Endogenizing Bidder's Choice in Financial Assets Auctions – An Experimental Investigation*

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Abstract

The objective of this paper is to investigate the preferences of potential bidders in choosing between uniform and discriminatory auction pricing methods. Many financial assets, particularly government bonds, are issued in an auction. Uniform and discriminatory pricing constitute the two most popular mechanisms used in public auctions. Theoretical papers have not been able to provide an unequivocal preference of one mechanism over the other. This study investigates both bidder choice and the impact of that choice on the outcome of the auction by allowing bidders to choose between the two alternative systems. The majority of the bidders in the survey prefer uniform pricing. Those preferring uniform auctions tend to bid more aggressively than those preferring discriminatory. On average, the proceeds to the issuer were higher under the uniform price mechanism.

1. Introduction

The impact of market design on the level of participation and prices in financial markets is a key issue in the literature on financial market micro-structure. A vast body of research focuses on this issue, particularly within the context of secondary financial markets.[1] Our study, while part of this literature, deals with auction design in primary bond markets and its affect on participation and pricing.

Many financial assets such as treasury bonds, corporate bonds and stocks are issued to the public via auctions. No consensus currently exists, either in the academic literature or in practice, as to the most appropriate method of pricing securities issued in auctions. The question whether uniform or discriminatory pricing should be used remains unresolved.[2]

This study is the first to investigate in a controlled environment the connection between the design of the auction and its potential impact on the participation in the offering and its outcome.

So far the academic literature in financial economics viewed the issuer of sovereign bonds as a monopolist and hence ignored the preferences of the buyers. While this view was more appropriate in the past where markets were more segmented, especially in less developed financial markets, it is less appropriate now when financial markets are more integrated and participants invest globally. For example, when 60% of

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[1] For a survey of the literature see Biais, Glosten, and Spatt (2005)

[2] In uniform price auctions (also known as single price auction), all bidders bidding above the market clearing price are awarded the entire amount, while those bidding at the clearing price are awarded on a pro-rata basis. All winners pay the same price, the market clearing price, for the entire quantity that they are awarded, regardless of the price submitted on their bid. In a discriminatory price auction (also known as multiple- price or pay-as-you-bid auction), bidders bidding above the market clearing price are awarded their bids. Each bidder, however, pays the price/s submitted in the bid.

Greece's debt in the second quarter of 2005 was held by foreign investors (IMF report 2006), it is hard to argue that the Greek's Treasury can ignore the preferences of foreign institutional investors.[3]

As barriers to investment in foreign countries decrease, investors have many options to choose from. A US based investor, for example, who is seeking to invest in AAA rated sovereign bonds, linked to the euro, can choose to participate in the German or French government bond auctions that use discriminatory price auction or in Finland's auctions that use the uniform price mechanism. He also can choose to participate in the Italian government auctions that use both mechanism or buy Austrian bonds that use none of these auction methods (See Brenner, Galai and Sade, 2009). Though these bonds differ by their characteristics there is no doubt that one can find several which are close substitutes. In addition, it is important to note that auctions are not only used for sovereign debt, but also for the issuance of corporate debt. In Israel, for example, a particular corporation can sell its debt using a discriminatory auction or a uniform one. An investor can decide which bonds to purchase.

In this paper we try to understand if participants prefer (or care) about the particular market design; the discriminatory price auction or the uniform one. This paper analyzes the results of a survey conducted among potential bidders. It is essentially impossible to collect relevant data regarding bidders' actions and their preferences for specific auction mechanisms, while controlling for other factors. Therefore, we surveyed potential bidders to learn about their preferences in choosing between alternative pricing mechanisms. To the best of our knowledge, our study is the first in which participants are

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[3] The IMF report also indicates that foreign investments in emerging markets have doubled from 2000 to 2005.

offered a choice, albeit simulated, between alternative multi-unit (identical) goods auction systems[4].

We conducted a survey among a variety of potential bidders, including financial professionals, business students, MBAs with a few years of work experience and executive MBAs in seven countries (US, Israel, Norway, South Africa, Luxembourg, Switzerland and The Netherlands.)[5] We initially received 220 qualified answers. Most surveys were conducted during 2004-5 (220 participants,) and our statistical results are mainly based on these surveys. A control group of 22 participants was used in a questionnaire given in March 2009. The survey focused on their preference for either a uniform or a discriminatory price auction.

The main findings are: a) 90.9% of the participants are not indifferent with respect to the pricing rule of the auction. b) 65.5% of those with a definite preference prefer to participate in a uniform price auction. This finding transcends country of origin and educational/professional background (MBAs, executive MBAs, undergraduates or professionals) and gender. Not only are the participants in our study preferring, on average, the uniform price mechanism, they also submit more aggressive bids under the uniform price mechanism (consistent with previous experimental work) and as result they are willing to pay, on average, a higher price. We do not investigate the reasons for their choices, but, concentrate on their revealed preferences as reflected in their answers.

Milton Friedman (1960) has argued that in the context of Treasury auctions, discriminatory pricing drives out uninformed participants because of the danger of over-

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[4] There have been attempts, in the single unit auction literature, to empirically and experimentally examine bidder preferences among existing mechanisms and to theoretically incorporate the notion that issuers may need to compete for bidders. See, for example, Ivanova-Stenzel and Salmon (2004), McAfee (1993), Levin and Smith (1994).

[5] All the university students that participated in our survey attended advance finance courses and have a background in economics and statistics. They came from more than 20 countries.

bidding, the so-called "winner's curse". As a result, discriminatory pricing attracts the better informed, typically large players, and may be more susceptible to collusion than uniform pricing. Hence, he predicts that by limiting the pool of bidders, discriminatory auctions lead to lower proceeds from the offering. Our paper provides experimental support to Friedman's hypothesis.

More recent work in the theory of divisible-unit auctions investigates trade-offs that policy makers face in the deployment of alternative pricing mechanisms.[6] These papers raise the following question: Given a set number of exogenous participants (N) at the time the rules are set, which mechanism will maximize proceeds from the auction? They show that a non-cooperative equilibrium exists under the uniform-price format, which supports collusive outcomes and is sub-optimal from the issuer's standpoint. These theoretical studies also show that collusive outcomes are not evident in discriminatory auctions, in contrast to Friedman's conjecture. They also claim that the uniform price mechanism may result in multiple equilibria.

In sum, in the case of divisible units, the theory is inconclusive. Also, there is no consensus as to which of the two methods will generate larger proceeds. Thus, the choice of the auction mechanism remains an empirical issue.

There is a growing strand of research in experimental economics investigating divisible good auctions[7]. The methodology employed in this research enables us to compare alternative pricing mechanisms in a controlled environment. In these controlled

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[6] See, for example, Wilson (1979), Back and Zender (1993), Ausubel and Cramton (2002) and Wang and Zender (2002) for theoretical discussions on strategic bidding in multi-unit auctions. A survey article on auction theory by Das and Sundaram (1996) discusses the implications of theoretical models for Treasury securities auctions and presents some empirical evidence.

[7] Starting from the early papers by Smith (1967), Miller and Plott (1985), Cox, Smith and Walker (1985) to the more recent papers by Goswami, Noe, and Rebello (1996) and Sade, Schnitzlein and Zender (2006).

experiments, the number of participants in each mechanism was set in advance and bidders were asked to participate in a specific pre-determined auction.

While these experiments are able to gauge the potential impact of auction structure on pricing, the inability of participants to choose between the auctions may limit the applicability of these findings to financial markets. In actual auctions, the outcome depends on both price and participation. Hence, no conclusions can be drawn regarding the impact of the auction mechanism without considering the number of participating bidders for each of the alternative pricing systems.[8]

Consistent with previous empirical research based on event studies our survey results suggest that by using the uniform price mechanism issuers may obtain higher revenues since the combination of the large number of bidders with their aggressive bidding strategies should yield larger proceeds .[9,10]

In addition to its contribution to the academic literature on auction mechanisms, our research has practical implications as well. Given that financial markets have become more global,[11] issuers, including sovereign governments, seeking to attract global participation, can no longer act as monopolists in their respective markets and must take into account preferences of potential bidders. Moreover, the degree of participation in the initial auction is likely to have a positive effect on the liquidity of the secondary market.

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[8] See, for example, Engelbrecht-Wiggans, List, and Reiley (2006) and Bulow, and Klemperer (1996).

[9] Our results are consistent with the empirical investigation of Umlauf (1993) who examined Mexican T-bill auctions, with Feldman and Reinhart (1995) who studied the International Monetary Fund's auction of gold and with Tenorio (1993) who studied Zambia's weekly foreign exchange auctions. See also Nyborg and Sundaresan (1996), Malvey and Archibald (1998) and Goldreich (2007) for the U.S. experiment.

[10] The experimental work by Goswami, Noe, and Rebello (1996) shows that discriminatory auctions yield higher proceeds than do uniform auctions.

[11] See, for example, the evidence from Finland: "The introduction of the euro has boosted market volumes as well as numbers of active counterparties and final investors. Already during the first year of the euro, domestic banks lost much of their earlier dominant position as the share of foreign demand increased to 75%, and the share is still increasing", Salavirta and Taipalus (2003, pp 44).

Our paper joins the strand of literature that uses both professionals and students in experimental/survey settings.[12]Within the context of financial market decision-making, several experimental papers have examined the choice of professional versus student subjects and found that the behavior of professional decision-makers does not qualitatively differ from that exhibited by the students.[13]

The paper is organized as follows. Section 2 describes the hypotheses relating to bidders' choice and discusses the design of the survey. In Section 3 we summarize and discuss the survey results. Section 4 provides concluding remarks.

2. The Hypotheses and Survey Design
2.1. Hypotheses about Bidders' Choices

As discussed above the existing theory does not provide us with a definitive answer regarding the pricing rule that an issuer of financial assets should choose in designing an auction. One possible alternative is to try to get a reading on the preferences of potential bidders. An experiment conducted by the U.S. Treasury between 1992 and 1996 compared the two auction systems. The results (see Malvey, Archibald and Flynn (1995) and Malvey and Archibald (1998)) are marginally in favor of the uniform price mechanism when the total revenues generated by the two methods are compared. In the uniform price mechanism, the experiment also gave indications of wider participation and less concentration.

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[12] Friedman and Sunder (1994) provide a detailed discussion on the choice of subjects for experimental economics and survey studies of different economic decisions.
[13] See, for example, DeJong, Forsythe and Uecker (1988), Dyer, Kagel and Levin (1989), Plott (1988) and Smith, Suchanek and Williams (1988).

The purpose of our study is to shed some light on the preference of potential market participants regarding the pricing mechanism in public auctions. Unable to measure these preferences directly from market data, and believing that they should have an impact on the propensity of investors to participate in auctions, we provide evidence obtained from surveys of potential bidders. These estimates are then entered into a model comparing the proceeds generated from uniform and discriminatory auctions, to render a more realistic analysis of how market design may affect the functioning of primary markets.

The first question to be addressed in the survey is whether in fact auction participants have a preference (or are they indifferent) to a specific type of pricing mechanism, be it uniform (UPA) or discriminatory (DA). Second, we tried to discover if the choice of mechanism affected bidding behavior. Is the bidding similar in either mechanisms or does one mechanism encourage more aggressive bidding? Third, we investigate the total impact of participation and bidding aggressiveness to find out if there is a significant difference in proceeds that the issuer collects.

2.2 Survey Design

2.2.1 Methodology

The responses to the surveys, which were conducted among different groups in several countries, constitute our source of data. Designing an effective survey is a challenging task since one needs to express a complicated realistic situation in a relatively short survey and elicit honest replies. We decided to adopt the experimental

design of SSZ (2006) as the base case of our survey. This enables us to check the consistency of our survey ("one shot game") with a multi-round experiment. Moreover it enables us to check the consistency of the results of two methods, unpaid survey versus a paid lab experiment.[14] In the design of the specific survey questions that are asked we used standard techniques to minimize potential biases. In addition, we applied IRB constraints. A copy of the survey is provided in Appendix A.

In order to keep the identity of the participants confidential the survey does not ask for specific individual identification such as name, birth date, or social security number other than gender. Yet, in order to incorporate the potential impact of financial experience, particularly financial auction experience, we do ask questions about experience in financial markets and previous participation in financial auctions.

The first part of the survey describes the objectives of the research and provides a detailed example of the two auction mechanisms. The second part consists of the questionnaire, including questions regarding the participants' experience.

2.2.2 Survey Questions and the Main Example

In our survey (see Appendix A) the participants were asked to imagine that the market consists of 10 participants and each participant can decide in which auction mechanism to participate. As in reality, the decision of each member of the group affects the number of bidders that he or she will eventually be bidding against. In other words, if more participants will choose the uniform price mechanism the total amount of bidders that they will compete with in a given auction will be larger. The parameters of the problem are based on SSZ (2006), which is described below.

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[14] For an elaborate discussion on the effects of financial incentives on performance in experimental tasks see Camerer and Hogarth (1999).

In their study there are N = 5 bidders in each auction mechanism (5 in the uniform and 5 in the discriminatory) who compete for Q = 26 units of a good. The after-market value of a unit is known in advance and is equal to 20.[15] Prices are discrete and the "tick size" is 1. In particular, bids were submitted for quantity orders at 4 distinct prices contained in the set {17, 18, 19, 20}. Quantities are in integers and the aggregate quantity demanded by each bidder is 26. Each quantity order is an offer to purchase the specified number of units at a given price (or below in the case of the uniform-price auction). The stop-out price is determined as the highest price at which demand equals or exceeds the supply of Q = 26 units. Winning bids are those submitted at or above the stop-out price. All quantities demanded at prices strictly above the stop-out price are filled while orders bid at the stop-out price are rationed on a pro-rata basis.

Given this structure, SSZ (2006) describes the Nash equilibria of the one-shot auctions. While the uniform price mechanism supports multiple equilibria (at all possible prices), the discriminatory price mechanism supports only one equilibrium at the auction price of 19.

In our setting, the experimental design which allocates 5 bidders to each mechanism can be thought of as a special case where either all the 10 participants choose to be indifferent between the two auction mechanisms or 50% of them choose to participate in a uniform price mechanism and the other 50% choose the discriminatory price mechanism. It should be noted that the equlibria described in the case where 10 players are divided into two groups of 5 each is not necessarily the equilibria obtained in

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[15] Since a known post-auction price was employed by SSZ (2006), there is a legitimate concern about this design decision. One motivation was to avoid the potential bidder bankruptcy, a factor we cannot control for in our survey. Another consideration was that, given a fairly liquid Treasury bond market, the reissuance of the same bonds occurs in a market with continuously observed prices.

other possible division of the 10 players. If, for example, only one participant decided to choose the uniform price mechanism, while the rest (9) decided to choose the discriminatory price mechanism, then the only equilibrium in the uniform price mechanism is 17.

In our survey the participants are presented with two identical firms which try to issue debt via an auction. The only difference between the two firms is the auction mechanism; one firm opts for uniform pricing, while the other uses discriminatory pricing.[16]

We asked the participants which, if any, preference they have, or whether they are indifferent to the pricing mechanism. Given their choice, they were asked to submit a schedule of bids. We also asked them which mechanism (if any) they thought most of the other participants would choose. We did not reward the participants with monetary prizes and participation in the survey was strictly voluntary. In the control group from 2009 we also asked them, using the same initial survey, to write the reasons for their choice.

2.2.3 Survey Sample

We conducted the survey in six countries in 2004-2005.[17] Our final sample consists of 220 participants. (USA (43.2%), Israel (22.7%), Switzerland (8.2%), Luxembourg (12.3%), Norway (7.7%) and South Africa (5.9%). The participants (see Table 1) consisted of bankers from South Africa attending a risk management course,

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[16] It is important to note that while the participants in our survey choose between two firms, we could have replaced the word "firm" with the word "country". Since we wanted the participants to be unbiased by the common practice of their own home country, we chose firms as the auctioning (offering) entity.

[17] We excluded a few cases of participants that either did not respond to the question of mechanism choice, did not submit bids, or submitted bids for more than 26 units from the sample.

financial professionals from one of the leading financial institutions in Israel, business undergraduates from the USA, MBA students from the USA, Israel, Luxemburg and Switzerland, as well as executive MBA students, primarily financial professionals, from Israel and Norway.[18]

The participants in our sample have on average 2.33 years of experience in financial markets (the maximum is 25 and the minimum is zero). 11.4% indicated that they had previously participated in financial asset auctions. Given the strand of literature that argues that gender may have an affect on various aspects of the decision making process, we also controlled for gender. Our sample included 21.8% female subjects.

We also conducted a robustness test (March, 2009) among risk managers in a major bank and an insurance company in the Netherlands and among Executive MBA students in Luxembourg with work experience in banks and financial institutions. Altogether, 22 students answered the questionnaire. This is our control group.

3. Analysis of the Findings
3.1 Choice of Pricing Mechanism

The first major finding is that 91% of the participants indicated a definite preference for a given pricing mechanism. 65.5% of those with a preference chose to participate in the uniform price auction. This finding persisted across countries and across types of education/professional experience (Executive MBA versus MBA versus Undergraduates). (See Table 1 for detailed results). In other words, the majority of the participants in each country and in each education group **preferred** uniform **pricing.**

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[18] Many of the students in the classes in Switzerland and Luxembourg are citizen of other countries such as Germany, France, Belgium and Holland.

What may affect bidders' choice? Some of the potential factors are information/knowledge, risk preference, behavioral biases, culture, or strategic behavior. As a proxy for information / knowledge we asked the participants to indicate the years of work experience in financial markets and if they had prior experience in financial auctions. Since there is indication in the academic literature that risk attitudes is related to gender and risk attitude may affect the mechanism choice, we also gathered information on the gender of the participants. As a proxy for potential culture difference we control for the US versus other countries where the survey took place.

Table 2 presents the univariate relationship between, gender, length of work experience in the financial industry and exposure to financial auctions to the chosen mechanism. Those preferring uniform pricing have, on average (p=0.057), greater professional experience in the financial industry than those favoring discriminatory pricing (2.7, and 1.8 years respectively). While the proportion of those that had previous exposure to financial auctions is higher among the group preferring discriminatory pricing, the difference is not significant. Neither gender nor location (i.e. most surveys that were conducted in the US) was statistically significant.

To investigate this question further in a multivariate context we estimated the following logit (probit) equations on the sample of participants who had a specific preference ("not indifferent") and answered all the essential questions (n=194):[19],[20]

$$UPM = \alpha + \beta_1 YE + \beta_2 Dummy(AE) \qquad\qquad (1)$$

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[19] We also conducted a multinomial logit test that included the "indifferent" group The results were essentially the same.

[20] In five cases the participants did not indicate the years of experience. They were excluded from the analysis.

UPM = α + β_1YE + β_2Dummy(AE) + β_3 Dummy(G) +Dummy (US)   (2)

Where:

UPM (Uniform Price Mechanism) is a dummy variable that gets the value 1 if the participant chooses the uniform price mechanism and 0 if the participant chooses the discriminatory price mechanism.

YE is years of experience that the participant has in the financial industry.

Dummy (AE) is a dummy variable that gets the value 1 if the participant has experience with financial asset auctions.

Dummy (G) is a dummy variable that equals 1 if the participant is a female and 0 if he is a male

Dummy (US) is a dummy variable that equals 1 if the survey was done in the US and 0 elsewhere.

The results obtained from estimating the above logit (probit) equations are consistent with the univariate analysis as follows: From equation (1) we find that the preference for the uniform price mechanism is positively correlated with years of financial market experience but it is barely significant (p=0.08 for the logit and 0.07 for the probit). Exposure to financial asset auctions has a non-significant negative correlation with auction choice. The pseudo R- square is rather low (0.017 for the logit and 0.018 for the probit) indicating that we are explaining a very small part of the variation in the auction choice. The basic result and the explanatory power of the model do not change

when we add a dummy for gender or a dummy for the US location as control variables (equation 2).[21] These two control variables were both insignificant.

We next divided the sample of participants into three groups according to their reported years of experience in the financial markets: The first group reported no experience in financial markets (n= 104), the second group is the group that reported experience of up to (including) 2 years (n= 32) and the last group is the group that reported experience of more than 2 years (n= 78). Figure 1 shows the preference of the participants for each of the three groups. Though all three groups show a preference for the uniform mechanism, the relatively strongest support for this mechanism is provided by the participants who reported to have financial market experience of over two years.[22]

3.2 Bidding Startegy

After observing that most bidders prefer the uniform price mechanism, the next question we examined was whether there is a difference in the bidding strategy among those that prefer uniform pricing compared with those that prefer discriminatory pricing and how that is translated to the revenue obtained by the issuer.

We find that not only do most bidders prefer uniform pricing, they are also willing to bid more aggressively under the uniform price mechanism. The weighted average (by quantity demanded) of the price submitted by bidders that chose the uniform price mechanism is 18.72 while the weighted average of the price submitted by bidders that chose the discriminatory price mechanism is 18.59. This result is statistically significant at the 10% level and is consistent with the finding of SSZ (2006).

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[21] The P value of the chi-square test for the model is also insignificant.
[22] It is interesting to note that the preference for the uniform mechanism is only slightly greater than for the discriminatory mechanism among those that have approximately two-years work experience.

To test whether the difference between the weighted average price that was bid in the two auctions is statistically significant, while controlling for relevant variables, we use the following Tobit regression[23]

$$AP = \alpha + \beta_1 YE + \beta_2 \text{ Dummy(AE)} + \beta_3 \text{ Dummy(G)} + \beta_4 \text{Dummy(UPM)} + \beta_4 \text{ Dummy(DPM)}$$

Where:

AP is the weighted average of the price submitted by bidders calculated as:

$$AP = \frac{\sum_{i=17,18,19,20} i * Qi}{\sum_{i=17,18,19,20} Qi} \qquad \text{Where Qi represents the quantity demanded at that price.}$$

Dummy (UPM) is a dummy variable that receives the value 1 if the participant chose the uniform price mechanism and 0 if the participant chose the discriminatory price mechanism or was indifferent. Dummy (DPM) is a dummy variable that receives the value 1 if the participant chose the discriminatory price mechanism and 0 if the participant chose the uniform price mechanism or was indifferent. YE is the amount of experience in round years that the participant had in the financial industry. Dummy (AE) is a dummy variable that receives the value of 1 if the participant had experience with financial assets auctions. Dummy (G) is a dummy variable that equals 1 if the participant was a female and 0 if he was a male. Dummy (US) is a dummy variable that equals 1 if the survey was done in the US and 0 elsewhere.

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[23] We use Tobit since the bidding prices in the survey are limited to the range between 17 and 20.

The only significant variable at the 10% level (P=0.07) is UPM and its coefficient is positive, which gives additional support to the hypothesis that those opting for the uniform price mechanism bid more aggressively on average.

In order to investigate which mechanism will yield greater proceeds to the issuer, given the participants' choices, we randomly assigned the 220 participants answers to twenty two groups of ten each. In each group we divided the participants' answers according to their mechanism choice; either discriminatory or uniform. Participants expressing indifference between the two mechanisms were randomly assigned. We calculated the auction price for the two mechanisms for each of the 22 groups. On average, the uniform price mechanism leads to significantly higher proceeds when compared to the discriminatory price mechanism (t=2.95 paired test). Consistent with SSZ (2006) we also find that there is higher variation in the proceeds obtained under the uniform price mechanism than under the discriminatory price mechanism. Table 3 shows the proceeds for each of the 22 groups. In most groups the uniform bids resulted in much higher proceeds (14 out of 22 groups). In thirteen cases the uniform bids actually yielded the highest possible proceeds of 520. The highest proceeds for the discriminatory bidders was 514 .

3.3 What Drives Bidders Preferences?

What is driving our results? Do bidders project correctly choices of other bidders? In our survey we asked the participants which method will be mostly chosen by others? About 20% of our sample did not answer this question. Hence the relevant sample decreased to 175. Out of them 10.3% predicted that most participants will be

indifferent, 66.3 % predicted that most participants will choose the uniform price mechanism and 23.4% predicted that most participants will choose the discriminatory price mechanism. Overall, the predictions of our participants were in line with the actual responses. Most thought that the majority will choose the uniform price mechanism and in fact, most did. It is interesting to note that 76.6% of the participants thought that most participants will choose the same mechanism that they chose. It is an interesting observation because participating in the mechanism that most players choose is not necessarily an optimal choice.

While focusing on the bidders' choice one may ask how our survey results fit into the paradigm of a general equilibrium. In a world with open financial markets and (relatively) free access to a variety of different auctions of close substitutes, shouldn't there be some kind of an irrelevance result that applies to any country? Under this paradigm, if bidders are rational and only concerned with paying the lowest price they will look for the best value across auctions taking into account their ability to extract rents from the seller and the anticipated participation in each auction.

To learn more about what drives bidders preferences we conducted 2 additional surveys with different groups in the early months of 2009. The first group that consisted of 13 risk managers in a major bank and an insurance company in the Netherlands and the second that consisted of 14 Executive MBA students in Luxembourg with work experience in banks and financial institutions. In addition to the questions presented before, the two groups were explicitly asked to answer why they chose a particular mechanism. Not all participant were willing to disclose their mechanism choice (4 did not). Of those that did, the majority chose the uniform price mechanism. We got varied

responses from those that picked the uniform price mechanism (equality of the price, risk, clarity of the mechanism and the luck of the winner curse) and we could not single out a clearly dominant reason that explains the mechanism choice. Our results, admittedly on a relatively limited sample, are consistent with the previous literature, and suggest that although price plays a major role in the preference of the uniform mechanism, it seems that there are other considerations as well. For example, the uniform price mechanism is associated with "fairness".

In designing the initial survey we focused on documenting the subjects' actions and demographic differences rather than asking their opinions and reasoning for their actions. We made this experimental choice in order to avoid some of the biases that may occurs in the responses answers otherwise. Only in the control group we also asked the subjects for the reasoning for their choices. What is clear from our exercise is that eventhough different bidders are driven by different reasons, such as fairness, complexity of the market or the illusion of expertise, the outcome is consistent with bidders preference for the uniform price mechanism.

4. Summary and Conclusions

Most governments and some corporations use auctions when offering securities and other financial assets to the public. The most common types of auctions for financial assets are based on either a uniform or a discriminatory (multiple) pricing mechanism. Existing theoretical and empirical work is ambivalent about which method is optimal for issuers. Experiments designed to compare the two mechanisms examine the impact of the auction's structure on pricing assume, however, that the level of investor participation

under each pricing system will be equal. This assumption does not necessarily reflect market reality. In many cases investors are not indifferent to the structural aspects of the auction. In order to more accurately compare between pricing mechanisms, the propensity of bidders to participate must be factored into experimental models. We propose a method for incorporating bidder preference into comparative models for auction pricing.

For the first time in the academic literature this paper provides survey evidence on the preference that potential bidders may have regarding uniform and discriminatory pricing. We surveyed over 200 financial professionals, executives and business students in order to learn about their preferences between the two auction mechanisms. Our survey revealed that an overwhelming majority of potential participants are not indifferent between auction mechanisms and the majority prefer uniform pricing. The only variable that we found to be positively correlated to the choice of auction mechanism is years of experience in financial markets. Other factors, such as country of origin, education level (undergraduate versus MBA versus executive MBA), previous exposure to financial auctions and gender had no bearing on bidder preference.

Our study documents that a majority of bidders preferred uniform pricing[24]. Though several countries have recently changed their auction method, from discriminatory to uniform, most countries are still employing discriminatory pricing (See Brenner Galai and Sade (2007)). Though the evidence from the experiment conducted by the U.S. treasury in 1992 was not significant with regard to the revenue generation, it did show that uniform pricing leads to greater dispersion among primary dealers which may be an

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[24] Though it has been shown that in indivisible good UPAs, bidders end up paying more than the average bidder in DAs , bidders may prefer UPAs since it is a less risky and more defensible strategy.

important factor in promoting the liquidity of secondary markets. In wake of the experiment the U.S. Treasury shifted to uniform pricing in all their bond issues. Our survey provides evidence consistent with the US experiment and suggests that issuers, including sovereign governments, seeking broader-based participation in securities auctions, should consider using the uniform price mechanism.

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Table 1
Bidders Choices between the Auction Methods

This table summarizes the responses of participants in a survey conducted during 2004 and 2005. Participants specify the location, academic institution, type of education or occupation. "Month and Year" specifies the date the survey was conducted. "Number" indicates the qualified answers from this sub-group. " %Uniform" denotes the percentage of the qualified answers preferring uniform pricing, while "% Discriminatory" indicates the percentage of the qualified answers preferring discriminatory pricing and "% Indifferent" indicates the percentage of the qualified answers stating indifference between the two alternative price mechanisms.

Participants	Month and Year	Number	% Uniform	% Discriminatory	% Indifferent
Executive MBA and Executive Courses					
Israel-Hebrew U-Executive MBA-Finance	June 2004 and April 2005	18	55.56%	38.89%	5.56%
South Africa-Bankers	June 2004	13	46.15%	30.77%	23.08%
Norway – Executive MBA at BI	May 2005	17	76.47%	17.65%	5.88%
MBA					
Luxembourg - School of Finance	February 2004 and January 2005	27	70.37%	25.93%	3.70%
Switzerland - Lausanne-MBA Finance	May 2004	18	50.00%	33.33%	16.67%
Israel – Hebrew U – Advanced MBA - Finance	November 2004	10	40.00%	60.00%	0.00%
NYU- -MBA 2-3 year part time MBA	December 2004	24	66.67%	20.83%	12.5%
NYU- full time 2nd year MBA	December 2004	40	62.50%	32.50%	5.00%
NYU- 2nd year MBA-Investment Banking, Business & Law School	December 2004	19	52.63%	31.58%	15.79%
Advanced Undergraduate					
NYU-Business Undergraduate- – Seniors	December 2004	12	41.67%	33.33%	25.00%
Professionals					
Financial professionals from a leading financial	January 2005	22	63.64%	36.36%	0.00%

institution in Israel					
TOTAL		**220**	**90.91%**		**9.09%**
TOTAL		**220**	**59.55%**	**31.36%**	**9.09%**

Table 2
Univariate Analysis – Bidders Characteristics and Preferences

This table summarizes the descriptive statistics of participant responses to a survey conducted during 2004 and 2005 according to mechanism of choice.

	Uniform	Discriminatory
Mean - Years of Financial Work Experience	2.72*	1.79*[25]
Median – Years of Financial Work Experience	0.67	0.25
% of Female	22%	25%
% of Previous Financial Auctions Experience	11%	14%
% of US Responses	43%	41%

* indicates that the variable is statistically significant at 10% confidence level (the p-value of the t-test was calculated assuming unequal variance and a two tail test.)

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[25] P-value equals 0.057

Table 3
Proceeds for Each Random Group for Uniform and Discriminatory Bidders

"U" and "D" denote proceeds from the simulated uniform and discriminatory price auctions respectively. "U-D" represents the difference in proceeds obtained under the uniform price mechanism versus those obtained under discriminatory pricing. "Avg" indicates the average of each of the variables.

Market	U	D	U-D
1	520	508	12
2	520	481	39
3	494	507	-13
4	520	494	26
5	520	495	25
6	520	494	26
7	520	478	42
8	520	496	24
9	520	495	25
10	520	494	26
11	494	497	-3
12	494	496	-2
13	520	494	26
14	494	494	0
15	520	500	20
16	494	513	-19
17	520	504	16
18	494	514	-20
19	494	495	-1
20	494	499	-5
21	520	505	15
22	494	495	-1
AVG	**509.36**	**497.64**	**11.73**

Figure 1
Mechanism Preference and Experience in Financial Markets

Figure 1 describes the distribution of choices of the participants among the pricing mechanism as a function of their years of work experience in the financial markets. "No Experience" represents the group of participant with no work experience in the financial markets. "Up to (including) Two Years" represents the group of participants that have positive work experience in financial markets that is less than (including) two years. "Above Two Years" represents the group of participants with above two years of work experience in financial markets.
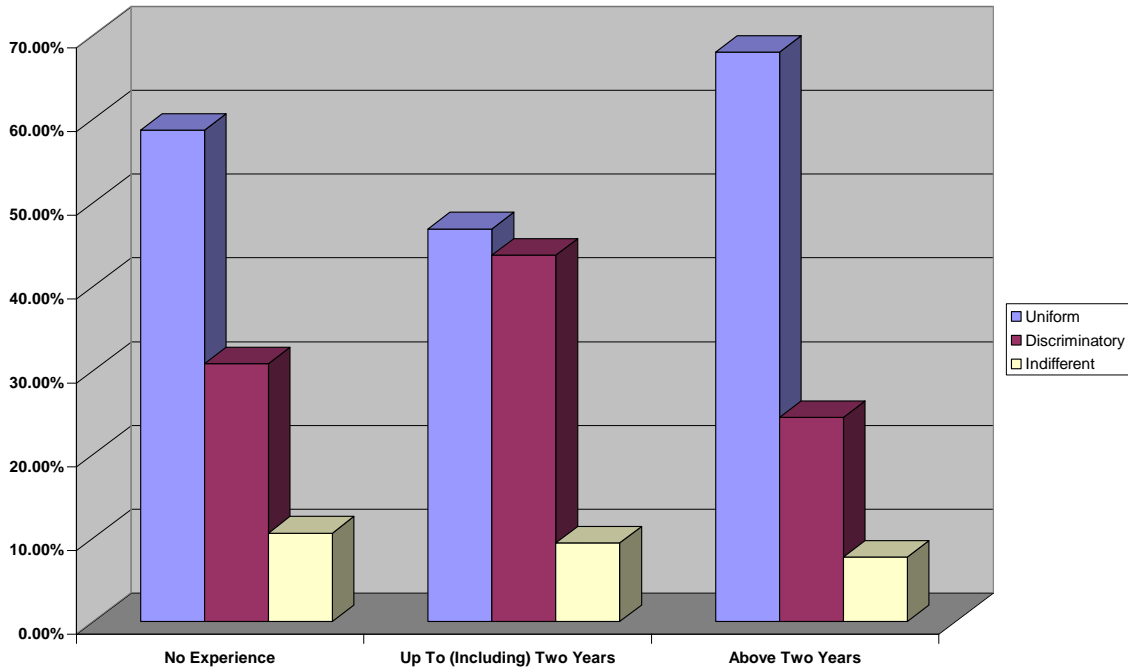
Appendix A – Survey Submitted to Individuals

Professor Dan Galai and Dr. Orly Sade *from the Finance Department at the School of Business Administration, Hebrew University of Jerusalem and* *Professor Menachem Brenner* *from the Finance department at New York University* *Stern School of Business* *are conducting academic research in an attempt to better understand auction design mechanism. For the purpose of this research we would like you to answer a few questions. Everything contained in these instructions and everything you hear in this session is an accurate representation of this research. Be sure to ask any questions that you may have during the instruction period, and ask for assistance, if needed, at any time. All subjects receive the same instructions. (**no minors are allowed to participate**).*

Your identity will be confidential with regard to the participation in this study. The survey does not ask for specific individual identification. The survey responses will be combined, and results will be presented only in aggregated form. Participation in this study is strictly voluntary. Omitting answers to specific questions is at the participant's discretion.

This Survey includes:

1. Case description
2. Examples
3. Survey

1. Case Description:

Two identical firms decided to issue bonds and to sell them via auctions. Each of the firms is going to sell 26 units. The economic value of each of the bonds in the secondary market is known with certainty and is equal to 20. The minimum price that can be submitted in the auction is 17. Bids can be made only in integers. Each participant can participate only in one of the auctions. The only difference between the two firms is the auction mechanism that is used: Firm "A" uses uniform price auction while firm "B" uses discriminatory (pay your bid) price auction. Each participant can bid for 26 units at most.

Firm "A"
This firm is going to issue bonds and sell them via "Uniform Price Auction"
<u>The Auction Method:</u>
There will be **26** units available for sale. You can submit bids for up to 26 units. Your resale value for each unit is **20.** (This means that after the auction your profit will be 20 for each unit that you hold, less what you paid for each unit). Prior to the auction, you are required to submit a schedule of bids. This schedule indicates the number of units you are willing to buy (including zero units) at each possible price level. The possible price levels will be 17, 18, 19, and 20**.** The sum of all of your bids may not exceed 26 units.

Once all participants have submitted their bids, the auctioneer will calculate the highest price at which all 26 bonds can be sold and will allocate units to players that submit bids that are equal to or higher than this price (if needed, the units will be allocated proportionally to the units demanded at the clearing price). **The price paid for each bond will be equal to the clearing price. The market-clearing price will be the highest price at which the total demand for bonds summed across all bidders is equal to 26.** If the total demand will be smaller than 26 at any of the suggested prices, the maximum total demand will be sold. A numerical example that illustrates this type of auction will be presented.

Firm "B"
This firm is going to issue bonds and sell them via "Discriminatory (Pay Your Bid) Price Auction"
The Auction Method:
There will be **26** units available for sale. You can submit bids for up to 26 units. Your resale value for each unit is **20.** (This means that after the auction your profit will be 20 francs for each unit that you hold, less what you paid for each unit). Prior to the auction, you are required to submit a schedule of bids. This schedule indicates the number of units you are willing to buy (including zero units) at each possible price level. The possible price levels will be 17, 18, 19, and 20. The sum of all of your bids may not exceed 26 units.

Once all participants have submitted their schedule of bids, the auctioneer will calculate the highest price at which all 26 bonds can be sold, and will allocate units to players that submit bids that are equal to or higher than this price (if needed, the units will be allocated proportionally to the units demanded at the clearing price). **The price you pay for each unit you receive, is equal to the price that you bid for that particular unit.** This means that it is possible that you will pay different prices for the bonds you buy, and it is possible that different bidders will receive bonds at different prices. If the total demand will be smaller than 26 at any of the suggested prices, the maximum total demand will be sold. A numerical example that illustrates this type of auction will be presented.

You will randomly be assigned to a group that contains 10 participants, you will not know in advance who are the members of your group. You must choose your preferred auction mechanism. Then, you will participate in the chosen mechanism and submit your bids accordingly. At the time that you submit your bids you will not know how many of your group members decided to play the type of auction as you have decided upon.

The number of units allocated to you and the price per unit will be determined based on the results of the auction mechanism of your choice and the bids submitted for that mechanism by members of your group.
The profits are calculated as: number of bonds purchased * 20 – total purchase cost

2. Examples

The following examples are for illustration purposes only. They are not intended to be suggested as "best" strategies and simply demonstrate the implications of a possible set of actions.

In the examples, for simplicity, we assume that 5 participants decided to choose the Uniform Price Auction and 5 participants decided to choose the Discriminatory Price Auction.

2.1 Results for the Uniform Price auction

Uniform Price Auction Example
(Numbers in the table are units)

		Participants				Demand	Aggregate Demand	Supply
Price	**A**	**B**	**C**	**D**	**E**			
20	11	0	5	0	0	16	16	26
19	5	0	3	2	0	10	26	26
18	5	0	8	6	18	37	63	26
17	5	26	10	18	8	67	130	26

The demand at each price is the sum of the demands of bidders A, B, C, D, and E. For example the demand at price 20 is equal to $11+0+5+0+0 = 16.$ The aggregate demand is equal to the total demand at that price and all higher prices. For example the aggregate demand at the price of 19 is 26: (Demand at 20) + (Demand at 19) = 26 units. The clearing price is the highest price at which the cumulative demand equals the supply. In this case, the cumulative demand equals the supply at price equal 19.

The allocations in units and profits of the participants is as follows:

	Participants				
Price	**A**	**B**	**C**	**D**	**E**
Allocation	16	0	8	2	0
Profit	16*(20-19)=16	0	8*(20-19)=8	2*(20-19)=2	0

Since the resale value of the bond for each player is 20, each player makes a positive profit for each unit that he/she buys at a price below 20. The equilibrium price is 19 hence each player will profit one for each unit allocated.

2.1 Results for the Discriminatory Price auction

Discriminatory Price Auction Example
(Numbers in the table are units)

	Participants					Demand	Aggregate Demand	Supply
Price	A	B	C	D	E			
20	1	0	0	0	0	1	1	26
19	20	0	3	2	0	25	26	26
18	0	0	13	6	18	37	63	26
17	5	26	10	18	8	67	130	26

The demand at each price is the sum of the demands of bidders A, B, C, D, and E. For example the demand at price 20 is equal to $+1+0+0+0 = 1$. The aggregate demand is equal to the total demand at that price and all higher prices. For example the aggregate demand at the price of 19 is 26: (Demand at 20) + (Demand at 19) = 26 units. The clearing price is the highest price at which the cumulative demand equals the supply. In this case, the cumulative demand equals the supply at price equal 19.

The allocations and profits of the participants are as follows:

			Participants		
Price	A	B	C	D	E
Allocation	21	0	3	2	0
Profit	1*0+20*1=20	0	1*3=3	2*1=2	0

Since the resale value of the bond for each player is 20, each player makes a positive profit for each unit that he/she buys at a price below 20. Player A receives one unit that he demanded at price 20 and pays 20 for it, and receives 20 units at price 19, and hence his profit is 20.

Questionnaire

1. I choose to participate in the auction of firm: (circle the appropriate answer)
   a. "A" Uniform Price Mechanism
   b. "B" Discriminatory Price Mechanism
   c. I am totally indifferent between participating in each of the two mechanisms
   d. I prefer not to participate in any of the suggested mechanism.

If your answer is either a or b please continue to question number 3 if your answer is c please continue to question 2 and if your answer is d please continue to question 4.

2. Please randomly select between the mechanisms. Your random selection is
   _____

Now continue to question 3

3. My bids are:

Price	Quantity Demanded
20	
19	
18	
17	

4. I believe that most of the participant will choose: A / B / indifferent

5. Gender:

   a. Female
   b. Male

6. Did you ever participate in financial assets' auction?
   a. Yes
   b. No

7. Years of work experience in financial markets_____