Underwriting Government Debt Auctions[1]

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Abstract

We examine a novel two-stage mechanism for selling government securities, wherein the dealers underwrite in the first stage the sale of securities, which are auctioned in stage 2, via either a Discriminatory Auction (DA) or a Uniform Price Auction (UPA). Using proprietary data on auctions during 2006-2012, we find under DAs (a) The underwriting commissions are higher and exhibit more volatility, (b) Stage 1 award concentrations are higher, and (c) Stage 2 bid-shading and the degree of underpricing are higher. Stage 1 outcomes are powerful in explaining Stage 2 auction outcomes including the likelihood of devolvement, and bid shading.

1 Introduction

Auctions of government securities (or "Treasurys") are by far the largest class of auctions in the world, widely used across the globe to sell hundreds of billions of dollars worth of securities annually. Even in large and liquid markets, however, these auctions sometimes fail—for instance, the Chinese treasury auction on June 23, 2015, of Rmb26 billion attracted total bids of only Rmb25.16 billion, the second time this had happened within a year[1]—and fear of auction failures has begun to haunt even the most developed markets.[2] Alongside fear of failure has been a persistent concern of possible collusion among bidders leading to subpar outcomes for the seller even when auctions do not fail.[3]

In this paper, we study a unique variant on standard Treasury auctions from India that addresses both of these concerns. The mechanism is one in which the issuer obtains insurance against auction failure as well as unsatisfactory auction outcomes (which may be the result of collusive behavior or simply poor market conditions). The providers of this insurance are precisely the primary dealers in the main auction, and the insurance is obtained from them via a competitive *underwriting auction* which precedes the main auction. This concatenation of auctions generates a number of questions of economic interest including the impact of competitive underwriting, especially information production in the underwriting auction and its impact on main auction outcomes outcomes and behavior in the main auction, as well as the costs and benefits of insurance; and a novel twist on an issue of traditional interest in auction theory: the differential impact of uniform-price versus discriminatory auction forms (UPAs vs DAs).[4] Our analysis of these questions is facilitated by a proprietary dataset obtained from India's central bank, the Reserve Bank of India (RBI).

[1]See "China treasury bond auction failure raises concerns on debt plan," *Financial Times*, June 24, 2015; http://www.ft.com/cms/s0/00129228-1a3c-11e5a130-2e7db721f996.html#axzz4Dvegvzos.

[2]In January 2016, a UK auction attracted barely enough bids to cover the amount on offer; the bid-to-cover ratio was the lowest since the last UK auction failure in 2009. (See, e.g., http://www.bloomberg.com/news/articles/2016-01-26/u-k-flirts-with-failed-debt-auction-as-analysts-wince-at-depth.) More recently, bond market volatility and Brexit-related issues have fed into fears of UK auction failures. See, e.g., https://www.ft.com/content/02181264-dc92-11e5-827d-4dfbe0213e07 or http://www.wsj.com/articles/u-k-government-bond-auction-could-fail-on-volatility-says-dmo-head-1433772690. For concerns in the US auction markets, see http://seekingalpha.com/article/3988056-failure-looks-like-10-year-treasury-auction-edition.)

[3]A recent investor lawsuit in the US alleges, for example, that fully 69% of all treasury auctions appear to have "suspicious" outcomes based on the same analytical techniques that exposed the Libor fixing scandal. See http://www.bloomberg.com/news/articles/2015-09-17/primary-dealers-rigged-treasury-auctions-investor-lawsuit-says.

[4]Government security auctions worldwide commonly use one of two structures. In a *discriminatory auction* (DA), winning bids are filled at the bid price; that is, the demands of the bidders are met by starting with the highest-price bidder down, until the entire quantity is exhausted. In a *uniform-price auction* (UPA), winning bidders pay a flat price, called the *stop-out price* for each unit they receive; the stop-out price is simply the lowest winning price, i.e., the maximum price at which the aggregate demand equals the supply being auctioned. A substantial literature has examined the theoretical implications and empirical performance of these auction forms, in particular, the possible dominance, from the seller's viewpoint, of one auction over the other. We briefly review this literature in Section 2.

A detailed description of the two-stage mechanism with an example is presented in Section 3, but here is a brief summary. In the first stage, the RBI, as debt manager, auctions the *underwriting* of the aggregate amount of the securities on offer. All primary dealers must mandatorily participate in the underwriting auction. This underwriting auction is discriminatory in style; its outcome determines the number of winning underwriters, the amount each winning entity underwrites, and the fees ("commission") received for providing these underwriting services. Upon completion of the underwriting auction, the results are announced, and the second stage, the actual auction of the debt, commences. This second stage auction is either a DA or a UPA (the form is announced in advance of the underwriting auction), and participants in this stage include the primary dealers as well as other financial market participants. Outcomes in this second stage are determined in the usual fashion—but with an important caveat: the RBI may, at its discretion, ignore all or part of the second-stage submissions, exercise its insurance option, and "devolve" any or all of the auctioned quantity to the winning underwriters in the first stage.

The economics of this two-stage auction forms our focus in this paper. The framework that informs our analysis is straightforward. By obtaining insurance via the underwriting, the government gains an option, the right to "put" any part of the supply in Stage 2 back to bidders in the event of unsatisfactory second stage outcomes such as insufficient demand. (We note that over the period of our study, this right was exercised by the RBI in over 8% of the auctions.) Set against this benefit are the costs of obtaining this insurance. The direct costs are the underwriting commissions paid, the magnitude of which depends on bidding behavior in the underwriting auction, behavior that will in turn depend on a number of factors including the anticipated strength of demand in the second round and the possibility of devolvement, whether the main auction is a UPA or a DA, and so on. In addition, there may be indirect costs in the form of "bid shading" by participants in the main auction, the extent of which may depend on whether the bidder is also a winner in the underwriting auction, whether the main auction is a DA or a UPA, the nature of information revealed in the underwriting auction, and so on.

Motivated by these considerations, there are two broad sets of questions we investigate in this paper. First, we examine the differential impact on auction outcomes of the second stage auction being a DA versus a UPA; we are interested in both the impact this choice has on first stage underwriting auction behavior and outcomes, as well as the broader question of whether from the seller's standpoint one auction form dominates the other. Second, we study the informational impact of the first-stage underwriting auction outcomes on second-stage behavior and outcomes, in particular, the extent to which first stage behavior and outcomes presage second-stage behavior and outcomes including the strength of second-stage demand, the extent of bid shading in the second stage, the likelihood of devolvement following the second stage, and how second-stage bidding behavior is affected by being a "winner" in the underwriting auction. We also examine whether and to what degree "underpricing," a widely-documented phenomenon in other Treasury auction markets, obtains here.

Theory and intuition offer some guide to what we might expect to find. Treasury auc-

tions, like all common value auctions, are subject to a "winner's curse" effect,[5] which induces auction participants to "shade" their bids. An argument going back at least to Friedman (1963), and demonstrated formally in Milgrom and Webber (1982) in the context of single-unit auctions, notes that the winner's curse stings less—and so participants in a common value auction are likely to bid more aggressively—under a UPA than a DA.[6] To the extent that this argument may be applied to Treasury auctions (which are multiple-unit auctions), the lower level of bid shading should, *ceteris paribus*, lead to a lower probability of devolvement; in turn, this implies we should observe lower underwriting commission rates demanded in Stage 1 when the second-stage is a UPA compared to a DA. Further, bids in the underwriting auction will depend on anticipated behavior and outcomes in the main auction; for instance, anticipated weak demand in the second stage would be reflected in more conservative bids in the form of higher commission rates demanded for underwriting. More generally, higher first-stage commission rates should, *ceteris paribus*, be associated with discriminatory auctions, weaker second stage demand, greater bid-shading and a higher probability of devolvement.

Utilizing a proprietary data set obtained from the RBI that covers 494 auctions of government securities in India from 2006-2012, we find this intuition resoundingly confirmed. Underwriting commissions for DAs are significantly (more than *six* times) higher on average and exhibit more volatility than those for UPAs. Award concentrations in Stage 1 are also higher for DAs. So, importantly, are second-stage bid shading and consequent main auction underpricing.[7] (It is useful to emphasize that the duration risk of the securities auctioned did not differ across the two auction formats in our sample.)

The greater bid-shading we find under DAs suggests that perhaps the benefits of obtaining underwriting insurance (the ability to "put" the securities to winning underwriters) may be greater for DAs than UPAs. And, indeed, we find that while devolvements in our sample occur across both formats, proportionately almost twice as many DAs were devolved (13.2%) as UPAs (7.4%). We undertake a monetary measure of the benefits in each devolved auction by comparing the revenues obtained by the government under devolvement to what it would have obtained without devolvement. We find that the average benefits per auction are almost three times higher under DAs than under UPAs. However, this is insufficient to offset the higher underwriting costs under DAs, which are, as we noted, on average more than *six* times higher than under UPAs. As a consequence, while the average *net* benefit per UPA is INR +4.8 million, there is a small net *loss* of INR 1 million on average for DAs. These results

[5]By definition the winning bids are the most optimistic of the submitted bids, This means the expected value of the object being sold conditional on everyone's information is less than the expected value conditional on the information of only the winning bidder. This is the "winner's curse."

[6]Or, more accurately, under a second-price auction (the analog of UPAs in the single unit case) than under a first-price auction (the analog of DAs). The work of Wilson (1979), Back and Zender (1993) and others suggests a more nuanced set of possibilities obtains in multiple-unit auctions; see Section 2 for a review of the literature.

[7]These results on award concentrations are similar to the evidence presented in Malvey, et al (1992) which was one of the reasons cited for the U.S. Treasury's decision to switch from DAs to UPAs.

collectively lend support to the policy view that UPAs may better serve the interest of the seller in this two-stage mechanism than DAs. Aggregated over both auction forms, we find that the underwriting scheme has roughly broken even overall over the 6+ years of our study with a small average net benefit per auction of INR +2.1 million.

Turning to the impact of the first stage underwriting auction on the second stage behavior and outcomes, we find strong evidence that underwriting auction outcomes predict the nature of the second-stage selling outcomes, such as devolvements, bid-shading and underpricing. We find that the bid shading by primary dealers in the main auction is, *ceteris paribus*, larger the more "pessimistic" are underwriting auction outcomes (especially, a higher underwriting auction cut-off price); bid shading is also greater the larger the amount underwritten in the first round, and is larger under DAs than UPAs. These results are obtained after controlling for information in pre-auction secondary market prices, which are trumped by information revealed in the underwriting auction. They are also economically significant; for example, one standard deviation increase in the amount underwritten increases bid shading by about 3.4%.

Measures of information produced in the first stage auction are also statistically and economically significant in explaining the strength of demand and the probability of devolvement in the second stage auction. In particular, measures of aggressiveness of the underwriting bids (such as the stop-out yields) and bidder uncertainty in the first stage auction matter. And once again, these auction-related variables trump measures constructed from secondary market information such as volume of trading prior to bidding in explaining the outcomes in stage 2 auctions.

Finally, a long literature in Treasury auctions has found evidence of "underpricing" in the auction (relative to market prices), a phenomenon commonly attributed to bid-shading caused by winner's curse fears. Consistent with this literature, we too find evidence of underpricing in the main auction: Pre-auction prices are systematically higher than the equilibrium prices at which the second stage auctions clear the supply, as are post-auction prices. This leads to a "V" shape reminiscent of the results in the auctions concessions literature, as in Lou, Yan and Zhang (2011). We find that the shoulders of the "V" shape are explained by the information produced in the first stage auction, and they improve the explanatory power well beyond other measures which rely only on secondary markets data.

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 describes the auction process. Section 4 describes the data, defines the variables of interest in our analysis, and provides summary statistics. Section 5 presents our results. Section 6 concludes.

2 Related Literature

The literature on auction theory and empirical work in Treasury auctions is extensive. A question of particular interest in this literature has been whether uniform-price auctions

(UPAs) dominate discriminatory auctions (DAs) from the seller's perspective. For auctions of a single indivisible unit, Milgrom and Weber (1982) and others have shown that second-price sealed bid auctions (the analog of UPAs) strictly dominate first-price sealed bid auctions. A fundamental reason is the impact the auction form has on the winner's curse. In unit auctions, winning implies that the conditional value of the good upon winning will be updated to a lower value relative to unconditional expectation. Rational bidders take this winner's curse into account and shade their bids. The extent of bid shading will depend on the precision of the signals that they have about the good that is being auctioned, but *ceteris paribus* will be lower for second-price auctions than for first-price auctions, as intuition suggests. Based on this intuition, a long line of authors from Friedman (1963) to Chari and Webber (1992) has made the argument that UPAs will generate more revenue for the seller than UPAs. However, theoretical support for this position is mixed: Treasury auctions are divisible good auctions, and the work of Wilson (1979) and Back and Zender (1992) suggests that a more nuanced set of outcome possibilities than in unit auctions.[8] More recently, however, Goldreich (2007) has offered a set of conditions under which UPAs do dominate DAs.

A substantial empirical literature has also explored the implications of auction theories in the context of Government securities auctions. Related work includes Boyarchenko et al (2015), Hortascu and Kastl (2012), Hortascu and McAdams (2012), Keloharju, Nyborg, Rydqvist (2005), Nyborg and Sundaresan (1996), and Nyborg, Rydqvist and Sundaresan (2002), among others. In the United States, the Treasury ran an experiment in which it simultaneously used both DAs and UPAs in its monthly auctions of two-year and five-year debt securities for a period of time. In the report prepared by the Treasury, which summarizes the results of the experiment, Malvey, Archibald and Flynn (1998), arrive at a number of conclusions, which offer a useful perspective for our paper. First, the report concluded that under UPAs, auction bids exhibited much higher variability, as the bidders do not have to necessarily pay their most aggressive bids. In contrast, DAs produced bids which were more tightly clustered. This is very much consistent with auction theory. In addition, the report found that the bidders in UPAs diversified their bids more by submitting additional price-quantity pairs in their demand curve. This, in part, contributed to a reduction in the award concentration. Finally, the bid shading, as measured by the difference between the auction clearing yield and the when-issued yield just prior to bidding was close to zero across all UPAs but was positive for DAs. The last result was also found by Nyborg and Sundaresan (1995). In part the last result was also driven by the higher volatility of bids in the uniform price auctions. (The work by Hortacsu and McAdams (2012) however suggests that a switch from Discriminatory to Uniform price auctions may not produce significant gains to the seller.)

[8] In such auctions, Ausubel (1997) has identified the problem of "champion's plague": the more the bidder wins in auction, the worse off the bidder is. A rational bidder in a multi-unit auction will reflect these economics by lowering the demand curve.

3 Institutional Description of the Two-Stage Auction

The auction of Government of India securities is conducted by India's central bank, the Reserve Bank of India (RBI). Each year, the RBI issues calendars of auctions in March and September listing the auctions to be held during, respectively, the first and second halves of the financial year. The calendars provide, for each auction, a 6-to-7 day time frame within which the auction will be conducted, the amount that will be auctioned (called the "notified amount"), and the maturity bucket of the auction (e.g., 5-9 years, 10-14 years, etc.). The auctions could be for new issues or for "re-issues," that is, for the further issue of a specified amount of an already existing security. Auctions are typically held on Fridays; the precise details of the security being auctioned are made available the preceding Monday and settlement takes place on the Monday following the auction.

What makes the auction distinctive is its use of a two-stage structure with an "underwriting auction" preceding the main auction. The underwriting auction is held the day before the main auction (so typically on a Thursday) and the entire notified amount of the main auction is underwritten at this point by the primary dealers, all of whom are required to participate in the underwriting auction. The underwriting auction determines (i) how much of the main auction's notified amount will be backstopped by each of the participating dealers, and (ii) how much each primary dealer will receive as underwriting commission for providing this backstop. Underwriting involves nontrivial risk: the RBI has the right, exercised at its discretion, to disregard the bids received in the second-stage main auction and "devolve" the entire notified amount to the primary dealers according to their first-stage backstopping commitments at a price determined by the RBI; the situation is akin to one where the auctioneer has a (secret) "reserve price" and exercises the devolvement right if demand in the main auction is insufficient to reach this reserve price. We describe below both the underwriting and the main auctions.

The Underwriting Auction

The underwriting part of the auction has two components to it. First, all primary dealers are subject to a mandatory *minimum underwriting commitment* or MUC. The commitment amount is the same across all dealers, irrespective of differences in their capital or balance sheet size.[9]. The MUC is chosen such that aggregated across all dealers, the total commitment is at least 50% of the notified amount. For example, through much of the period of our study, there were 17 primary dealers, so the typical MUC was around 3% of the notified amount per dealer.[10]

[9]See, Revised Scheme for Underwriting Commitment and Liquidity Support, RBI document, Money, Banking and Finance, Volume 77, May 2006. Most of the institutional details are derived from RBI publications. See also Sahana and Ghose (2012).

[10]Currently (November 2014), there are 20 primary dealers, and the MUC per dealer is typically 2.50% of the notified amount.

The second component is the auction part. All primary dealers are required to submit bids for *additional competitive underwriting* or ACUs for the remaining 50%. A bid is a quantity-commission pair denoting the commission rate—i.e., the compensation—the dealer wants for underwriting the specified quantity. Each dealer may submit multiple bids (effectively, may submit an underwriting supply curve), but there are two constraints specifying limits on the total quantity bid. Each dealer must bid for a *minimum* total quantity in the ACU; this minimum is set to be the same across all dealers and is again chosen so that the total bids amount to at least 50% of the notified amount. For instance, through much of the period of our study, there were 17 primary dealers, so the minimum quantity each dealer had to bid for in the ACU was around 3% of the notified amount. In addition, there is a *maximum* cap: the total bids submitted by a dealer cannot exceed 30% of the notified amount.

The underwriting commissions are worked out separately for the MUC and ACU parts. For the ACU, the commission rates are determined by the auction. The rules specify that

> The auctions could be either uniform price-based or multiple price-based [i.e., discriminatory] depending upon the market conditions and other relevant factors, which will be announced before the underwriting auction for each issue.[11]

In practice, however, the ACU auctions have followed a discriminatory format. Organizing the submitted quantity-commission rate pairs in ascending order by commission rate, the cut-off commission rate is determined as the smallest commission rate at which the total submitted quantity equals or exceeds the amount to be filled via the ACUs, i.e., the amount not underwritten by the MUCs. (Since the total ACU bids submitted are required, by construction, to exceed the amount not underwritten by the MUCs, there is no risk of a underwriting shortfall.) Commission rates for the ACU are then allocated accordingly.

For the MUC component, the RBI compensates the dealers differentially depending on how aggressively they bid in the ACU auction. Those dealers who win 4% or more of the notified amount in the ACU get a commission on their MUC amount equal to the weighted average of *all the accepted* bids in the ACU. All other dealers will receive a commission on their MUC equal to the weighted average rate of the *three lowest* bids in the ACU.

The Main Auction

The main auction of the notified amount is itself a standard government securities auction in many respects. As with other treasury auctions worldwide. the auction may be a uniform-price or discriminatory auction; the auction format that will be followed is announced in advance of the auction (typically on the Monday of the week the auction is conducted). Our data set consists of both discriminatory auctions and uniform-price auctions; the latter are much more preponderant in the data during our period of study, accounting for just under three-quarters of all auctions (420 out of 565). This leaves in the data with over 140

[11] See `http://www.rbi.org.in/scripts/NotificationUser.aspx?Id=2804&Mode=0`

discriminatory auctions, giving us a unique opportunity to explore how dealers underwrite securities under two very different auction mechanisms.

Secondly, again as is not uncommon in treasury auctions worldwide, the auction could be for the issue of a new security or for the "reissue" of an existing security (i.e., for the sale of a further quantity of a previously-issued security).[12] Our data base consists of both new issues and re-issues. Auctions for new issues are conducted on a yield basis (i.e., bids are yield-quantity pairs) while auctions of re-issues are conducted on a price basis (bids are price-quantity pairs).

Finally, there is one wrinkle on the standard formats. Each primary dealer is required to bid for an amount in the main auction at least equal to the amount of the dealer's commitment in the ACU and MUC combined. Since the entire notified amount has been underwritten, requiring each dealer to bid at least its underwritten amount ensures there is no danger of the auction failing—there is always adequate demand in the main auction to take up the entire notified amount. Nonetheless, the RBI retains the right to disregard any or all of the bids received in the main auction, and instead to devolve any balance amount to the primary dealers according to their underwriting commitments, and at a price that is set by the RBI.

An Example

In September 20xx, the RBI conducted a discriminatory auction for the re-issue of INR 50 billion of a 10-year bond issued April 20xx and maturing April 20yy. This was a re-issue, and hence the auction was conducted on a price basis.

In the underwriting stage, the aggregate MUC amount was INR 25 billion and the ACU underwriting auction for the remaining 25 billion. A total of 19 primary dealers participated in the auction. The ACU underwriting auction saw a total 49 bids (quantity-commission rate pairs) submitted, representing a total quantity of INR 60.85 billion, well above the INR 25 billion to be underwritten. The lowest commission rate submitted was INR 0.000018 (per INR 100 face value of bonds) for a quantity of INR 200 million, while the highest submitted commission rate was over 50 times higher at INR 0.001 per INR 100 face value. The bids included one for a quantity of INR 14 billion (28% of the entire notified amount) by a single bidder at a commission rate of 0.000037, which turned out to be the cut-off commission rate. The aggregate underwriting supply curve is pictured in the upper panel of Figure 1; the large flat segment around the cut-off represents the INR 14 billion submission; INR 13.50 billion of this bid was met, representing 27% of the entire notified amount of the auction. Note

[12]For example, all four auctions conducted by the RBI on September 19, 2014, were for re-issues of existing bonds—INR 20 billion in face value of the 8.27% bond originally issued June 9, 2014 and maturing June 9, 2020; INR 60 billion in face value of the 8.40% bond originally issued July 28, 2014 and maturing July 28, 2024; INR 20 billion in face value of the 8.32% bond originally issued August 2, 2007 and maturing August 2, 2032; and INR 20 billion in face value of the 9.23% bond originally issued December 23, 2014 and maturing December 23, 2043.

the sharp steepening of the curve a bit further down. The weighted-average commission rate of all successful bids—which was the commission rate for the MUC for those dealers who underwrote at least 4% of the notified amount in the ACU underwriting auction—was roughly INR 0.000033 per INR 100 face value, while the weighted average commission rate of the three lowest bids—used as the MUC commission rate for all other dealers—worked out to only 60% of this amount at INR 0.000020 per INR 100 face value.

In the main auction on September 20xx, a total of 225 bids representing an aggregate quantity of INR 106 billion—well in excess of the INR 50 billion on offer—were received, ranging from a high bid of INR 100.15 for a quantity of INR 100 million to a low bid of INR 97 for a quantity of INR 1 billion. (Bids are for INR 100 in face value.) The aggregate demand curve is pictured in the lower panel of Figure 1; as in the underwriting auction, the aggregate curve (here, a demand curve) steepens sharply beyond a point. The cut-off was reached at a price of INR 99.58.

4 The Data and Summary Statistics

This section describes the data set, defines the variables of interest in our analysis and presents summary statistics.

4.1 Data

Our data set has two components: primary market auction data and secondary market trading data. Both sets of data were received from the Centre for Advanced Financial Research and Learning (CAFRAL), a research wing of the RBI. The primary market dataset has two components, the first stage underwriting auction that determines underwriting commissions and quantities, and the associated second stage main auction for the government securities. For each auction, We have all the basic information such as auction date, notified amount of the government bond being auctioned, its maturity date and coupon rate, the number of primary dealers participating, individual price quantity pair bids by each bidders in the underwriting as well as in the main auction.

The identities of the primary dealers and other bidders are masked but in a consistent way across auctions that enables us to follow the bidding behavior of each primary dealer across the first stage (underwriting) auction and the second stage (bond) auction for the same issue.Our total database covers 494 auctions of government securities over the period 2006- 2012. The secondary market data contains intra-day trading information (prices and quantities) for each trade for each bond. We have secondary market trading price and volume information for the bonds in 452 of the 494 auctions.

We observe the complete supply curve (commission rate-quantity pairs) submitted by each dealer in the ACU auction, and thereby, the cut-off commission rate at which the entire auctioned quantity is underwritten, as well as the commissions received by each primary

dealer as ACU commission and MUC commission. The availability of this data enables us to compute an important component of the costs of underwriting the sale of government securities.

The second stage auction may be, also as noted in Section 3, uniform-price or discriminatory in style. Of the 494 auctions in our dataset, 403 were of the uniform price format and 91 were discriminatory. For each auction, we observe the entire demand curve (price-quantity pairs) submitted by each bidder, and the cut-off auction price, the highest price at which demand equals or exceeds supply. A total of 42 of these auctions ended up being devolved by the RBI. For the devolved auctions, we also observe the devolvement price set by the RBI and the quantity devolved to each primary dealer. For each devolved auction, we also calculate the price at which the auction would have cleared the entire supply had devolvement not occurred. (Since each of the primary dealers is required, in the main auction, to bid for an amount at least equal to the amount underwritten by them, the total demand always equals at least 100% of the notified amount (i.e., the amount being auctioned), so this hypothetical clearing price is always well-defined.)

4.2 Summary Statistics & Non-parametric Results

Tables 1 and 2 provide some basic summary statistics across the auctions in our data set. They highlight some important points. Devolvement is more common when the main auction is a DA than a UPA; 12 out of 91 (or roughly 13.2%) of DAs were devolved compared to 30 out of 403 (about 7.4%) of UPAs. And strikingly, when the second-stage auction is a DA, the average underwriting commission cut-off in the first stage is, at 13 basis points, more than *six times* higher than the corresponding number when the second-stage auction is a UPA.

Figure 3 provides kernel densities for selected Stage 1 and Stage 2 outcomes. The figure makes several points. The top left panel shows that the underwriting allocations in stage 1 are much more concentrated when Stage 2 auctions are DAs compared to when they are UPAs. The top right panel shows that the average underwriting cut-off rates are much more skewed to the right when the Stage 2 format is a DA; the underwriting cut-off rates are also much higher when the Stage 2 auction format is a DA. These findings are consistent with the intuition expressed in the Introduction that, anticipating higher bid-shading under discriminatory auctions (and thence a greater probability of devolvement), primary dealers will demand higher underwriting premium if the second stage is a DA. Primary dealers are also asymmetric in terms of their inventory holding capacity in case of a devolvement; for example, Bank PDs can absorb some of their inventory towards reserve requirements. In turn, this may lead to the wider variability of underwriting bids documented in table 2, and to concentrated underwriting allocation as in the top left panel.

That Stage 2 bid-shading is significantly higher when the auction format is a DA is confirmed in the lower left panel of Figure 3. The lower right panel looks at devolved auctions and the difference between the actual price (at which devolvement occurred) and

the the counterfactual price (that would have prevailed had devolvement not taken place). As anticipated, this difference is much larger for DAs. Overall Figure 3 supports the hypothesis that the DA format not only makes the second stage less competitive but has a significant effect on the level of competition of the first stage too.

Table 3 provides the names of the primary dealers (PDs) who were active in mid-2014. (There are 20 PDs during this period; through much of the period of our study, the number of primary dealers was a bit smaller at around 16-18.) The PDs are classified as either standalone primary dealer (Standalone PD) or bank primary dealer (Bank PD). Bank PDs are those primary dealers who also provide other banking services in India. Our masked identities include information on whether a primary dealer is a Bank PD or a Standalone PD. The distinction is important because Bank PDs may use the amount of government bonds won in an auction towards meeting their "statutory liquidity ratio" or SLR, the reserve requirement that commercial banks in India are required to maintain with the RBI. The ability to buy in the auction to fulfill the SLR may induce the Bank PDs to bid differently from the Standalone PDs. We explore this possibility later in our analysis.

Key Economic Variables of Interest

Table 4 describes the key economic variables of interest that we use as dependent variables in our various regressions. There are four key ones: a devolvement dummy, the bid-cover ratio, the degree of bid shading by an individual dealer, and the degree of auction underpricing. Section 5.1 uses a logistic regression with a devolvement dummy to estimate the probability of devolvement. Section 5.2 uses the bid-to-cover ratio (the total volume of bids submitted at all prices to the notified amount, i.e., the amount being auctioned) as a measure of the strength of demand in the main auction. Section 5.3 examines bid-shading at the dealer level defined as

$$1 - \frac{\text{value-weighted average bid}}{P_{t+2}},$$

where "value-weighted average bid" is computed from the bids submitted by that dealer in that auction and P_{t+2} is the post-auction secondary market price measured two days after the auction. (That is, a lower submitted value-weighted average bid relative to the post-auction secondary market price corresponds to a greater degree of bid shading.) Finally, Section 5.4 looks at the degree of underpricing resulting in the main auction, defined as

$$\ln\left(\frac{P_{t+2}}{\text{Auction Stop-out Price}}\right) .$$

That is, a lower auction-identified price relative to the post-auction secondary market price corresponds to a greater degree of underpricing[13]

[13]For discriminatory auctions, the measure for underpricing is:

$$\ln\left(\frac{P_{t+2}}{\text{Weighted average of winning prices in the auction}}\right) .$$

Table 5 provides summary statistics on these variables. On average, there is bid shading of about 0.9 basis points and underpricing of about 0.21 basis points per INR 100 in face value. But the data reveals wide variability across auction formats. In particular, and as a branch of auction theory has long predicted (going back at least to Friedman (1963)), discriminatory auctions result in a substantially greater degree of bid-shading and underpricing relative to uniform-price auctions. Similarly and unsurprisingly, auctions that were ex-post devolved were associated with a much greater degree of bid-shading and underpricing that those that turned out successful.

Independent Variables

Table 6 defines the right-hand side variables we use in our regressions, listed alphabetically.[14] The variables fall into three groups.

The first group consists of numbers that characterize the auction, such as the notified amount (the amount being auctioned), the time-to-maturity of the bond being auctioned, and the number of bidders participating in the main auction.

The second group comprises outcomes of the underwriting auction: the underwriting cut-off price, the variance of the submitted bids in the underwriting auction, and amount "won" by each dealer (i.e., the amount underwritten in the ACU auction). A greater variance of the submitted bids in the underwriting auction suggests a larger range of opinions among the dealers concerning the main auction, and so perhaps increases the winner's curse.

The final group of variables is data from secondary markets (both pre- and post-auction). Since the underwriting auction is held the day before the main auction, for pre-auction data, we use data from two days before the main auction. For consistency, we do the same for post-auction data (i.e., use data from two days after the auction), but our results are unaffected if we use data from the day after the auction instead. The secondary market data used in our analysis includes the pre- and post-auction market prices (defined as the value-weighted price obtained from all trades on that day), the volume of trading (measured in INR billions), and the standard deviation of intra-day pre-auction prices (calculated using all trades on that day). The last variable is a proxy for the winner's curse effect; a larger standard deviation implies a larger range of opinions concerning the correct market price.

Table 7 provides summary statistics on each of these variables.

5 Regression Analysis

As we noted in the Introduction, our main expectations, based on the extant theoretical literature, are twofold. First, we expect first stage-underwriting auction outcomes to be in-

[14]We also examined the impact of several other variables but found that they were insignificant and did not affect the results in any way, so in the interest of brevity, we do not describe them here.

formative about key outcomes in the second stage main auction, in particular, concerning the likelihood of devolvement, strength of main auction demand, and second-stage bid shading and auction underpricing. Second, we anticipate that when the second stage is a DA, rather than a UPA, bidding will be less aggressive, there will be more bid shading and greater auction underpricing, and involve higher underwriting commission rates. The descriptive statistics in the last section and the kernel density plots provided some evidence of the last set of hypotheses. We build on that evidence here using regression analysis.

Sections 5.1 and 5.2 look, respectively, at the probability of devolvement and strength of main-auction demand, and establish the key role of the underwriting auction in information production. Potential bid-shading at the dealer level is the subject of Section 5.3, while Section 5.4 looks at underpricing in the main auction relative to secondary market prices. Finally, Section 5.5 looks at the overall economics of the auction with an eye, especially, to comparing the outcomes under DAs and UPAs.

5.1 The Likelihood of Devolvement

A key question underpinning our analysis is the the information content of the underwriting auction: Does the underwriting auction generate information in addition to that already reflected in pre-auction secondary market prices?

Table 8 provides a first answer. The table examines the extent to which the likelihood of devolvement is predicted by outcomes of the underwriting auction. It presents the results of a logistic regression where the dependent variable takes the value 1 if the auction devolved and 0 if was successful (i.e., did not devolve). The independent variables include both pre-auction secondary market variables (the variance of pre-auction market prices and the volume of pre-auction trading) and underwriting auction outcomes (including the variability of ACU bids and the underwriting cut off price), as well as time dummies. Since there was no devolvement in the year 2007, we lose those observations due to the presence of year fixed effect and 420 observations for the final set of regressions.

As the third (and most inclusive) column of the table shows, the only pre-auction or underwriting auction variable that is statistically significant in explaining devolvement is the underwriting cut-off price, and in the expected direction: a higher value of the cut-off increases the probability of devolvement. Other underwriting auction outcome variables lose significance when the underwriting cut-off is included, while the pre-auction information is (as Column 1 shows) even by itself of limited value in explaining devolvement.

The underwriting cut-off price is also economically significant. One percentage point increase in the log underwriting cut-off increases the probability of devolvement by about 5.1%.

5.2 The Strength of Main-Auction Demand

As noted earlier, although the auction rules do not explicitly specify conditions for devolvement, it is reasonable to presume that one driver of the decision to devolve is weak demand in the main auction. Table 9 looks at the strength of demand in the main auction, in particular, the extent to which weakness in demand in the main auction is anticipated by outcomes in the underwriting auction. The dependent variable in the regressions is the bid-to-cover ratio (i.e., the total competitive amount bid relative to the notified amount) in the second stage auction. The independent variables again include both pre-auction secondary market information as well as outcomes in the underwriting auction.

As the table shows, the regression coefficients are fairly similar whether we look at all auctions or only successful ones. Including the underwriting auction information renders the constant term insignificant and increases the adjusted R^2 of the regressions. Two variables play a statistically significant role in predicting the strength of main auction demand. The first is, once again, the underwriting cut-off price. The sign of its coefficient is negative meaning that a higher cut-off price for underwriting is associated with weaker demand in the main auction, which is as expected. The second strongly significant variable is the standard deviation of pre-auction trading, which is a proxy for the secondary market liquidity; its coefficient is, also as expected, positive, meaning that a higher volume (a larger secondary market liquidity) leads to stronger main-auction demand.

The variables are also economically significant. A one standard deviation increase in the log underwriting cut-off commission rate lowers the bid-cover by about 19%. A one standard deviation increase in the proxy of pre-auction secondary market liquidity increases the bid-cover by about 6%.

5.3 Bid Shading in the Main Auction

As auction theory has noted, participants may rationally "shade" their bids in common value auctions in response to the threat of a winner's curse; bid shading may also stem from other sources such as risk-aversion. We measure the degree of bid-shading by a dealer by

$$1 - \frac{\text{value-weighted average bid}}{P_{t+2}},$$

where "value-weighted average bid" is computed using all the bids submitted by the dealer in that auction and P_{t+2} is the post-auction secondary market price measured 2 days after the auction).

Table 5 shows that there is average bid-shading over all dealers and all auctions of around 0.9 basis points (i.e., INR 0.009 per INR 100) in our data. The average degree of bid shading is substantially higher in discriminatory auctions than in uniform-price auctions (1.85 bps versus 0.75 basis points) and in devolved auctions than in successful ones (1.41 bps versus 0.89 basis points).

Table 10 examines the determinants of the degree of bid-shading at the level of the primary dealer. The dependent variable in the regressions is the degree of bid-shading by a dealer; the independent variables include, apart from the ones identified in Table 6, a dummy variable indicating if the bidder is a Bank Primary Dealer (as opposed to a standalone Primary Dealer); as we noted earlier, Bank PDs can use the amount won in the auction towards their statutory liquidity requirements.

Column 4 of the table, the most inclusive one, confirms the key role of the underwriting auction in influencing dealer behavior in the main auction. As the numbers show, the degree of bid shading increases with an increase in the underwriting cut-off and with an increase in the standard deviation of pre-auction secondary market prices, a proxy for the winner's curse. (Puzzlingly, however, the degree of bid-shading decreases with an increase in the variance of ACU bids, another proxy for the winner's course.)

A key variable of interest is the impact of auction format on bid-shading. As we argued earlier that in equilibrium the primary dealers shade their bid more in the discriminatory format which in turn led them to demand more underwriting commission in the first stage. This channel is confirmed here, the uniform auction dummy is significantly negative, signifying that primary dealers shade their bid less in uniform price auction relative to discriminatory format.

The coefficients are also economically significant. A one standard deviation increase in the log of the underwriting cut-off increases the degree of bid shading by 24 basis points, while a similar increase in the standard deviation of secondary market prices increases the degree of bid shading by .45 basis points. A move from discriminatory to uniform price format reduces the bid shading by about 60 basis point.

Besides these, a number of other variables are also significant in explaining bid shading. For instance, bid shading increases with the time-to-maturity of the bond being auctioned (larger duration risk), while a higher volume of pre-auction secondary market trading (greater secondary market liquidity) decreases bid shading. Bid shading also decreases if the dealer is a Bank PD and increases with the amount won in the ACU auction.

5.4 Underpricing in the Main Auction

One potential consequence of bid shading by dealers is underpricing in the main auction (relative to the secondary market price). We measure the degree of underpricing by

$$\ln\left(\frac{P_{t+2}}{\text{Auction Stop-out Price}}\right)$$

Table 5 provided summary statistics on underpricing in our data set[15] The average level of underpricing across all auctions is around 0.21 basis points (i.e., INR 0.0021 per INR 100 face

[15]The results are qualitatively similar if, for discriminatory auctions, we use the weighted average of winning bids in the denominator, rather than the auction stop-out price.

value), and, as auction theory predicts, is substantially higher in discriminatory auctions than in uniform price auctions (0.58 bps versus 0.12 basis points, respectively). Unsurprisingly, the degree of underpricing is also sharply higher in auctions that end up being devolved versus ones that do not (0.53 basis points versus 0.19 basis points, respectively).

Figure 2 compares the average auction-identified price to the averages of both pre- and post-auction secondary market prices (computed two days before and two days after the auction, respectively). The bands represent the mean ± one standard error for each of these quantities. In all the formats of the auctions, the prices depict a striking V-shaped pattern signifying underpricing in the auction relative to both pre- and post-auction secondary market prices. Expressed in rupee terms, the total volume of ex post underpricing is INR 31.48 billion (18.67 basis points of the total notified amount of INR 16,860 billion) while the ex ante measure is INR 30.74 billion (or 18.23 basis points of the total notified amount).

Table 11 looks to identify the determinants of underpricing using both pre-auction and underwriting auction variables on the right-hand side. As in the earlier analyses, the underwriting auction cut-off again emerges as a significant explanatory variable. It is also very economically significant. Using the coefficients in the last column and against an average level of underpricing in our data of 0.21 basis points, a one standard deviation increase in the underwriting cut-off increases underpricing by 0.15 basis points.

In addition, as with bid shading, the time-to-maturity of the bond being auctioned (a measure of duration risk) and the volume of trading in the secondary market (a measure of market liquidity) again emerge as significant drivers of underpricing with the degree of underpricing increasing with an increase in bond duration and decreasing with an increase in secondary market liquidity. The winner's curse proxies however are insignificant.

5.5 The Economics of the Underwriting Auction

Tables 12 and 13 summarize the direct cost and direct realized benefit of the underwriting auction from the RBI's standpoint. In option-theoretic terms, the cost is the premium paid for the option to put the bonds to the dealers and the benefit is the depth-in-the-money of the put when it is exercised.

The direct cost is the total amounts paid as underwriting commission (for both the MUC and the ACU) summed over all the auctions in our data. Table 12 shows that the mean direct costs when the second stage auction is a DA is, at INR 54 million, roughly 6 times the mean direct cost of INR 9 million when it is a UPA.

The direct realized benefit is the extra revenue generated from devolvement, i.e., it is the sum over all devolved auctions of the amount

$$(P_{\text{dev}} - P_{\text{auc}}) \times \text{Devolved Amount} \div 100,$$

where P_{dev} is the price (per INR 100 in face value) at which the devolved amount is devolved and P_{auc} is the auction stop-out price (per INR 100 in face value) that would have

prevailed in the absence of the devolvement. Table 13 shows that the direct realized benefit of underwriting when the second stage is a DA is around INR 13.4 million, about three times the direct realized benefit when the second stage is a UPA.

The final column of Table 13 describes the direct *net* benefits of the underwriting auction, i.e., the direct realized benefits minus the direct costs. While the underwriting auction provides, on average, a small net benefit to the RBI of INR 2.1 million per auction, the net benefit under UPAs is about INR +4.8 million while that under DAs is negative at INR −1 million.

6 Conclusion

In this paper, we analyzed a unique two stage auction process in which the conduct of the main auction is preceded by a first-stage underwriting auction via which the auctioneer obtains insurance against unfavorable outcomes in the second-stage main auction. We find that Stage 1 outcomes differ a great deal depending on whether the Stage 2 auction is a discriminatory auction (DA) or uniform price auction (UPA). Average underwriting premia are significantly higher when DAs are used in stage-2, as is the the concentration of underwriting allocation. DAs also lead to greater bid-shading in the second round and consequent greater auction underpricing. We also find that the first stage underwriting auction outcomes provide significant information about the possible devolvement (tail risk) of the main auction, bid-shading in the second stage, and consequent main auction underpricing. Finally, we find that while DAs lead to average underwriting benefits that are four times higher than under UPAs, they also have direct costs in the form of underwriting premia that are six times higher, and as a result the net benefit to the auctioneer is larger under UPAs than under DAs. Collectively, our results suggest that UPAs may better serve the interests of the seller in this two-stage auction format.

Figure 1: The Auction: An Example

This figure describes the auction of INR 50 billion on September 20xx, as described in the text. The upper panel shows the bids received in the ACU underwriting auction that preceded the main auction. The vertical axis represents the commission rate bid (in INR per INR 100 face value of bonds) and the horizontal axis represents the aggregate quantity of bonds. The ACU underwriting auction was for a total of INR 25 billion as shown in the figure, and as the figure shows, the cut-off commission rate was 0.000037 per INR 100 in face value. The lower panel shows the bids received in the main auction. The vertical axis represents the price bid per INR 100 face value of bonds while the horizontal axis represents the aggregate quantity of bonds. The total volume of bonds being auctioned was INR 50 billion, as shown in the figure, and the cut-off price was INR 99.58.

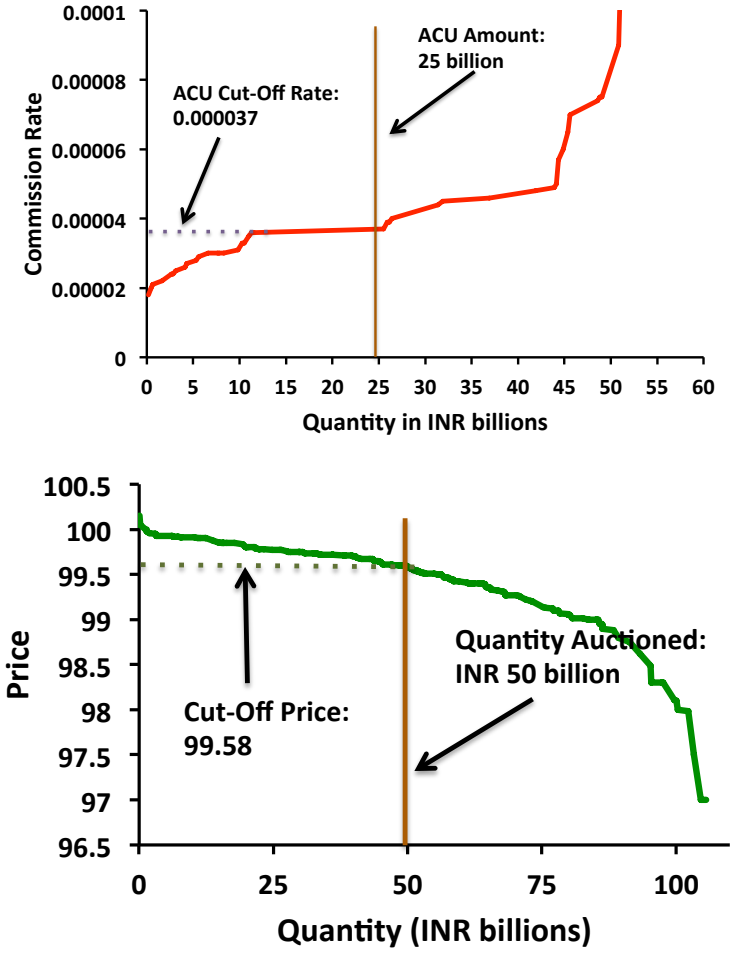

Figure 2: Price Behavior around Auction Day

This figure compares pre- and post-auction value-weighted secondary market prices to the price arising in the auction. The numbers are averaged across all auctions. The bands around each price represent 95% confidence intervals.

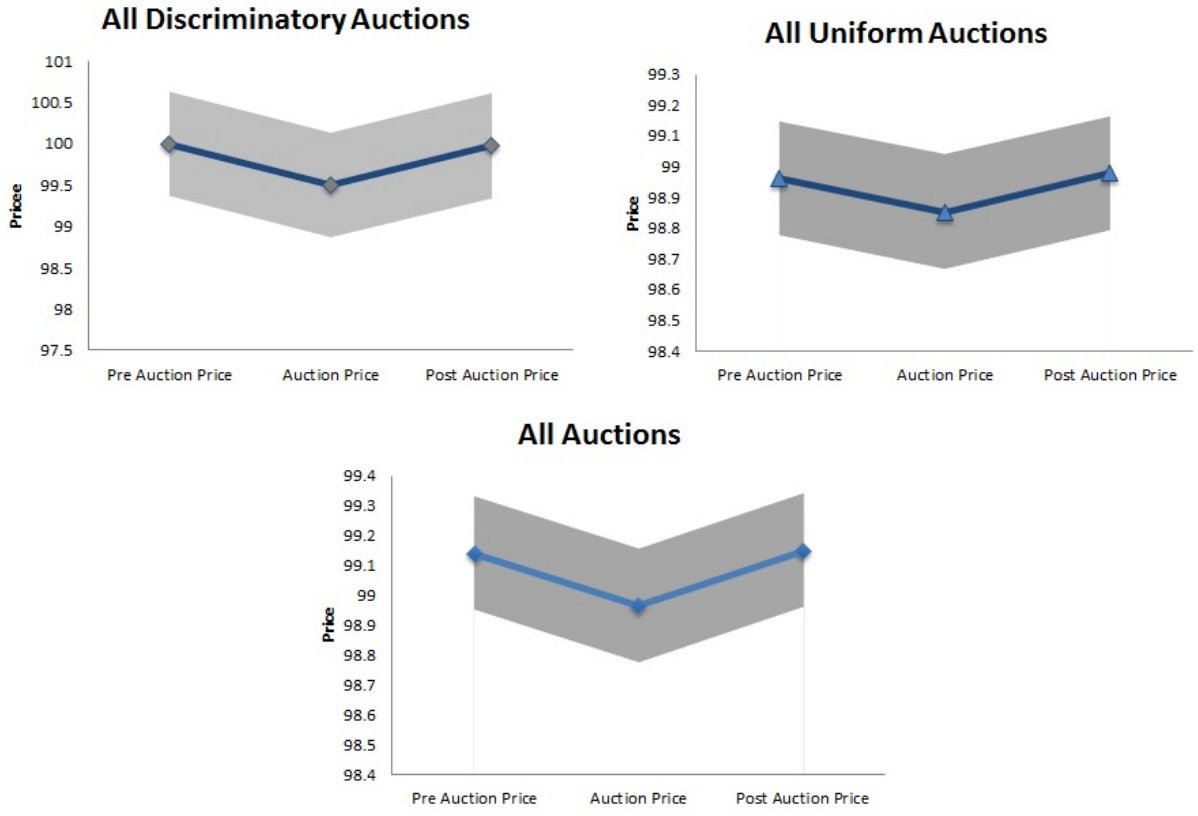

Figure 3: Kernel Densities for Stage-1 and Stage 2 Outcomes

This figure provides kernel densities for selected Stage 1 and Stage 2 outcomes. The two figures in the top panels relate to Stage 1 outcomes; the one on the upper left concerns underwriting allocations, while the one on the upper right concerns average underwriting cut-off rates. The two figures in the bottom panels relate to Stage 2 outcomes; the one on the bottom left looks at bid-shading in the main auction, while the figure on the bottom right compares the actual price to the counterfactual price (that would have obtained had the auction not been devolved) in devolved auctions. Within each of the four figures, the dotted lines corresponds to the second stage auction being a UPA while the solid lines correspond to the second stage being a DA. In all cases, the shaded area represents the bootstrapped standard error.

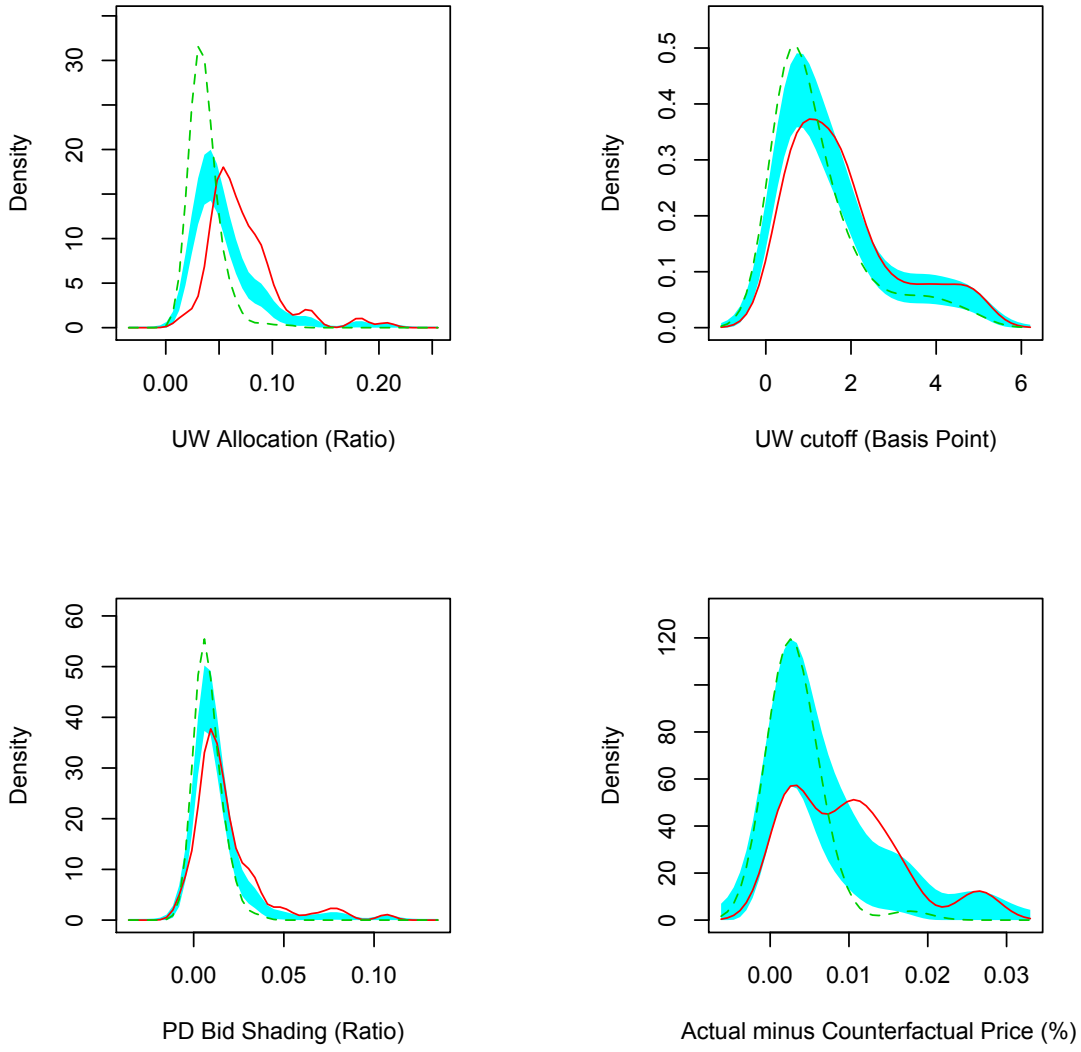

Table 1: Summary Statistics of the Auctions

This table provides summary statistics concerning the auctions in our sample such as the average auction size ("Notified Amount"), number of auctions that were devolved, and the duration of the securities being auctioned. Panel A looks at all 494 auctions in our sample. Panel B looks at that subset of 452 auctions for which we also have secondary market prices of the bonds being auctioned. Note that all 42 devolved auctions are also in Panel B.

	Uniform	Discriminatory	Total
Panel A: All Auctions			
Number of Auctions	403	91	494
Average Notified Amount (INR Billions)	38.8	44.2	39.8
Number of Devolved Auctions	30	12	42
Average Auction Identified Price	98.79	99.22	98.87
Average Duration of Auctioned Security	7.6	8.6	7.8
Panel B: Auctions with Secondary Market Prices			
No of Auctions	372	80	452
Average Notified Amount (INR Billions)	39.2	45.3	40.2
Number of Devolved Auctions	30	12	42
Average Auction Identified Price	98.79	99.12	98.85
Average Duration of Auctioned Security	7.6	8.4	7.7

Table 2: Stage 1 Auction Outcomes

This table provides summary statistics of outcomes in the first stage underwriting auctions in our sample divided into two groups: those underwriting auctions for which the second-stage main auction was a uniform-price auction and those for which it was a discriminatory auction. The underwriting auction outcomes include the underwriting cut-off, i.e., the highest winning underwriting bid; the average underwriting share (measured as a percentage of the total auction notified amount) won by each winning bidder; the average share won by each bidder in the main auction; the average range of underwriting bids, averaged first over individual bidders in an auction, then averaged over the auctions; and the average underwriting bid volatility, i.e., the variance of bids submitted by each individual bidder, averaged over each auction and then averaged over all the auctions.

	Uniform	Discriminatory	Difference
Underwriting Cut-off (bps)	1.98	13.14	11.16***
Underwriting Share (in %)	2.53	6.63	4.10***
Main Auction Share (%)	2.40	2.68	0.28***
Average Underwriting bid range (bps)	1.45	8.72	7.27***
Average Underwriting bid volatility	0.63	3.66	3.03***

*** implies that the difference is significant at the 1% level using the Kolmogorov-Smirnov Test

Table 3: List of Primary Dealers in India: June 13, 2014

This table provides a list of the 20 primary dealers in India as of June 13, 2014, further identified by whether they were also banks or standalone dealers. All primary dealers have to mandatorily participate in the underwriting auction and take on mandatory underwriting commitments, as described in the text. During the period of our sample, the number of primary dealers varied between 17 and 21.

Standalone Primary Dealers	**Bank Primary Dealers**
ICICI Securities Primary Dealership	Bank of America
Morgan Stanley India Primary Dealer	Bank Of Baroda
Nomura Fixed Income Securities	Canara Bank
PNB Gilts	Citibank
SBI DFHI	Corporation Bank
STCI Primary Dealer	HDFC Bank
Goldman Sachs (India) Capital Markets	HSBC
	J P Morgan Chase Bank
	Kotak Mahindra Bank
	Standard Chartered Bank
	Axis Bank
	IDBI Bank
	Deutsche Bank

Table 4: Variable Definitions: Key Economic Variables

This table provides definitions of the key economic variables used in the various regressions in our analysis. As noted in the text, P_{t-2} refers to the value-weighted price in the secondary market two days before the main auction computed using all the market trades in that bond on that day. P_{t+2} is defined similarly, using traded secondary market prices two days after the auction.

Economic Variables	Definitions
devolved	Dummy variable, takes on the value 1 if the auction devolved, and is 0 otherwise
bid cover	Total competitive demand divided by the notified amount
bid shading	1-(value weighted bid submitted by dealer/P_{t+2}).
Underpricing	ln(P_{t+2}/Auction cut-off price)

Table 5: Summary Statistics of Dependent Variables

This table provides summary statistics for the dependent variables used in our analysis in Section 5.3. The variables are defined in Table 4.

All Auctions

	Mean	Median	Std Dev
bid cover	2.37***	2.3***	0.7
bid shading (bps)	0.9***	0.5***	1.86
underpricing (bps)	0.21***	0.13***	0.01

Uniform Price Auctions

	Mean	Median	Std Dev
bid cover	2.27	2.22	0.47
bid shading (bps)	0.75***	0.45***	1.36
underpricing (bps)	0.12***	0.1***	0.4

Discriminatory Price Auctions

	Mean	Median	Std Dev
bid cover	2.58***	2.59***	0.69
bid shading (bps)	1.85***	1.03***	3.24
underpricing (bps)	0.58***	0.33***	1.35

Devolved Auctions

	Mean	Median	Std Dev
bid cover	1.75***	1.72***	0.28
bid shading (bps)	1.41***	0.66***	2.39
underpricing (bps)	0.53	0.11	1.78

Successful Auctions

	Mean	Median	Std Dev
bid cover	2.42***	2.34***	0.57
bid shading (bps)	0.89***	0.5***	1.8
underpricing (bps)	0.19***	0.13***	0.52

Table 6: Variable Definitions: Independent Variables

This table describes the independent variables used in the various regressions in our analysis. As noted, P_{t-2} refers to the value-weighted price in the secondary market two days before the main auction computed using all the market trades in that bond on that day. P_{t+2} is defined similarly, using prices two days after the auction.

Variable Name	Definition
Underwriting Auction Variables	
Underwriting bid Volatility	Standard deviation of ACU bids normalized by Pt-2, the value-weighted price 2 days before the main auction
Underwriting Share	ACU amount won by a primary-dealer bidder in underwriting auction normalized by notified amount
Underwriting Stopout commission rate	(Natural) log of the cutoff price in the underpricing auction
Main Auction Variables	
Auction Supply	(Natural) log of the amount being auctioned measured in INR billions
Auction Competition	The number of bidders in the main (i.e., the second-stage) auction
Duration	The Macaulay duration of the underlying bonds
Secondary Market Variables	
Secondary market volatility	Std dev of secondary market prices 2 days pre-auction computed using all trades and normalized by Pt-2
Pre-Auction Secondary Market Volume	The volume of secondary market trading (measured in INR billions) 2 days before the auction

Table 7: Summary Statistics of Independent Variables

This table provides summary statistics for the independent variables used in our analysis. The variables are defined in Table 6.

	Mean	Median	Std Dev
ACUBids_Var	0.03***	0.02***	0.03
ACU_AmtWon	0.075***	0.04***	0.083
log_UWCutOff	-9***	-9.24***	1.21
log_Ntfd-Amt	3.63***	3.68***	0.35
No of bidders (main auc)	47.26***	47***	9.72
Ntfd-Amt (INR Billions)	40.04***	40***	14.53
Stdev_2daypre	0.0014***	0.0009***	0.0018
Time-to-maturity	13.98***	11***	7.68
UW_SupplyCurveIntercept	0.44***	0.59***	2.37
Volume_2daypost (INR Billions)	13.42***	2.36***	22.91
Volume_2daypre (INR Billions)	13.54***	5.3***	19.34

Table 8: The Determinants of Devolvement

This table describes the results of a logistic regression where the dependent variable is 0 if the auction was successful and 1 if the auction ended up devolving. Robust t-statistics are in the parentheses. As usual, *, **, and *** represent significance at 10%, 5%, and 1% levels, respectively.

	Spec 1	Spec 2	Spec 3	Spec 4
Underwriting bid Volatility			8.931	3.797
			(1.4)	(1.0)
Underwriting stopout commission rate				0.847
				(3.42)***
Uniform Auction Dummy	-0.092	0.428	-0.013	1.292
	(0.2)	(0.6)	(0.0)	(1.69)*
Duration	-0.192	-0.140	-0.139	-0.236
	(2.66)***	(1.75)*	(1.6)	(2.51)**
Auction Supply	2.612	3.479	3.542	2.765
	(3.97)***	(4.48)***	(4.42)***	(3.21)***
Auction Competition	-0.157	-0.166	-0.154	-0.145
	(5.35)***	(4.93)***	(4.60)***	(4.04)***
Secondary market volatility		-94.127	-106.777	-167.490
		(0.8)	(0.9)	(1.3)
Pre-Auction Secondary Market Volume		0.003	0.002	0.017
		(0.2)	(0.2)	(1.1)
Constant	-4.042	-8.221	-8.758	0.812
	(1.6)	(2.80)***	(2.84)***	(0.2)
Year Fixed Effects	Yes	Yes	Yes	Yes
N	493	420	420	420

Table 9: The Underwriting Auction and Main Auction Demand

The following are the OLS regressions about the aggregate demand in the main auction. The dependent variable is the bid cover in each auctions. Robust t-statistics are in the parentheses. As usual, *, **, and *** represent significance at 10%, 5%, and 1% levels, respectively.

	Spec 1	Spec 2	Spec 3	Spec 4
Underwriting bid Volatility				-0.372
				(0.6)
Underwriting stopout commission rate				-0.064
				(2.33)**
Uniform Auction Dummy	-0.183	-0.321	-0.321	-0.384
	(1.4)	(2.39)**	(2.39)**	(2.89)***
Duration	0.008	0.012	0.012	0.018
	(0.6)	(1.0)	(1.0)	(1.5)
Auction Supply	-0.805	-0.847	-0.847	-0.797
	(8.77)***	(8.77)***	(8.77)***	(8.06)***
Auction Competition	0.023	0.027	0.027	0.025
	(5.39)***	(5.81)***	(5.81)***	(5.33)***
Secondary market volatility		-0.001	-0.001	-0.002
		(0.8)	(0.8)	(1.2)
Pre-Auction Secondary Market Volume		-5.555	-5.555	-5.736
		(6.69)***	(6.69)***	(6.74)***
Constant	3.458	3.435	3.435	2.668
	(8.71)***	(7.27)***	(7.27)***	(4.46)***
Year Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R-squared	0.25	0.33	0.33	0.34
N	493	452	452	452

Table 10: Bid Shading by Primary Dealers

This table presents the results of OLS regressions on determinants of the bid shading by primary dealers in the second stage auction. The dependent variable is (1 − value weighted bids/P_{t+2}) by each bidder. Robust t-statistics are in the parentheses. The * represents levels of significance *p< 0.1; ** p<0.05; *** p<0.01.

	Spec 1	Spec 2	Spec 3	Spec 4
Underwriting bid Volatility			-0.0279	-0.0253
			(4.76)***	(4.47)***
Underwriting stopout commission rate			0.0024	0.0020
			(8.76)***	(7.71)***
Underwriting Share			0.0096	0.0095
			(4.13)***	(4.00)***
Uniform Auction Dummy	-0.0162	-0.0081	-0.0089	-0.0060
	(9.00)***	(5.11)***	(4.08)***	(3.01)***
Duration	0.0017	0.0014	0.0011	0.0010
	(15.51)***	(11.55)***	(11.66)***	(9.62)***
Auction Supply	-0.0030	-0.0004	-0.0033	-0.0032
	(4.48)***	(0.4)	(3.66)***	(2.94)***
Auction Competition			-0.00004	0.00002
			(1.85)*	(1.0)
Secondary market volatility		2.0591		1.3349
		(8.69)***		(5.10)***
Pre-Auction Secondary Market Volume		-0.0001		-0.0001
		(8.71)***		(4.07)***
Bank Primary Dealer Dummy			-0.0013	-0.0013
			(4.02)***	(3.85)***
Constant	-0.0112	-0.0187	0.0205	0.0133
	(3.20)***	(4.08)***	(4.96)***	(2.75)***
Year Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R-squared	0.15	0.16	0.14	0.14
N	8,143	7,592	6,983	6,825

Table 11: Auction Outcomes and Underpricing

This table reports the results of OLS regressions in which the the dependent variable is the extent of underpricing in each auction measured as log(Pt+2/Auction-identified Price), where P_{t+2} is the secondary market price on the second day following the auction. Robust t-statistics are in the parentheses. The * represents levels of significance *p< 0.1; ** p<0.05; *** p<0.01.

	Spec 1	Spec 2	Spec 3	Spec 4
Underwriting bid Volatility			0.001	-0.003
			(0.180)	(0.300)
Underwriting Stopout commission rate				0.001
				(0.980)
Uniform Auction Dummy	-0.0028	0.0003	0.0002	0.0009
	(0.640)	(0.070)	(0.060)	(0.230)
Duration	0.0003	0.0003	0.0003	0.0003
	(2.16)**	(2.11)**	(2.04)**	(1.98)**
Auction Supply	0.0009	0.0011	0.0011	0.0006
	(0.650)	(0.700)	(0.690)	(0.470)
Auction Coompetition	-0.00005	0.00000	0.00001	0.00001
	(0.850)	(0.090)	(0.100)	(0.320)
Secondary market volatility		-0.167	-0.166	-0.222
		(0.490)	(0.480)	(0.610)
Pre AuctionSecondary market volume		-0.00003	-0.00003	-0.00002
		(1.440)	(1.430)	(1.070)
Constant	-0.016	-0.019	-0.019	-0.011
	(3.18)***	(3.02)***	(3.03)***	-1.580
Year Fixed Effects	Y	Y	Y	Y
R^2	0.120	0.140	0.140	0.150
N	409	380	380	380

Table 12: Underwriting Insurance Costs

This table reports the total cost of insurance premium paid by the RBI to underwriters. The insurance premium paid has two components: the minimum compulsory underwriting (MUC) and additional competitive underwriting (ACU) determined via auction. All numbers except the number of auctions are in INR billion.

Panel A: All Auctions

	Mean	Median	Std. Dev.	Total	No. of Aucs.
Total Commission	0.017	0.003	0.065	8.414	494
Total ACU Commission	0.006	0.002	0.018	2.743	494
Total MUC Commission	0.011	0.001	0.049	5.672	494

Panel B1: All Uniform Auctions

	Mean	Median	Std. Dev.	Total	No. of Aucs.
Total Commission	0.009	0.002	0.040	3.469	403
Total ACU Commission	0.003	0.001	0.007	1.269	403
Total MUC Commission	0.005	0.001	0.032	2.200	403

Panel B2: All Discriminatory Auctions

	Mean	Median	Std. Dev.	Total	No. of Aucs.
Total Commission	0.054	0.014	0.120	4.946	91
Total ACU Commission	0.016	0.004	0.037	1.474	91
Total MUC Commission	0.038	0.009	0.086	3.472	91

Panel C1: All Devolved Auctions

	Mean	Median	Std. Dev.	Total	No. of Aucs.
Total Commission	0.061	0.015	0.101	2.665	42
Total ACU Commission	0.015	0.008	0.019	0.673	42
Total MUC Commission	0.045	0.007	0.085	1.992	42

Panel C2: All Successful Auctions

	Mean	Median	Std. Dev.	Total	No. of Aucs.
Total Commission	0.013	0.003	0.059	5.749	452
Total ACU Commission	0.005	0.001	0.017	2.069	452
Total MUC Commission	0.008	0.001	0.042	3.680	452

Table 13: The Net Benefits of Underwriting

This table summarizes the gross and net benefit of underwriting to the RBI. The numbers are in INR billions. The benefit is calculated by using the devolved auctions. For uniform auctions, this amount is simply the difference between the devolvement price and the price that would have prevailed based on auction bids (multiplied by the notified amount). For discriminatory auctions, it is the difference between the devolvement price and the value weighted average price above the cut-off that would have prevailed absent devolvement (again, multiplied by the notified amount). The cost is simply the direct cost of the underwriting commissions that were paid over all auctions.

	Total Benefit	Avg Benefit	Std Dev	Avg Cost	Avg Net Benefit
All Auctions	9.44	0.0191	0.073	0.0170	0.0021
Uniform Auctions	5.39	0.0134	0.046	0.0086	0.0048
Discriminatory Auctions	4.05	0.0445	0.139	0.0544	-0.0098

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