of the issuer should not be taken for granted. Recent SEC investigations of IPO practices of the top investment firms have revealed that the investment banks used to allocate shares of "hot" IPOS to the clients based on the commissions generated in the past. Furthermore, the investment banks received kickbacks in the form of inflated commissions from the clients who were allocated IPOs.[9] For example, CSFB's customers paid commissions of $1 per share or more, some as high as $3.15 per share (in contrast to usual 6 cent per chare) for the transactions of highly liquid stocks executed on the day of, the day before/after the "hot" IPO the shares of which they were allocated.

Besides the above anecdotal evidence Reuter (2006) provides empirical test of the conflict-of-interest assumption analyzing IPO allocations across mutual funds in 1996-1999. The author reports a strong positive correlation between underpriced IPO allocations and annual brokerage payments in the late 1990s and infers that the amount of favoritism was economically significant. Complementary to Reuter's study, Nimalendran, Ritter, and Zhang (2006) present a systematic analysis of the link between high-frequency data on commissions on trading liquid stocks and allocation of IPOs. They document abnormal (though modest[10]) volume of trading in the 50 most liquid stocks in the week before a "hot" IPO during bubble period.

Another side of using IPO allocations as cash for obtaining commissions business is that the shares are often intentionally allocated to be flipped the first day. This being in contradiction with investment bankers sustaining that they seek to

[10] According to the authors, the minor increase in volume suggests that the commission per share and not the volume was the primary tool in directing the revenue to the investment banks.

allocate the IPO shares to the long-term holders rather than "flippers"[11] and explaining the underpricing as inevitable for attraction of desired buy-and-hold investors. While discouraging individual investors from selling their shares for 30 to 90 days through penalty bids, investment banks often do not take steps when it comes to flipping from the side of institutional investors[12]. Moreover, several studies support the view that the price stabilization (connected with the flipping activity), which previously was considered to be costly to the underwriter, is in fact profitable and the profits from aftermarket trading depends positively on the level of underpricing (Ellis, Michaely, and O'Hara, 2000; Aggarwal, 2000; Fishe, 2002).

On the other side, the conflict-of-interests assumption could be abandoned in the favour of the assumption of competitive new issue market, indeed, the strong competition between investment banks would sweep out above-normal profits. The underwriters compete in several dimensions such as fees, underpricing, reputation, and placement service. Chen and Ritter (2000) point out that for the prevailing majority of IPOs in the US the spreads are clustered around 7%, and argue that this is above competitive levels. Hansen (2001) does not find support for the collusion hypothesis and argues that competition takes place in other aspects. In competitive environment the banks who underprice the most would be punished by losing their market shares. While in the 1970s and 1980s the empirical evidence supports this claim (Michaely and Shaw, 1994; Beatty and Ritter, 1986), the trend reverses in the 1990s – the most prestigious underwriters (with the highest market shares) underprice the most (Beatty and Welch, 1996; Kumar et al., 1998). Thus, the banks do not compete in underpricing neither.

[11] Boehmer and Fishe (2000) find support for an interesting view that underwriters in fact do encourage flipping in order to create liquidity in aftermarket and as the primary market maker the underwriter gains trading profits.
[12] See www.sec.gov/rules/proposed/33-8511.htm.

Answering the questions how issuers choose underwriters and why they switch them could shed the light on the competition factors. In Brau and Fawcett (2006) two most important criteria reported by CFOs in selecting the underwriter were underwriter's overall reputation and quality of its research department. Interestingly, at the same time CFOs are well-aware of the underwriter's self-interest in underpricing the issue but as Krigman et al. (2001) shows the firms do not punish excessive underpricing by switching to other underwriter for SEO rather, in line with Brau and Fawcett's survey, the firms change to the underwriters who are more prestigious and who provide better research.

Wilhelm (2005) argues that reputation concern mitigates abusive behaviour by investment banks. However, the evidence above shows that underpricing does not belong to key reputation determinants, rather, having an all-star analyst gives an investment bank certain market power and, consequently, space for extracting above normal profits. Further, Wilhelm asserts that the position of intermediary requires to satisfy both sides. Being absolutely true it should also be kept in mind that investment bank interacts incomparably more frequently with its institutional investors than with issuers and, thus, "cherishes" much more the relationship with its constant customers.

All in all we believe that the conflict of interests between underwriters and issuers is essential in modelling and designing new IPO mechanisms.

2.2 Empirical evidence

Existing empirical studies unambiguously demonstrate that auctions are associated with less underpricing compared to other methods. However, auctions were tried and subsequently abandoned in more than 20 countries in the 1980s and in the

1990s, so that currently auctions are used only in France, Israel, Taiwan, and the US[13] (Jagannathan and Sherman, 2005). On the contrary, if before 1990s bookbuilding was used almost exclusively in the US, today it is by far the most popular method of going public worldwide.

In Table 1 the first-day returns from France, Japan, and Taiwan show that offerings conducted via auctions are significantly less underpriced than bookbuilding or fixed price offerings[14]. In Israel, where until 2003 the law forced companies to employ exclusively auctions to go public, Kandel, Sarig, and Wohl (1999) document average abnormal return of 4.5% on the first day of trading in 1993-1996.

Table 1

AVERAGE INITIAL RETURNS ON FRENCH, JAPANESE, AND TAIWANESE IPOS, BY SELLING MECHANISM

Selling mechanism	Time period	Number of IPOs	Average first-day return
France			
Fixed price	1992-1998	24	8.9%
Auctions	1992-1998	99	9.7%
Bookbuilding	1992-1998	135	16.9%
Japan			
Fixed price	1970-1988	441	32.5%
Auctions	1989-1997	733	14.1%
Bookbuilding	1997-2000	368	43.7%
Taiwan			
Fixed price	1986-1995	241	34.6%
Auctions	1995-1998	52	7.8%

Source: Ritter (2003a, Table 7)

[13] In Israel bookbuilding is not available under current regulations.
[14] Except for France, where fixed price offerings are underpriced less than auctions, though the difference is negligible – less than 1%.

2.3 The Dominance of Bookbuilding

While in theoretical literature polar opinions coexist as to the efficiency of the issuing methods and empirical studies based on few countries where more than one method are in use reveal that auctioned new issues are underpriced less than bookbuilt, in last decades bookbuilding has gained dominant position in the new issues market worldwide. Several explanations were put forward for this puzzling phenomenon, which rest on the observation that discretion of bookbuilding is highly beneficial to two out of three parties of an IPO transaction – underwriters and institutional investors – and, thus, the issue to explain is actually the compliance of the issuers to accept losing millions of euros.

Ljungqvist and Wilhelm (2003) argue that the decision makers became more tolerant to underpricing as the CEO fractional ownership decreased while ownership fragmentation and share allocations to "family and friends" increased, and find empirical support for these claims. Loughran and Ritter (2004) propose alternative explanations – the analyst lust hypothesis and the spinning[15] hypothesis. The analyst lust hypothesis states that recently research coverage gained great importance for firms' valuation, and as a consequence, the issuing firms along with underwriting services are buying research coverage. The issuers hire the investment banks with influential analysts even if they have to pay high indirect costs (underpricing). Thus, the presence of analysts with high ranking gives the investment bank a certain degree of power, which allows to underprice while remaining "unpunished" by low market share. Cliff and Denis (2004) support the analyst lust hypothesis by finding that underpricing is positively related to analyst coverage and the presence of an all-star

[15] Spinning is the practice of opening personal brokerage accounts for allocating hot IPO shares to venture capitalists and corporate executives who could influence their employers' choice of investment bankers.

analyst working for the leading underwriter. Additionally, Bradley, Jordan, and Ritter (2004) show that initiations of coverage after the end of quiet period were mostly from the analysts associated with managing underwriters.

The second hypothesis – spinning – is based on the agency-conflict between the decision-makers of the issuing firm (the general partners of the lead venture capital firm and the top management) and other pre-issue shareholders – limited partners of venture capital firms and other minor shareholders. The spinning explanation states that the underwriters bribe decision-makers of the firms planning to go public, so that the decision-makers deliberately choose underwriters with a history of underpricing. In recent NASD investigation of CSFB IPO practices it was revealed the existence of over 300 accounts of "Friends of Frank"[16] to which IPO shares were allocated and flipped back creating sizeable profits[17].

Thus, investment bankers and their large favoured clients enjoy huge profits from underpricing, and issuers do not present strong opposition due to the internal conflict of interest between the decision-makers and other pre-issue holders and the lust for influential research coverage. However, in recent years the situation seems to be changing as more large companies adopt non traditional issuing methods. The experimental investigation of the new mechanisms is the subject of the next two chapters.

[16] Frank Quattrone was the head of the technology sector investment banking unit of CSFB.
[17] NASD report provides an example of one account with total gains of more that $1,3 million and a rate of return of about 58,000 percent over a 19-month time period.

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CHAPTER 2.
UNDERPRICING, BOOKBUILDING AND COMPETITIVE IPO: AN EXPERIMENTAL ANALYSIS

1. Introduction

The investigations in the beginning of the 2000s of the IPO practices following dot.com bubble have revealed the dark side of investment banking and resulted in fines of hundreds of millions for top investment banks and hot debates among regulators as well as academics about the issuing methodologies commonly in place. This discussion about the superiority of one or another traditional IPO mechanism in controlling the underpricing is still largely open (Biais et al, 2002; Derrien and Womack, 2003; Ritter, 2003; Sherman, 2005), while practitioners have taken a different approach, starting to develop and test innovative mechanisms.

A notable example of this behavior has been the 2004 mega-offerings of Google and PagesJaunes, which went public through non-traditional methods: Google, the path-breaking internet search engine, has chosen a modified Dutch auction with certain degree of control over bids, while, on the other hand, PagesJaunes, the French telephone directories business, has employed a pioneering method (which lately has been named "competitive IPO") designed by Dresdner Kleinwort Wasserstein, its financial advisor.

While Dutch Auction is a relatively well-known methodology (already adopted, though on a small scale, in France and Israel among others), competitive IPO is a novel mechanism blending traditional bookbuilding and auctions in an innovative way. Under this mechanism an "auction" stage is introduced before the appointment of bookrunners. The issuer performs a contest among investment banks interested in

securing a bookrunner mandate, in which each participating bank must submit the indicative price range based on preliminary marketing and collected investors' interests. The bank(s) with the highest (or middle, if the issuer is concerned more with price accuracy than with the proceeds) price ranges win the bookrunner mandates, and eventually IPO follows the standard path. Another important feature of competitive IPO is the adoption of a "no-fee" threat: the mandate winners do not obtain their fees if the final price ends up being below the lower end of the price range. The novelty of this method, aimed at increasing pre-marketing competition among investment banks, derives from the combination of late bookrunner appointment and no-fee threat, which aligns the incentives of the issuer and the bookrunners (though decreasing drastically the profits of the latter).

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 up pressure on the analysts affiliated with the participating banks and covering the issuing company (Wilson, 2005). However, new floats have followed in 2005, adopting this procedure: Inmarsat (the UK-based mobile satellite company), Telenet (Belgian cable company), EFG International (Swiss private bank), Eutelsat (French satellite company). The average price jump for these companies was 7.26% 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%[18].

The present paper aims at providing some evidence on investors' behavior in a competitive IPO. In particular, we stipulate that this methodology increases competition not only among banks but also among investors, resulting in more information revelation and less underpricing compared to traditional bookbuilding.

[18] Data are from Dealogic, investment banking data provider (www.dealogic.com).

For testing these conjectures, we adopt an experimental methodology approach, which has proven to be a useful tool when no field data are available. The paper proceeds as follows. Section 2 discusses competitive IPO on the case of PagesJaunes and formulates the research hypotheses. Section 3 develops the experimental design. Results of the experiments are reported in Section 4. Section 5 concludes.

2. Competitive IPO

PagesJaunes (PJ), went public in July 2004 using for the first time the "competitive IPO" approach developed by Dresdner Kleinwort Wasserstein (DrKW). Since then, this pioneering methodology was applied again in 2005 in four additional IPOs. The new approach is meant to eliminate the drawbacks of traditional IPOs caused by the presence of conflicts of interests in banks, limited competition between 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. PJ hired DrKW as financial advisor who prepared the company for the IPO and closely monitored the entire issuing process while the selected banks carried the offering (i.e. engaged in pre-marketing, collected investors' interests and allocated the shares). Second, the competition between banks is sustained throughout the process. Usually, in France, the bookrunner positions are assigned six months (or even a year) before the launch of IPO; in the PJ case, the banks learnt about their syndicate roles only two weeks before pricing. Third, a "punishing" fee scheme is introduced: if the final price is set below the lower end of the price range, underwriting fees are not paid.

Next, we highlight key points of competitive IPO, using as an example PagesJaunes case, and discuss their possible impact on the underwriters and investors.

2.1 Competitive IPO: Case of PagesJaunes

The issuing process has started with selecting a financial advisor (DrKW) who had to prepare the offering but not to execute it. The aim was that the financial advisor by not participating in the profits from the share allocations, would not 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. The financial advisor organized a beauty contest among interested banks and short-listed several banks as potential syndicate members based on the proposals submitted by the participants. The proposals contained the banks' views on market sentiment, potential demand, offering structure, valuation and other relevant offering details.

The short-listed banks were informed that their syndicate roles (bookrunner or non-book position) would be assigned only after a pre-marketing stage. Each bank received a list of investors to contact (the accounts highlighted as important in the beauty parade) and had to send to DrKW daily reports. After collecting investors' feedback the banks would submit price range proposals, and the financial advisor would present the issuer the conclusions about the price range and syndicate composition. The issuer would then take the decision about the final price range and appoint the banks with the mid price-ranges as bookrunners, and others as Joint-Lead Managers[19].

The going-public would then proceed in the usual way: road shows were launched followed by building the book. In order to maintain banks' selling effort,

[19] For the issuer the price accuracy was of key importance, and, thus, the bookrunner's positions were filled in by the banks with average valuations of the issue.

fees were split in two: a base fee and an incentive fee. The base fee would be paid only in the case the final price would fall within or above the price range. The half of the incentive fee is paid automatically if the price is in the upper tier of the price range.

The PagesJaunes' listing was completed successfully with a final price set at a significant premium compared to market comparables and was followed by a very stable aftermarket.

2.2 The effect of the competition on the underwriters and investors

The implementation of such an innovative IPO methodology has become possible as a result of the introduction of an additional agent in the usual process: the financial advisor (FA), in this case DrKW. The advisor role is to provide expertise and perform thorough monitoring of the entire process. Not being involved in shares allocation implies that FA is not exposed to usual conflicts of interests 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 appointment of bookrunner(s) and the threat of not getting the fees. The combination of these characteristics creates competition among investment banks, which are encouraged to submit aggressive but realistic enough price estimates in order not to lose their 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. Allocation discretion would still

be in place but hardly it could compensate zero-fees. 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 (in particular, institutional investors) behavior, 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 to orders made to other syndicate members. Though the analysis of allocations is highly problematic due to 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 equal, obtained 35 percent extra allocations. In the dataset of Jenkinson and Jones (2004) the effect of submission to the bookrunner is even more pronounced with 55 percent increase in allocations for all IPOs (68 percent for hot IPOs, 25 percent 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 then introduce the following two research 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. Experimental design: Setup

The experimental setup is designed to capture the crucial characteristics of the competitive IPO 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 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 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[20]. 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 changing the results qualitatively. For investors, being in a long-term relationship with the bank that is appointed as Bookrunner implies preferential treatment of their orders, i.e. *coeteris paribus*,

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

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. Bookrunner sets the final price and allocates the shares. For testing the hypotheses, as a benchmark we will model bookbuilding-like procedure without the competition among banks.

3.1 Subjects and information structure

As argued in the previous section, competitive IPO all but eliminate the conflict of interests between the issuing company and the investment bank, therefore, we will consider these two agents as one aggregated agent. Since the focus of this study is the investors' behavior, the decisions of issuer-underwriter are taken automatically, according to a profit-maximizing algorithm, while the 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 C, subjects are divided in several groups (clients of different banks), the groups remain the same throughout the sessions to reflect the repetitive character of the game; in treatment B there is only one group.

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]* [21]. 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]* 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 produce signals given to subjects inside the true value range *[10; 110]* with probability close to one, i.e. there will be no signals more informative than others.

3.2 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.

Each period (IPO) proceeds as follows.

- In Step 1, the true value *V* is realized and subjects are given private signals S_i.
- In Step 2, subjects submit their valuations v_{ij}' (*j* stands for the group). The optimal price range is built automatically for each group *j*:

$$\left[\overline{v_{ij}'} - 2; \overline{v_{ij}'} + 2\right]; \quad \overline{v_{ij}'} = \frac{1}{3}\sum_i v_{ij}', j = \overline{1,4}.$$

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

- 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:

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; 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 quantity bid, and k is rationing coefficient defined as $k = \frac{Q}{a\sum_{b} q + \sum_{nb} q}$, 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 the level of double subscription (60 shares demanded), 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.

3.3 Bookbuilding (Treatment B)

Treatment B is analogous to Treatment C with several 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 – they obtain shares pro

rata: each winning subject gets kq shares, where $k = \frac{Q}{\sum q}$, Q is the total amount of IPO, $\sum q$ 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 will introduce the similar condition in this treatment: if the medium bid submitted is less than tolerance level (which we define at $0.7V$), IPO is cancelled.

3.4 Experiment rounds

The experiments were conducted in the Computer Laboratory of Bocconi University. Subjects were undergraduate and graduate students recruited by public advertisement at Bocconi University. Each subject was allowed to participate in one session only.

60 subjects have participated in the experiments: 30 subjects in treatments C and further 30 in treatment B. Each session consisted of 24 periods and lasted 60 – 80 minutes. Before each session, instructions (see Appendix A) were read out loud, all questions were answered and a short test, checking the understanding of the rules was run. At the end of each session the participants were asked to fill out the questionnaire and experimental currency was exchanged in euros at a defined rate (average payoffs were 15 euro in Bookbuilding treatments and 11 euro in Competitive IPO treatments). All subjects were paid a show-up fee of 5 euros.

The experimental software was developed and conducted in *z-Tree* (Zurich Toolbox for Readymade Economic Experiments (Fischbacher, forthcoming)).

4. Experimental results

Section 4.1 illustrates investors' behavior with specific emphasis on information revelation under different treatments. After analyzing the whole sample we divide the subjects in several categories depending on their bidding strategies and perform the analysis of the subsample of bidders more likely to be found among IPO investors. Next, we explore the last 12 rounds of the experiments in order to give a closer look at the experienced subjects' behavior. In Section 4.2 underpricing is examined for all subjects and for experienced ones. Further, we look at the position of the final price inside the price range and its relationship with underpricing.

4.1 Information Revelation

Figure 1 provides scatter diagrams of indicative bids reported to the banks relative to the signals received by bidders. Examining the diagrams the first eye-catcher is that in Treatment C the prevailing majority of indicative bids is densely concentrated 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 at first sight confusing because it appears to be more pronounced in bookbuilding experiments rather 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. 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 exaggerated indicative bids could be rather than mitigating low bids to avoid the IPO annulment, the attempt to get her bank appointed as a Bookrunner. On the other hand, the observed behavior could stem from reasons not connected with mechanisms under consideration but rather with the carrying out experiments such as failure to induce preferences for some subjects, attention problems, typing errors, and others. We will give a closer look at these explanations when discussing individual bidding strategies.

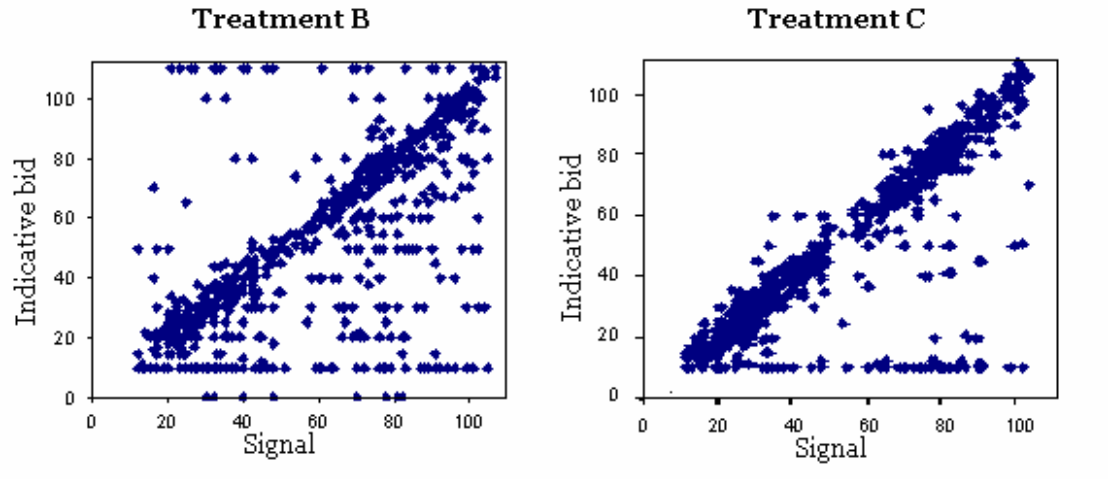

Figure 1. Scatter diagrams of indicative bids relative to signals in Treatments B and C.

For testing the information revelation hypothesis we will apply nonparametric Wilcoxin ranked-sign test (the null hypothesis being that the differences between the indicative bids and the signals 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 I 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.

Table I

INFORMATION REVELATION
(mean of the difference between the indicative bid and the signal; standard error in parentheses)

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

[a] The values are due to two subjects excluding which the values would be -0.63 (4.29)
*** Wilcoxin ranked sign test, 1% level, for pooled data only

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). According to Wilcoxin ranked sign test this difference between treatments is significant at 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 session 1 and the mean value for overall sample. Examining the individual bidding data uncovers that this fact is due only to two subjects with average differences -35.21 and -56.13 while for the rest of the subjects the mean is -0.63. Thus, behind the aggregate data there are very diverse bidding behaviors to be explored.

Graphical analysis of individual bidding information suggests dividing main bidding patterns in several classes according to the magnitude of information revelation. More specifically, we group subjects in 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 stayed 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 positive part in determining the price range submitting credible bids in majority of rounds.

Type III. The difference exceeding 10 in absolute value had place 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 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, there can be distinguished two subcategories: i) the subjects with bids swinging from very low to very high; and ii) the bidders without large negative swings.

Figure 2 illustrates bidding strategies of representative subjects from each group.

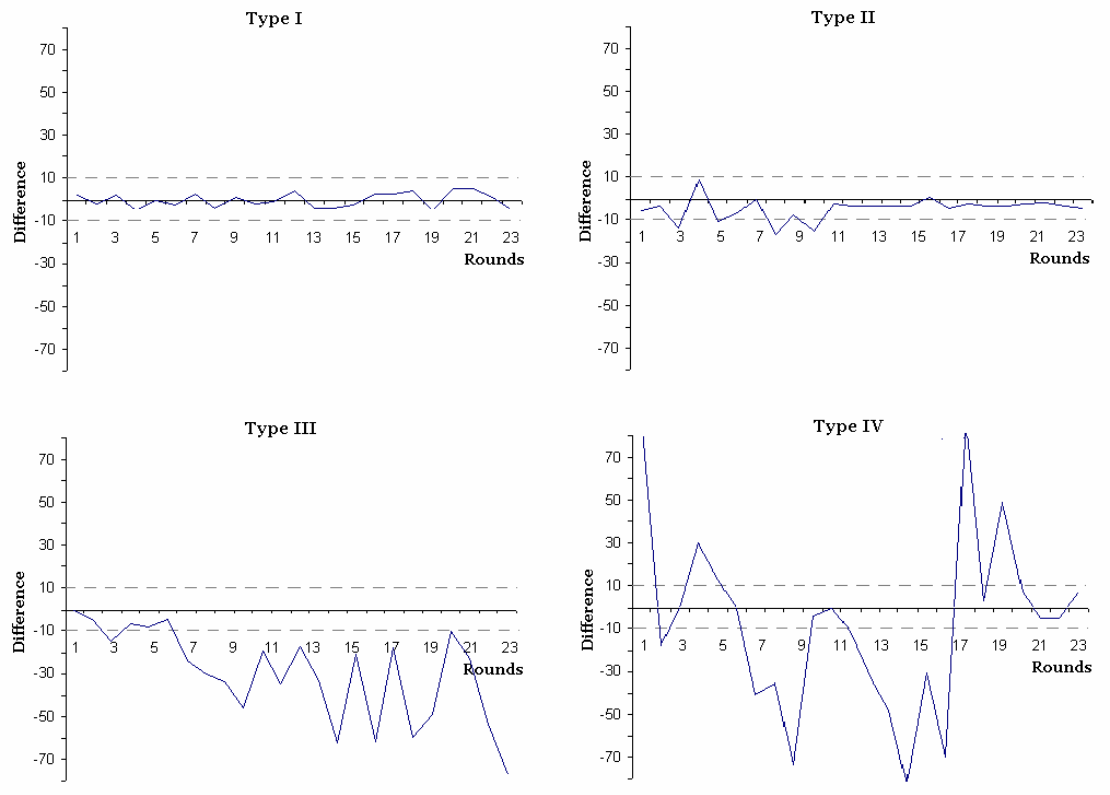

Figure 2. Bidding patterns of representative subjects from different types.

Table II reports the distribution of bidding types in both treatments. The type composition varies drastically across the treatments – bidders of Type I and II (revealing more information) constitute 46.7% in bookbuilding experiment while in 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.

Table II.

BIDDING TYPE DISTRIBUTION (%)

	Treatment B				Treatment C			
Type/ Session	I	II	III	IV	I	II	III	IV
1	25.0	33.3	16.7	25.0	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	20.0	30.0	23.3	53.3	23.3	20.0	3.3

As mentioned above, subjects submitting indicative bids extremely large relative to the signals obtained can have several rationales. Let us explore each treatment separately. In the bookbuilding setting, exaggerated indicative bids could be an attempt to avoid IPO cancellation by offsetting others' too low bids. Subjects following to some extent this strategy would be attributed to the second subcategory, in our sample there are two out of seven, the rest of subjects alternating too high bids with very low ones, for which we were not able to identify any pattern or reaction to the particular opponents' behavior in previous rounds.

In competitive IPO, bidding extremely high values could be again 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, though securing the place of Bookrunner in four out of five periods where she submitted too high values, the resulting price range was over-inflated thus resulting in negative or zero profits for this player and others, which clearly provide evidence of the dangers associated with such a strategy.

On the other hand, too low bids deprive the chance to get "your" bank appointed as Bookrunner, and in any case does not decrease the price range[22]. 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 bookbuilding experiment and of Type III and IV for competitive IPO experiment are hardly to meet among professional investor, thus, below we provide analysis excluding subjects of Type IV for bookbuilding and subjects of Type III and IV for competitive treatment. Table III presents the results of this reduced sample. Generally, the results are stronger than of the whole sample: the difference in information revelation significantly increases from 2.02 to 8.41 (Wilcoxin ranked sign test at 1% level).

Table III

INFORMATION REVELATION (REDUCED SAMPLE)
(mean of the difference between the indicative bid and the signal; standard error in parentheses)

	Subjects of Type I-III for treatment B and of Type I-II for treatment C		
Session (Number of Subjects)	Treatment B	Treatment C	Difference (C minus B)
1	-4.71	-0.63	4,09
(n = 12)	(8.69)	(4.29)	(10,57)
2	-15.68	-2.08	13,65
(n = 9)	(17.90)	(2.68)	(16,87)
3	-12.32	-2.10	10,23
(n = 9)	(16.02)	(2.68)	(15,51)
Pooled	-9.86	-1.45	8,41***
	(14.09)	(3.74)	(14,01)

*** Wilcoxin ranked sign test, 1% level, for pooled data only

Now we look at the data of last 12 rounds when subjects had time to get familiar with the structure, gain experience, and develop the strategies. This sub-

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

sample represents a major interest, as the focus of this work is on institutional investors who are repeated players in the new issues market. Table IV reports the results of the analysis of this data. The previous results as for the higher information revelation in competitive IPO against bookbuilding get 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 (Wilcoxin ranked sign test at 1% level).

Table IV

INFORMATION REVELATION: LAST 12 ROUNDS
(mean of the difference between the indicative bid and the signal; standard error in parentheses)

Session (Number of Subjects)	All subjects		
	Treatment B	Treatment C	Difference (C minus B)
1	-6,76	-1,48	5,28
(n = 12)	(11,14)	(5,20)	(13.12)
2	-16,77	-2,58	14,18
(n = 9)	(20,41)	(3,31)	(18.95)
3	-15,95	-1,37	14,58
(n = 9)	(17,37)	(2,74)	(16.89)
Pooled	-12,21	-1,71	10,50***
	(16,28)	(3,97)	(16.28)

*** Wilcoxin ranked sign test, 1% level, for pooled data only

4.2 Underpricing

Figure 3 provides scatter diagrams of the final price with respect to the true value and the development of underpricing (measured as the difference between the true value and the final price) throughout the experiment in different treatments.

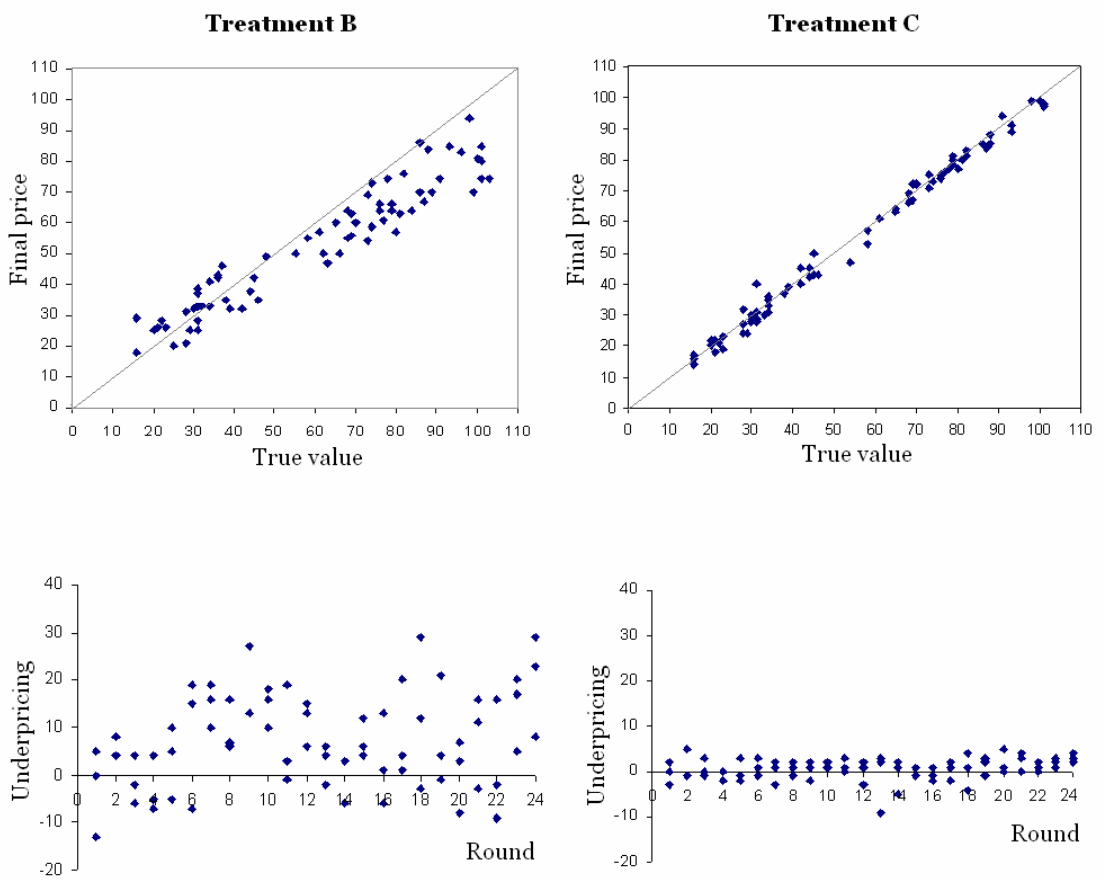

Figure 3. Underpricing in bookbuilding and competitive IPO treatments
Top panel: Scatter diagram of the final price with respect to the true value.
Bottom panel: Underpricing development throughout the time

The top panel clearly demonstrates that the magnitude of underpricing is drastically lower in treatment C compared to treatment B as well as the dispersion. Interestingly, while the final price stays close to the true value in all ranges in the competitive IPO setting, in bookbuilding, the price tends to move farther from the true value as the latter increase. Further, the cases of negative underpricing are present under both treatments but in bookbuilding they only occur for the lower part of the true value range (from 10 to 50) whereas in competitive IPO the negative underpricing is observed for the entire range.

The bottom panel 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 practically 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 even 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. Table V reports the mean values and standard deviations of underpricing for all rounds and for the last 12 rounds under both treatments.

Table V

UNDERPRICING
(mean of the difference between the true value and final price; standard error in parentheses)

	All rounds			Last 12 rounds		
Session (Number of Subjects)	B	C	Difference (C minus B)	B	C	Difference (C minus B)
1	2,08	0,83	-1,25	2.00	1.75	-0.25
(n = 12)	(4,72)	(1,15)	(4,46)	(3.17)	(1.04)	(3.21)
2	9,88	-0,5	-10,38	9.83	-0.58	-10.42
(n = 9)	(6,72)	(2,46)	(6,84)	(7.33)	(3.32)	(6.92)
3	9,58	1,92	-7,75	9.67	1.33	-8.33
(n = 9)	(10,12)	(1,03)	(10,35)	(11.39)	(1.00)	(11.44)
Pooled	7,18	0,72	-6,45***	7.17	0.83	-6.33***
	(7,82)	(1,79)	(7,98)	(8.15)	(1.90)	(8.39)

*** Wilcoxin ranked sign test, 1% level, for pooled data only

The difference between treatments is significant (Wilcoxin ranked sign test at 1% level) both for all rounds and for the last 12 rounds. The average underpricing remains the same for both samples, and this is attention-grabbing if we keep in mind that the information revelation has changed considerably in the second half of

experiments for both treatments: from -7.84 to -9.86 and from -5.82 to -1.45 in treatment B and treatment C respectively. While this fact can be explained in a competitive IPO setting where the price range (and thus, to large degree, 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 is the average share valuation, the closer the final price will be to the top extreme of the price range.

Table VI reports the position of the final price with respect to the middle of the price range[23]. As shown, in a competitive IPO the final price end up being set at the lower end of the range (-1.49), which is in line with the bidders expected behavior of pushing the price range as high as possible at the competitive stage and then trying to obtain the minimum price.

TABLE VI

The position of the final price inside the price range
(with respect to the middle)

	All rounds		
Session (Number of Subjects)	B	C	Difference (C minus B)
1	0,79	-1,63	2,42
(n = 12)	(0,81)	(0,59)	(1,00)
2	0,54	-1,63	2,17
(n = 9)	(1,37)	(0,5)	(1,33)
3	-0,33	-1,21	0,88
(n = 9)	(1,42)	(0,40)	(1,46)
Pooled	0,33	-1,49	1,82***
	(1,25)	(0,59)	(1,35)

*** Wilcoxin ranked sign test, 1% level, for pooled data only

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

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 the above stated hypothesis.

5. Discussion and policy implications

Feeling the urge for better control over underpricing IPO practitioners have recently introduced new issuing methodologies, competitive IPO being the most mind-striking recent one. While only a limited number of companies went public using this mechanism, their flotation results are impressive with an average underpricing four times less than average of European IPOs that year. This paper tries to shed some light on competitive IPO expected outcomes, focusing particularly on investors' behavior. The experiments conducted demonstrate that in competitive IPO investors consistently reveal more information compared to traditional bookbuilding, and for experienced investors the difference in information revelation between two mechanisms becomes even more pronounced. The underpricing (and its volatility) is significantly lower for newly introduced method. Interestingly, although the gap between information revelation under competitive IPO and bookbuilding increases considerably as investors become more experienced, this does not impact the level of underpricing. Deeper investigation brings to light the strong positive correlation between the difference between the true value and average valuation and the final price position inside the price range.

Keeping in mind the potentially significant gap between laboratory environment and real primary markets, we should be careful to extrapolate the data

from one setting to the other. However, the systematic behavioral differences under two methods revealed in the experiments are suggestive for design of efficient IPO, although many other factors which are not the subject of this study should be examined carefully. For example, some detractors stipulate that competitive IPO leads to the potential conflict of interest as the contest among banks puts the pressure on the analysts of the relevant banks to produce positively biased research. Further, competitive IPO requires hiring financial advisor whose responsibility is to monitor closely the whole 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 firms. As an alternative to traditional issuing methods, the latter may consider to go public by employing Ausubel auction (Ausubel, 2004), a new multi-unit mechanism proved to perform well in some environments (Grimm and Engelmann, 2003; Kagel et al., 2001; Kagel and Levin, 2001; Manelli et al., 2001). Investors and issuers' behavior with this methodology are the focus of further direct and comparative research.

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APPENDIX A.

EXPERIMENT INSTRUCTIONS

Instructions for treatment B

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:

0. 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!

Instructions for treatment C

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:

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

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

8. 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'* - 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.

9. 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.

10. 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*.

11. 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^* : $q \cdot (V - p^*)$, 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 1 euro per 20 points and will be paid to you.

Thank you for taking part in our experiment!

CHAPTER 3.

AUSUBEL AUCTION FOR NEW ISSUES MARKETS: AN EXPERIMENTAL INVESTIGATION

1. Introduction

Employing auctions in various markets with high uncertainty about the value of the goods auctioned, such as mobile licenses, spectrum, US and Japanese government bonds has proved to be very successful and brought many insights in the efficient auction mechanism design.

In new issues markets, although the auctions result in less underpricing compared to other IPO methods, their use has decreased throughout the 1990s and recently auctions are employed occasionally in few countries[24]. One of the reasons behind this can be that, frequently, the IPO auctions employed in practice are not designed efficiently. For example, in Japan the discriminatory auction method prohibited the participation of informed investors and considerably limited the maximum number of shares the participants could purchase, thus deliberately discouraging the information production and hampering the price discovering process (Kutsuna and Smith, 2004).

Auction theory tries to keep the pace with practical needs analyzing the properties of existing multiple unit auctions and developing new mechanisms. One of the recent developments is proposed by Ausubel (2004). In several settings the new design has strong theoretical properties, which are confirmed by experimental studies, and as stipulated by the author, this auction could perform well in IPOs.

The present study offers an investigation into the implementation of the Ausubel auction in new issues markets with primary focus on the price discovery and

[24] See Chapter 1, Section 3.

underpricing characteristics. Taking into account the lack of theoretical work on the properties of the novel mechanism in the environment suitable for modelling IPO market, we adopt an empirical approach and compare the Ausubel auction to the uniform price clock auction in the setting capturing the crucial features of IPO markets.

The chapter proceeds as follows: Section 2 describes the Ausubel auction. The following Section outlines theoretical properties of the Ausubel auction and research hypotheses. The survey of the previous experimental studies of the Ausubel auction is offered in Section 4. Sections 5 and 6 provide the experimental design and experimental results respectively. Section 7 presents a brief summary and discussion.

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2. Ausubel auction and its application to IPO markets

Efficient Ascending-Bid auction for Multiple Objects (commonly referred to as the Ausubel auction) was developed by Lawrence Ausubel who combined two essential rules of effective auction design in the challenge to create the dynamic version of multi-unit Vickrey auction. First prescription left by the father of auction theory, William Vickrey, is that that the price paid by the winner(s) ideally must depend only on other participants' bids while being independent from her (their) own valuation(s) (Vickrey, 1961). The auction designed following this recommendation would give the incentives to the participants to fully reveal their information as in the sealed-bid second price auction. The 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 the 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 auction is based on the uniform price clock auction (or ascending-bid clock auction) which works as follows: the auctioneer announces a price and bidders submit the bids (the quantities of the auctioned good they want to purchase at the current price). The bids must be non increasing, i.e. at any price a bidder can not bid for more units than he bid at lower prices. If the total demand exceeds the supply, the price is raised, otherwise the auction stops. The winners pay the final price times the final quantities. In the Ausubel auction the payment rule differs. At each price for any bidder i, if the rivals' total demand is less than the supply, the bidder *i* "clinches" the difference, which is awarded to her at the current price.

The example below illustrates the auction mechanism.

Example

Suppose 3 bidders are bidding for 5 identical items. 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, thus, 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 can't increase the quantities demanded, 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, it 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	$2 \cdot 15 = 30$	$1 \cdot 15 + 2 \cdot 20 = 35$	$1 \cdot 20 = 20$

Theoretically, the design proposed by Ausubel removes the incentives for demand reduction present in the uniform-price auctions. As the price of a 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, as the auction creator argues, the rules of the auction are simple enough for understanding and thus putting in practice. This is in contrast to the multi-unit Vickrey auction, which seems to be difficult to carry out due to the sophisticated rules. Another useful characteristic is privacy preservation of the winners' valuations. Some academicians 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 disclosing their demand curves above the winning price.

3. Theoretical considerations

In this Section we present the simplified model of the Ausubel auction and main results in private-value and interdependent-value environments. Full description and detailed analysis can be found in Ausubel (2004).

The model

Let M be the number of shares to be allocated among n bidders. Each bidder i can bid for at most λ_i , $0 < \lambda_i \leq M$. Let the bidder's i 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 $u_i(\bullet)$, $U_i(x_i) = \int_0^{x_i} u_i(q)dq$.

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 – a game of incomplete information. For simplicity, two constraints are imposed on bidding strategies. First, the bids must be non increasing in price. Second, the bidders should not bid for smaller quantities than they have already clinched.

The model is developed as a dynamic game in discrete time. 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 cumulative clinch for bidder i is calculated at each time as

$C_i(p) = \max\left\{0, M - \sum_{j \neq i} x_j(p)\right\}$. In its turn, the payment of bidder *i* is calculated as Stieltjes integral: $y_i = \int_{p^0}^{p^*} p dC_i(p)$, where p^* is the final price.

Main results

Theorem 1. In the alternative ascending-bid auction (Ausubel) auction with private values, sincere bidding by all bidders is an ex post perfect equilibrium.

The above theorem states that in the setting with weakly diminishing private values among possible equilibria of Ausubel auctions, there is one, where the demand reduction is eliminated. Theorem 2 states even stronger result for the incomplete information case:

Theorem 2. Under private values, incomplete information and the full support[25] *assumption, sincere bidding by all bidders is the unique outcome of weakly dominated strategies in the alternative ascending-bid (Ausubel) auction*.

Unlike the private-value setting in the interdependent-value case the sincere bidding is proved to be 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, the experimental analysis will be aimed at comparing the Ausubel auction against not theoretical predictions but rather against a benchmark auction – the uniform price clock auction.

[25] For the definition of full support see Ausubel (2004).

We put forward the following hypotheses about the price discovery and underpricing properties of the two auction mechanisms:

Hypothesis 1. *The final prices in the Ausubel auction on average will be higher than the final prices in the Uniform price clock auction.*

Hypothesis 2. *The underpricing will be lower in the Ausubel auction than in the Uniform price clock auction.*

Before proceeding to the experimental design, we review key experimental studies on the Ausubel auction.

4. Previous experimental studies

Several experimental studies have focused on comparing the Ausubel and other auction formats in different settings. Kagel and Levin (2001), Kagel, Kinross and Levin (2001), and Grimm and Engelmann (2002) have explored the Ausubel auction in the private value framework.

Kagel and Levin (2001) focus on demand reduction in the sealed-bid uniform-price, the uniform-price clock, and the Ausubel auction. In their experiments a subject with a two-unit demand competes against computerized bidders with single-unit demands on the markets with two-unit supply. Kagel and Levin find evidence of considerable demand reduction in both uniform-price mechanisms but not in the Ausubel auction. However, the Ausubel auction generates less average revenue than the uniform sealed-bid auction.

Kagel, Kinross and Levin (2004) complement the above study examining three alternative versions of the Vickrey auction: the Ausubel auction with and

without dropout information[26] and the static sealed-bid Vickrey auction. In line with Kagel and Levin (2001), the results show that bidders bid closest to their private valuations in the Ausubel auction with dropout information rather than in the Ausubel auction without dropout information or the static sealed-bid auction. The authors explain this better performance by the combination of dynamic format and transparency (the dropout information).

Grimm and Engelmann (2003) investigate diverse auctions, experimentally comparing five formats: a sealed-bid uniform-price auction; an ascending-bid uniform-price auction; a pay-as-bid auction; a Vickrey auction; and the alternative ascending-bid auction (the Ausubel auction), focusing mainly on revenue equivalence and allocative efficiency. The experiments are conducted in the two-bidders two-units setting, and the findings are generally in line with those of Kagel and his co-authors.

Manelli, Sefton, and Wilner (1999) explore the properties of a sealed-bid Vickrey auction and the Ausubel auction in different settings. In their experiments three certificates are auctioned to three bidders having non-increasing demand for additional units. The bidders' valuations are either private information or have a common-value component (the interdependent-value setting). The authours find that that overbidding is present under both formats in both settings, however, the Ausubel auction is less prone to it than the Vickrey mechanism.

[26] With dropout information – bidders are informed immediately about clinching an item/items. Without dropout information – bidders are informed that they have clinched an item/items and at what prices only *after* the auction is over.

5. Experimental design

The objective of this experimental investigation is two-fold: the exploration of the Ausubel auction as a potential IPO method; and the comparison of the Ausubel mechanism with Competitive IPO. Therefore, we set the parameters in line with those utilized in the previous study.

In Section 3 we suggest that the appropriate setting for IPO auction analysis is common-value framework bearing in mind that after IPO the value of the shares is identical for everybody and determined by the price on the secondary market. Next, the information structure should reflect high degree of uncertainty characterizing IPO markets. Third, the repetitive character of the game and stable sets of subjects emphasizes that the investors on new issues markets (in particular, we are interested to model institutional investors) interact continuously and represent a stable group.

We used a "between-person" experimental design with two distinct treatments: Treatment A (the Ausubel auction) and Treatment U (standing for the uniform price clock auction). In the beginning of each treatment all subjects have received equal endowments of a fixed amount of experimental currency to which the profits/losses made throughout the session were added/subtracted respectively.

In our experiments we have applied the two-step procedure of generating the informational parameters (the value of the units and the private signals about this value) as in Kagel and Levin (1986) which is widely used in experimental auction studies with common and affiliated values. The "true value" V of the items auctioned (this value could be interpreted as secondary market price in the IPO context) is drawn from a uniform distribution with support *[a; b]* [27]. Participants are not

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

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. Participants know only their signals and not those of other players. Diverse signals could be thought of as either pessimistic (signal below the true value) or optimistic valuations of the issue by different investors. We set the support for the true value to be $[10; 50]$ and the support for investor signals to be $[V-5; V+5]$.

An experimental session consisted of 24 independent rounds, in all of them 15 identical items were auctioned among five participants. Before each auction the participants obtained their estimates. Auctions started at the minimum price of 10, and the price incremented automatically by one with specified delay. Subjects entered their bids (quantity of units they want to buy at the current price) with several constraints on bids: i) maximum of 10 units could be demanded; ii) the bids must be non-increasing; iii) for the Ausubel auction, bids should be more or equal to the number of units already clinched. In the case demand fell too sharply (below the supply), the final price was set at the current price minus one, and equal proportions of the bids were allocated to the participants.

The information structure and auction rules apply to both treatments, while the difference between auction formats lies in the payment rule. In uniform price clock auction all the winners pay the final price multiplied the quantity of items they were allotted; in the Ausubel auction the payment is calculated applying the clinching rule described in detail in Section 2.

Throughout 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 number of items clinched at different prices.

The experiments were conducted in the Computer Laboratory of Bocconi University. Subjects were mostly graduate students recruited by public advertisement at Bocconi University. Each subject was allowed to participate in one session only.

Four sessions of each treatment were run with average duration of 50 minutes. Before each session, instructions (see Appendix A) were read out loud, all questions were answered and a short test, checking the understanding of the rules was conducted. At the end of each session the participants were asked to fill out the questionnaire and experimental currency was exchanged in euros at a defined rate. All subjects were paid a show-up fee of 5 euros.

The experimental software was developed and conducted in *z-Tree* (Zurich Toolbox for Readymade Economic Experiments (Fischbacher, forthcoming)).

6. Experimental results

The experimental results are broadly divided in two subsections. The first subsection reports the results on the price discovery characteristics of the investigated auctions and bidding strategies, paying particular attention to the outcomes of the last 12 rounds when the players became more experienced. In the second subsection the comparison of the performance in terms of underpricing is carried out between the auctions and competitive IPO.

6.1 Price discovery

Figure 1 presents scatter diagrams of final prices and corresponding true values for the Ausubel and the uniform price clock auctions (later referred to as uniform clock or uniform auction). There are no stark differences between the two

treatments: under both auctions the observations are densely concentrated around the 45˚ line with only few bids situated relatively far. Although the points are distributed quite symmetrically with respect to the 45° 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 above observation (Table I). In the Ausubel auction final prices are slightly above relative true values, while the situation is reverse in the uniform auction with prices slightly below true values. The difference between auction formats is small (-0.97) but significant (Wilcoxin 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

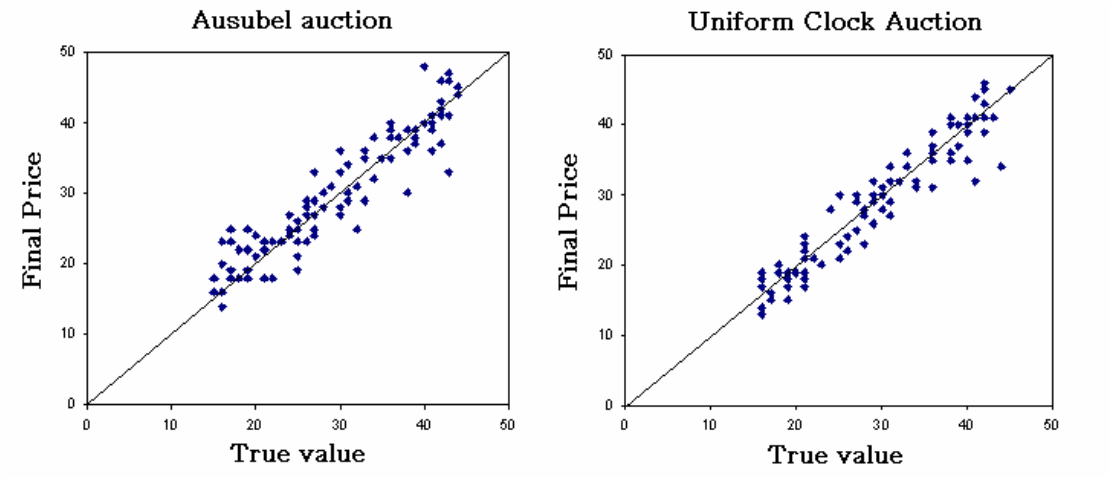

Figure 1. Scatter diagrams of final prices relative to true values

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 and Roth, 1995). Table I illustrates that in three out of 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[28]. This finding, nevertheless, does not imply that the Ausubel format is more susceptible to the winner's curse, since the prices different from the final could have been paid for some units bringing positive overall profit. This issue is addressed later during the underpricing analysis.

Table I

PRICE DISCOVERY
(mean of the difference between true values and relative final prices;
standard error in parentheses)

	All rounds		
Session	A	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)

** Wilcoxin ranked sign test, 5% level, for pooled data only

Next, we look at the development of the price discovery over time. Figure 2 demonstrates that in the first 7 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

[28] 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.

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.

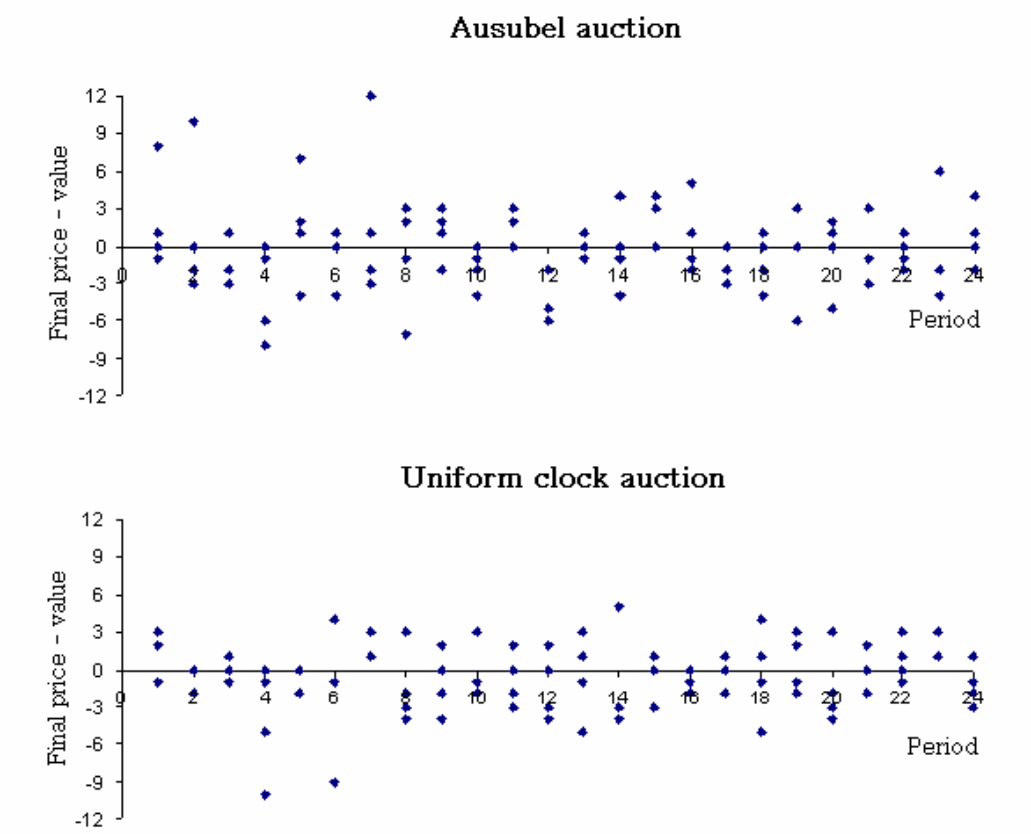

Figure 2. The development of the price discovery over time

Common value auctions are complicated for developing a strategy as they require 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 risk to "quit" too late winning too many units at the price above the value and vice versa – to quit too early not winning any units. While decreasing the demand after the risk-free threshold gradually smoothes the risk together with the potential profits. In the uniform price clock auction the above risks

are accentuated as, unlike other format 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 indicates that the subjects have used the same limited set of strategies under both treatments. 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 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 amount until the auction end. This category constitutes 45% in both treatments.

Figure 3 provides bidding patterns of subjects from different categories.

Figure 3. Bidding patterns of different categories of subjects.

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 to the uniform auction.

We proceed with examining the subjects' behavior after the familiarity with the mechanisms has been acquired and the strategies have been set. Figure 4 provides scatter diagrams of the difference between true values relative to final prices for the last 12 rounds. As occasional "outliers" (the observations situated 10 or further points away from the 45° line) owed to first periods vanish, the distributions become smoother and the minor difference (weak prevailing of overbidding cases in treatment A and underbidding cases in treatment U) disappears. However, overbidding still occurs under the Ausubel as well as under the uniform mechanisms.

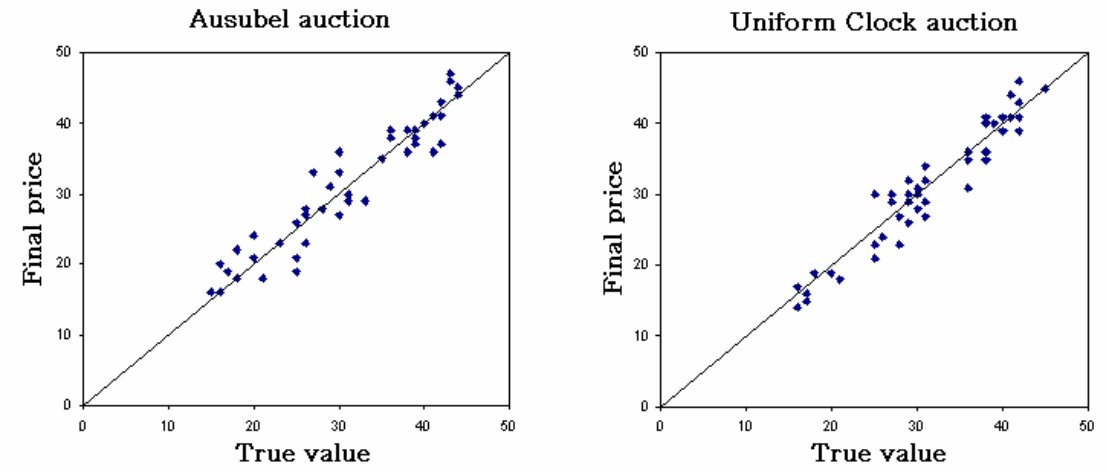

Figure 4. Scatter diagrams of final prices relative to true values for last 12 rounds

Table II summarizes the data reported in Figure 4 and compares it to the data of the first 12 rounds. As the players become more experienced, the differences between true values and final prices shift slightly towards zero (Treatment A: from -

0.54 to -0.13 and Treatment U: from 0.85 to 0.42) under both auction formats, thus, decreasing the winner's curse consequences This small change sufficed to erase the significance of the difference between the treatments, thus rejecting the hypothesis about higher final prices in the Ausubel compared to 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 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 that potential demand considerably exceeding the supply (3.3 times). In this environment several tries to decrease the bids early did not take 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.

Table II

PRICE DISCOVERY
(mean of the difference between the true value and the final price;
standard error in parentheses)

	First 12 rounds			Last 12 rounds		
Session	A	U	Difference (U minus A)	A	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)

* Wilcoxin ranked sign test, 10% level, for pooled data only

6.2 Underpricing

In our experimental setting we measure underpricing as the difference between the true value and the final price, however, in the Ausubel auction, the price paid for some units can differ from the final price and thus underpricing definition above requires modification. We proxy the unique final price as the total payment divided by the total number of the units auctioned, where total payment is the amount paid by all participants for all units.

Comparative analysis of underpricing is reported including the results of the competitive IPO treatment. Bearing in mind the treatment comparability, while projecting the experimental environment for auction study, we tried to keep the key features of experimental environment such as the generation of true values and private signals and similar ratio of potential demand to supply (is equal to 3 in the competitive IPO and is 3.3 in auction treatments), however, some changes were inevitable due to the experimental constraints. The most tangible modification was introducing the narrower interval from which the true values were drawn. Since all auctions start with the minimum price of 10 and price increments every 4 seconds, whenever true values are set high, participants would have to wait for a long time until the current price would approach the true value and "real" bidding would start (e.g. it would require 5 minutes to reach the true value of 85). These delays could cause loss of concentration, increase the probability of distraction errors, and thus potentially to bias the data. Approaching the time issue from the other side, we tried to speed up the price increments, but the players have objected that they can not enter their bids in time if the price changes faster than 4 seconds. However, the range of true values remains wide, and thus, it does not put any constraints on the level of potential underpricing. Moreover, since we defined underpricing as "true value minus

final price" and not as a percentage of final price, the underpricing magnitudes are directly comparable.

Figure 5 presents scatter diagrams of final prices relative to true values and the development of underpricing during experimental sessions under two auction and the competitive IPO treatments[29]. On the competitive IPO's scatter diagram we present only the lower part of the values (from 10 to 50) to facilitate visual data comparability[30], while on the bottom panel and in further analysis all data is included.

As implied by the price discovery findings, two auction formats have basically the same levels of underpricing, but interesting result is that the third mechanism, competitive IPO, also has similar to auctions magnitudes. In all three methods the share of negative underpricing is considerable, but the uniform auction suffers the most from it and the competitive IPO is on the opposite end (the uniform auction: 41% of rounds; the Ausubel auction: 31%; and the competitive IPO : 25%).

Table III presents underpricing for three mechanisms and the differences of the uniform auction and the competitive IPO relative to the Ausubel auction. The underpricing means are 0.95, 0.64, and 0.72 for the Ausubel, Uniform, and competitive IPO treatments respectively. The unarmed eye's observation of scatter diagrams as to the similarity of underpricing levels is confirmed by Wilcoxin ranked sign test, which did not find significant differences among treatments.

Going into 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 negative underpricing. However, the magnitudes are insignificant (range from -0.32 to -0.42 for experienced subjects), and on the aggregate level the influence of winner's curse is not felt.

[29] There are three sessions of data (72 observations) for Competitive IPO against four (96 points) of auction treatments.
[30] However, the lower and higher parts of the range have the same characteristics.

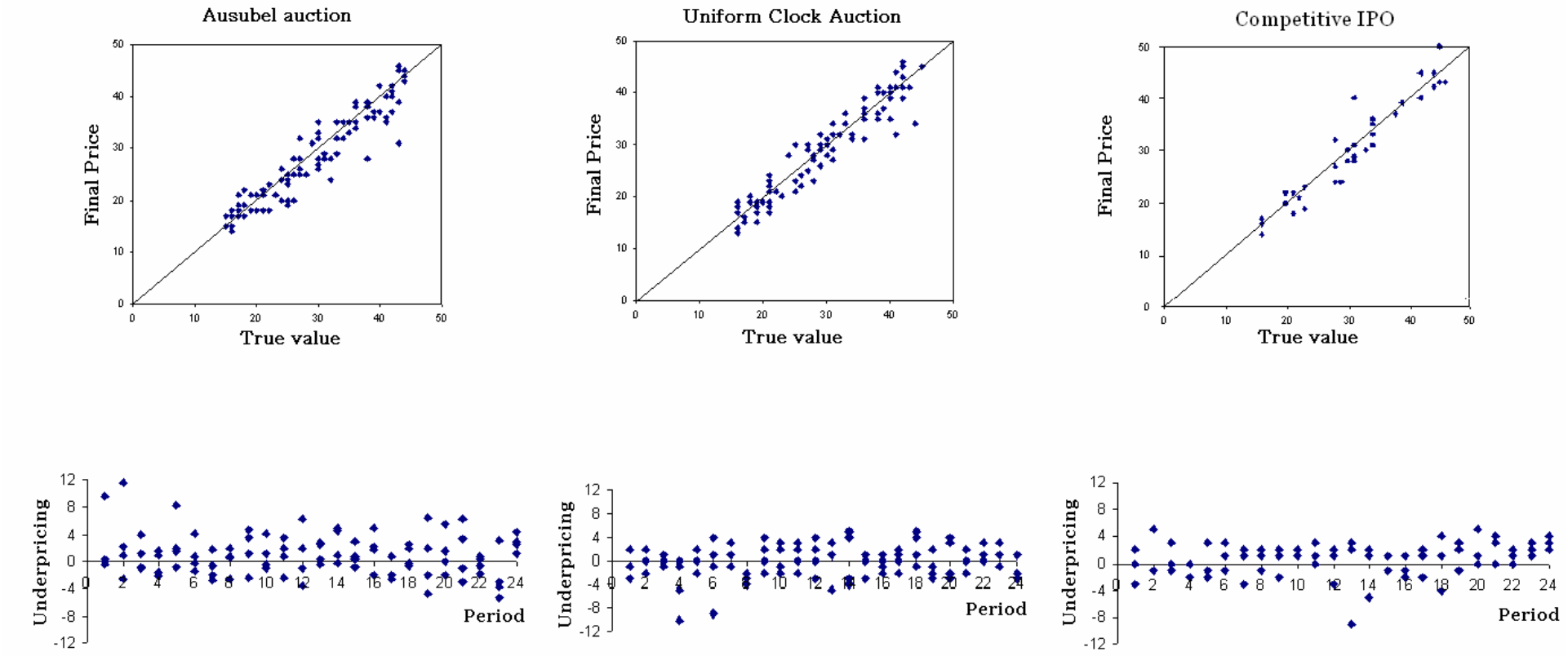

Figure 5. Underpricing in Ausubel auction, Uniform price clock auction, and Competitive IPO
Top panel: Scatter diagrams of final prices relative to true values
Bottom panel: Evolution of underpricing over time

Table III

UNDERPRICING

(mean of the difference between the true value and the final price;
standard error in parentheses)

	All rounds					Last 12 rounds				
Session	A	U	C	Difference (A minus U)	Difference (A minus C)	A	U	C	Difference (A minus U)	Difference (A minus C)
1	0.75	1.50	0.83	-0.6	0.06	0.95	1.00	1.75	0.26	-0.67
	(2.07)	(2.29)	(1.15)	(3.09)	(2.23)	(2.23)	(1.83)	(1.04)	(2.25)	(2,00)
2	-0.38	-0,33	-0.5	-0.05	0.12	-0.41	-0.42	-0.58	0.01	0.25
	(1.79)	(1.94)	(2.46)	(3.36)	(3.16)	(2.22)	(2.18)	(3.32)	(4.03)	(4.50)
3	3.6	0,21	1.92	3.39	1.76	2.82	-0.33	1.33	3.15	1.50
	(2.63)	(1.96)	(1.03)	(3.63)	(2.55)	(2.03)	(1.67)	(1.00)	(3.18)	(2.33)
4	-0.17	1,17	-	-1.33	-	-0.32	1.42	-	-1.73	-
	(1.52)	(1.76)	-	(2.16)	-	(1.87)	(1.65)	-	(2.11)	-
Pooled	0.95	0.64	0.72	0.35	0.65	0.77	0.42	0.83	0.42	0.36
	(2.25)	(2.05)	(1.79)	(3.30)	(2.71)	(2.22)	(1.96)	(1.90)	(3.08)	(3.09)

* Wilcoxin ranked sign test, 5% level, for pooled data only

7. Summary and conclusions

The present experiment provides the first investigation into the potential application of the Ausubel auction to the new issues markets. The Ausubel auction, born as the dynamic version of the multi-unit Vickrey mechanism, possesses outstanding theoretical property: inducing sincere bidding in private-values and for a limited set of interdependent-values environments. Several groups of researchers have conducted experimental studies comparing the performance of the Ausubel auction and other multi-unit auction formats. The findings unanimously confirm the theoretical predictions about the superiority of the Ausubel mechanism in controlling the demand reduction and higher levels of allocative efficiency in private-value auctions. However, suitable framework for analyzing IPO markets is common-values with incomplete information (the common value being the secondary market price of the shares after IPO), for this setting no theoretical predictions exist. Therefore, in the present study rather than comparing the experimental characteristics of the Ausubel auction to its theoretical properties, we take an empirical approach and test the performance of this mechanism against a benchmark – the uniform price clock auction – in the experimental setup tailored to capture the key features of new issues markets such as large potential demand, high uncertainty, and stable group of players.

Both auctions perform equally excellently as price discovery mechanisms with the mean difference between the true value and the final price of -0.13 and 0.42[31] (in the integer parameter values setting) for the Ausubel and the uniform price clock auction

[31] These and the following values are reported for the last 12 rounds.

respectively. No difference found between the two auction formats can be the result of the strong competition, which eliminates the effects of demand reduction in the uniform clock auction (Ausubel, 2003). As well as for the price discovery there are no significant differences in the levels of underpricing: both mechanisms produce underpricing below one price tick (with the volatility roughly equal to two price ticks). Extending the analysis to the competitive IPO reveals that the values generated by this third mechanism are very similar as well – 0.83 (1.90) for underpricing. With the similar levels of efficiency and considerably lower costs than competitive IPO the auctions could be a good option for small cap companies.

Even though the experimental data should be treated with caution as extrapolation from the computer laboratory to the real markets can be hazardous, the results obtained are a promising step in investigating the auctions as alternative IPO mechanisms. Further research shedding light on other important characteristics, in particular the entrance of bidders to the auction and tacit collusion, is essential. Sherman (2005) suggests that in the environment where information acquisition is costly and investors have to decide whether to enter the auction, the assumption of sufficiently large number of informed investors entering the auction should not be taken for granted. Indeed, as (Klemperer, 2004) stresses, encouraging the entrance of bidders is one of the major concerns of practical auction design as well as the tacit collusion, which can lead to significant underpricing.

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APPENDIX A

EXPERIMENT INSTRUCTIONS

Instructions for the 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.

In sum,

	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

	Bidder A	Bidder B	Bidder C
Profit	2 * 30 – 30 = 30	2 * 30 – 35 = 25	1*30 – 20 = 10

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!

Instructions for the uniform price clock 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 and will be paid to you.

Thank you for taking part in our experiment!

CONCLUSION

The present dissertation has focused on the investigation of two issuing methods potentially more efficient than the existing mechanisms, in particular, on the connected characteristics – investors' information revelation and underpricing. The challenge of the non availability of data (connected to few or no implementations of the novel procedures in practice) is met by adopting the experimental approach. In the experimental laboratory the setting tailored to capture the key features of new issues market was designed, and two experimental studies were conducted.

The first experiment investigates the investors' behaviour under the competitive IPO and bookbuilding mechanisms. We stipulate that the competitive IPO stimulates the increased competition not only among investment banks but also among institutional investors under the assumption of the long-term relationship between these parties. The amplified investors' competition should have positive effect on the information revelation and, consequently, diminish the level of underpricing. The experimental results support these claims. In the competitive IPO investors are revealing much more information than in bookbuilding, this difference being even more acute for experienced players. The same applies to underpricing.

The second experiment examines the Ausubel auction and the uniform price clock auction offering the first insights on the performance of the Ausubel auction in the common values setting. Both auction designs have performed equally excellently as price discovery mechanisms yielding the same low levels of underpricing (and volatility). Extending the underpricing comparison to the competitive IPO, we find that there are no statistically significant differences between the three mechanisms.

The initial investigations into the alternative to bookbuilding IPO methods suggest that they are better in controlling the underpricing. However, many other considerations have to be taken into account before recommending the new mechanisms. For the competitive IPO, the major concerns are the additional costs of the financial advisor and attracting the investment banks. Since the participation in the contest is costly for the banks, probably, only large flotations will be able to gather enough interest from the banks. For small firms going public the valid alternative to the competitive IPO is auctions, which present considerably less expensive option with similar underpricing characteristics. Important issues requiring attention in the auction context are the bidders' entry and tacit collusion.