Auctioning the Underwriting Spread: Implications for Information Production and Insurance [1]

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Abstract

Government securities are auctioned in India, using a novel two-stage auction procedure. In the first stage, a discriminatory auction is used to arrive at an underwriting schedule consisting of aggregate quantity back-stopped by each of the primary dealers and the associated underwriting commissions that the Government agrees to pay the bidders, irrespective of the amount of devolvement in the second stage of the auction. Then, in the second stage, Government securities are auctioned using either uniform price or discriminatory auctions. Primary dealers enter the second stage of the auction procedure having committed to absorb any devolvement in the second stage and enter as residual claimants of unmet supply in the second stage. Using data collected from the RBI on Government securities auctions over the period 2006-2012, we provide empirical evidence, which shows that the information produced in the first stage is powerful in explaining devolvements, extent of bid shading, and bid to cover ratios in the second stage. We also provide a measure of the amount of money left on the table by the Government under this mechanism.

1 Introduction

This paper is an empirical examination of the novel mechanism used by India's central bank, the Reserve Bank of India (RBI), to auction Government securities in India. The auction has a two-stage structure. The second stage is a standard (either uniform-price or discriminatory) treasury auction. What makes the mechanism distinctive is the presence of a first stage underwriting auction that precedes the main auction and via which the RBI obtains insurance from the primary dealers on the *entire* quantity to be auctioned in the second stage. All primary dealers must mandatorily participate and take on specified minimum underwriting commitments in this first stage. This underwriting auction is discriminatory in style; its outcome determines the quantity underwritten by each primary dealer and the ex-ante fees each receives for providing this service. But, importantly, the underwriting auction does *not* determine the quantum of benefit that is provided by this insurance—i.e., it does not determine the price at which the RBI may "put" the notified amount (the amount being auctioned) to the underwriters—or the conditions under which this right may be invoked by the RBI. Rather, following the receipt of bids in the second stage, the RBI may, at its discretion, disregard any or all of the bids received and "devolve" the notified amount, in part or in full, to the winners of the underwriting auction according to their underwriting commitments *at a price determined by the RBI*. Thus, the situation is akin to one where the auctioneer (the RBI) has a secret reserve price and is long put options to sell the notified amount to the underwriters (who are short the puts) at that secret price. A detailed description of the auction is provided in Section 2.

The use of an underwriting auction preceding the main treasury auction appears unique in the context of Treasury auctions and potentially offers insights into how bidder uncertainty in the first stage about the demand in the second stage could affect auction outcomes. The underwriting of new issues, to our knowledge, is rarely ever done through a formal auction procedure; rather, this is achieved through a firm commitment contract or "best efforts" distribution per contractual arrangements between the issuers of new securities and a syndicate of intermediaries. Importantly, the auctions we study frequently "devolve," so the underwriting risk is non-trivial. As noted above, in devolvement, the Reserve Bank of India (RBI) chooses the price at which it "puts" the securities to the successful bidders in the first stage auction.

Our focus is this paper is on the underwriting auction and its consequences, in particular, its informational and economic effects. Our data set is unique: we are able to identify the bidders in each stage of the auction and trace their behavior throughout our sample period, through unique bidder IDs. This allows us to examine, at the bidder level, how their first stage bidding influence their bidding in the second stage. In addition, we have the secondary market prices (daily and intra-day) of the Government securities, which allow us to compute measures of bid shading, volatility of pre-auction and post-auction prices, etc.

We begin with two simple questions concerning the informativeness of the underwriting auction, specifically, the extent to which information generated in the underwriting auction presages behavior and outcomes in the main auction. First, does the underwriting auction contain information (beyond that contained in pre-auction secondary market data) that predicts the strength of demand in the main auction? Second, does the underwriting auction predict the likelihood of devolvement following the main auction (again, beyond pre-auction secondary market data)? To be sure, these questions are intimately related: While the rules guiding the RBI's devolvement decision are not public, the decision to devolve is presumably related to the strength of the demand submissions in the main auction with weak demand increasing the likelihood of devolvement. We find very strong evidence on both questions underscoring the informativeness of the underwriting auction. Information generated in the underwriting auction (in particular, the stop-out price) is strongly significant, economically and statistically, in predicting strength of demand in the second-stage auction as well as the probability of devolvement following the second-stage auction. Of importance, underwriting auction-generated information trumps measures constructed from secondary market information; in the presence of the former, no pre-auction secondary-market information (e.g., trading volumes, price behavior) is significant in predicting strength of demand or devolvement in the second stage.

We then turn our attention to the auction price and its influencers. Analysis of the raw pricing data reveals a very clear V-shaped pattern of prices around the auction date in which pre- and post-auction secondary market prices are both higher than the auction-identified price. This form of auction "underpricing" has been widely documented in the Treasury auctions literature and is commonly attributed to "bid shading" by auction participants, the submission of bids below true value, perhaps because of "winner's curse" considerations.[1,2] We find that the extent of bid-shading is very strongly affected by information revealed in the underwriting auction even after controlling for pre-auction secondary market information and what that reveals about winner's curse considerations. In particular, a higher underwriting auction cut-off price and more conservative bidding in the underwriting auction are associated with a greater degree of bid-shading in the main auction.

A natural follow-up question this leads to is the influence of underwriting auction outcomes on *post-auction* secondary market price formation. Is there any residual information in the underwriting auction beyond that captured by main auction outcomes and that influences post-auction secondary market prices? We find that such is indeed the case. These results unambiguously

[1] "Winner's curse" is the name given to the observation that in a common value auction, the winning bid is the most optimistic of the submitted bids, so the value of the object being auctioned conditional on the information of all participants is likely to be lower that the value conditional on the information of just the winning bid. In the context of multi-unit auctions such as Treasury auctions, the winner's curse is sometimes referred to as the "champion's plague."

[2] Underpricing is also a well-documented stylized fact in the extensive finance literature on initial public offerings (IPOs) where too underwriting plays a key role.

indicate that there is significant additional information generation in the underwriting auction beyond what is available in secondary market data.

Finally, we provide some computations on the direct costs of underwriting (the premium payments). We note that underwriting has indirect effects too. In particular, it is possible, even plausible, that an underwriter bidding in the main auction may shade bids less to reduce the possibility of costly devolvement, that is bid-shading may be lower in the presence of the underwriting auction that without it. While the total cost of bid-shading is not difficult to measure (we provide an estimate in the paper), the differential levels of bid-shading with and without the underwriting component involve a counterfactual that is not readily measured. Underwriting has the further direct benefit to the RBI of providing the RBI with the ability to put the issue to the underwriters if second-stage demand is deemed insufficient. A first empirical estimate of this put may be estimated by taking the difference between the prices at which devolved issues were put to the underwriters and the auction price that would have prevailed in the absence of the devolvement, but of course, estimating the ex ante value of the put is a much more complex issue that we do not tackle here.

The rest of this paper is organized as follows. The remainder of this section indicates the related literature. Section 2 describes the auction in some detail. Section 3 restates our hypotheses formally. Section 4 describes the data and provides summary statistics; it also provides definitions of the variables used in our analysis and documents the V-shaped pattern of prices around the auction in the raw data. Section 5 describes our results. Section 6 concludes.

Related Literature

We review briefly in this section the literature that is most relevant to our paper.[3] Our paper examines the relationship between the underwriting mechanism, and how it may relate to the equilibrium outcome in the second stage auction (such as extent of devolvements, bid to cover ratios and bid shading). In this sense our paper is related to the IPO literature, and syndicated corporate bond underwriting literature, where the focus is on the extent of underpricing its relationship to the mechanism used to distribute the securities.

Our paper is also related to the auction theory as applied to Government securities. Winner's curse plays a central role in auction theory where bidders are likely to have affiliated beliefs about the common value of the securities on which they are bidding. Winning in such (unit good auctions) imply that the conditional value of the good upon winning will be updated to a lower value relative to unconditional expectation. Rational bidders take this into account and shade their bids: the extent of bid shading will depend on the precision of the signals that

[3]The literature on auction theory and empirical work is extensive. We make no attempt here at an extensive discussion.

they have about the good that is being auctioned. Weber (1977), Milgrom and Weber (1982) have analyzed these issues. A number of papers have extended the auction theory to multi-unit auctions and Government securities auctions. They include Back and Zender (1993), Demange, Gale, and Sotomayor (1996), and Bikhchandani and Huang (1993). In the context of multi-unit auctions, Ausubel (1997) has identified the problem of "Champion's plague": the more the bidder wins in auction with affiliated beliefs, the worse off the bidder is. A rational bidder in a multi-unit auction will reflect this by lowering the demand curve. A number of papers have explored the empirical implications of auction theories in the context of Government securities auctions, including, Hortacsu, and McAdams, (2012), Keloharju, Nyborg, Rydqvist (2005), Nyborg and Sundaresan (1996), Nyborg, Rydqvist and Sundaresan (2002), and others. We do not explore the full implications of auction theories in this paper, but rather focus our efforts on the interaction between the information produced in the first stage underwriting auction and the equilibrium outcomes in the second stage auction. We intend to exploit the bidder-specific data and address issues relating to "champion's plague" in follow-up work.

2 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 elaborate below on 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.[4]. 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.[5]

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.[6]

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

[4]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).

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

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

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).

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). 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. 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. A total of 49 auctions in our study period were devolved, representing 8.7% of the total, and split roughly proportionately between uniform price auctions (38 auctions, 9% of all uniform price auctions) and discriminatory auctions (11 auctions, about 7.5% of all discriminatory auctions).

An Example: The September 12, 2008 Auction

On September 12, 2008, the RBI conducted a discriminatory auction for the re-issue of INR 50 billion of the 8.24% 10-year bond issued April 22, 2008 and maturing April 22, 2018. Since this was a re-issue, the auction was conducted on a price basis.

In the underwriting stage, the aggregate MUC amount was INR 25 billion and the AUC underwriting auction for the remaining 25 billion. A total of 19 primary dealers participated in the auction. The AUC 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 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 AUC 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 12, 2008, 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.

3 A Guide to the Analysis

The distinguishing feature of the auction structure described in Section 2 is the presence of the underwriting auction, and it is on the underwriting auction and its impact (on both the main auction and the post-auction secondary market) that we focus our analysis in this paper.

Bidders in the underwriting auction face a trade-off. On the one hand, conditional on the auction not being devolved (i.e., the insurance they provide not being utilized), it is in their interests to bid as aggressively as possible to "win" the underwriting auction and thereby maximize their underwriting commission receipts. On the other hand, bidding aggressively in the underwriting auction carries the risk that if the auction is devolved, potential losses from having to absorb the devolved amount fall on the winners of the underwriting auction. Thus, a bidder's anticipation of the possibility of devolvement should play a key role in the submitted bids, and the underwriting auction outcomes should reflect these anticipations.

The first question we examine concerns this "tail risk," i.e., the possibility of devolvement following the main auction, and the extent to which underwriting auction outcomes anticipate or predict this event. Using a logistic regression, we find (Section 5.1) that underwriting auction outcomes—particularly the auction's stop-out price—are significant drivers of the probability of devolvement. Moreover, the underwriting auction carries information about the probability of devolvement over and above that in pre-auction secondary market information: indeed, in the presence of underwriting auction information, all pre-auction secondary market information is insignificant in predicting devolvement.

Although the auction rules do not explicitly prescribe rules under which the auction will be devolved, one reasonable possibility is that devolvement occurs if a(n unspecified) reserve price is not met in the main auction, which failure may, in turn, stem from weak demand in the auction's second-stage. This motivates our second question, closely related to the first: To what extent do underwriting auction outcomes presage the strength of second-stage main auction demand?

To be sure, demand in the main auction depends on anticipated post-auction demand in the secondary market. Since the auctioned bonds we study are all re-issues of existing bonds, any anticipation about post-auction demand would also likely be reflected in pre-auction secondary market trading. So, more precisely, the question we examine is: To what extent does the underwriting auction carry information about the strength of main auction demand over and above that already present and summarized in pre-auction secondary market information? We find (Section 5.2) that the underwriting auction, particularly the stop-out price, is a key predictor of this strength, and that in the presence of underwriting auction information, much of the pre-auction information (with the notable exception of a proxy for the winner's curse; see discussion below) loses relevance.

From the aggregate demand curve, we then turn to examining the impact of the underwriting

auction on individual dealer-level bids in the main auction. Of particular interest is dealer "bid shading." Auction theory predicts that in common-value auctions (of which Treasury auctions are an example), fear of a "winner's curse" may cause participants in an auction to "shade" their bids, i.e., to bid less than their true valuation.[7] Such bid shading has been widely documented in the context of treasury auctions worldwide, and as we document in Section 4, is also a feature of the auctions we study.

In Section 5.3, we look at the extent to which underwriting auction behavior and outcomes contribute to bid shading after controlling for pre-auction variables that, in particular, also proxy the anticipated winner's curse effect. In line with our earlier results, we find that dealer-level bid shading is heavily influenced by underwriting auction outcomes in the expected direction (e.g., a higher stop-out price in the underwriting auction leads to increased bid shading presumably because it conveys a pessimistic outlook concerning secondary market demand). Importantly, the winner's curse too continues to exercise a significant effect with an increase in the anticipated winner's curse leading to increased bid shading.

One possible consequence of bid-shading by participants in an auction is auction *underpricing*, i.e., an auction price that is lower than the post-auction secondary market price. Such underpricing too has been widely documented in the context of Treasury auctions worldwide and, as we document in Section 4, is very much present in our data set too. In Section 5.4, we examine the determinants of this underpricing, looking in particular at the role of the underwriting auction in predicting the degree of underpricing. We find, once again, that it, and especially the stop-out price, play a significant role.

In summary, the underwriting auction and its outcomes are strong predictors of (i) the likelihood of second-stage devolvement, (ii) the strength of second-stage main auction demand, (iii) the extent of bid shading by individual dealers in the main auction, and (iv) the extent of underpricing in the main auction.

Finally, in Section 5.5, we compute the direct costs and benefits of the underwriting auction. We find that the underwriting auction is overall slightly profitable in terms of these direct costs and benefits, even without taking into account its other indirect benefits such as information production and insuring against market breakdowns.

[7] The "winner's curse" is the name given to the observation that the bidder submitting the highest bid has, by definition, the most optimistic outlook on the post-auction market value of the good being auctioned, so the expected value of the good conditional on all bidders' information will be less than that conditional on the winner's information alone. Anticipation of a winner's curse will lead to bid-shading for obvious reasons, but bid-shading may also result from other sources such as risk-aversion.

4 Data and Summary Statistics

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 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, and so on. The identities of the primary dealers 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 590 auctions of government securities over the period 2006-2012. A total of 565 of these auctions (or just under 96% of the total) were for reissues of existing bonds, while the remaining 25 were for issues of new bonds. Since much of our analysis utilizes pre-auction secondary market information as controls in the regressions, we focus only the 565 re-issue auctions in the sequel. 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 416 of the 565 auctions.

As described in Section 2, the underwriting auction is, in practice, always a discriminatory price auction in which primary dealers compete to underwrite 50% of the amount that will be sold in the main auction; the remaining 50% is equally distributed among the primary dealers and must be mandatorily underwritten by them. The outcome of the underwriting auction determines not only the "additional competitive underwriting" (ACU) commission dealers get for the non-mandatory underwriting to which they commit but also, depending on how aggressively they bid in the ACU auction, the commission they get for their mandatory "minimum underwriting commitment" (MUC). 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 second stage auction may be, also as noted in Section 2, uniform-price or discriminatory in style. Of the 565 auctions in our dataset, 420 were of the uniform price format, and the remaining 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 49 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.

Table 1 gives some basic summary statistics across the auctions in our data set. There are minor differences (one in 11 uniform-price auctions ended in devolvement compared to one in 13 discriminatory auctions, etc), but the numbers are broadly similar with one important exception: the underwriting commission cut-off in discriminatory auctions at 0.0013 (i.e., 13 basis points) was more than six times higher than the corresponding number for uniform-price auctions (0.0002).

Table 2 provides the names of the primary dealers who were active in mid-2014. (There are 20 during this period; through much of the period of our study, the number of primary dealers was smaller at around 16-18.) The primary dealers 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.

Dependent Variables

Table 3 describes the dependent variables in our various regressions. 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.

Table 4 provides summary statistics on these dependent 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 auction theory has long predicted (going back at least to Friedman (1951)), 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 5 defines the right-hand side variables we use in our regressions, listed alphabetically. (We note that we also looked at the impact of including several other variables but all were insignificant and did not affect the results in any way, so in the interests of brevity, we do not describe them here.) The variables come from 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 underwriting supply curve intercept, 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). The underwriting supply-curve intercept is defined as the value of the intercept A obtained from estimating separately for each auction, the aggregate submitted log-supply curve $\ln Q = A + B \ln P$. A higher underwriting cut-off price and a higher intercept of the submitted supply curve are each indicative of a greater premium for insurance and so could signal anticipation of a greater likelihood of devolvement in the main 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 are results are unaffected if we use data from the day after the auction instead. The secondary market data used in our analysis includes the market price pre- and post-auction (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 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 6 provides summary statistics on each of these variables.

5 Results

As described in Section 3, we present our findings in several parts. 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.

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 7 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 also time dummies.

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.

Comment: Add numbers here on economic significance of the result.

5.2 The Strength of Main-Auction Demand

As noted in Section 3, 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 8 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. The first two columns of table look at all auctions while the last two columns focus solely on successful auctions. In each case, the respective first column looks at using only pre-auction information, while the second column also includes underwriting auction outcomes.

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 coefficient of the underwriting supply curve intercept is also negative, but it is marginally significant in the second column and insignificant in the fourth.) The second strongly significant variable is the standard deviation of pre-auction prices, which is a proxy for the winner's curse; its coefficient is, also as expected, negative, meaning that a higher standard deviation (a larger anticipated winner's curse) leads to weaker main-auction demand.

Comment: Add numbers here on economic significance of the result.

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 4 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 9 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 **??**, 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 lending 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.)

The coefficients are also economically significant. A one standard deviation increase in the underwriting cut-off increases the degree of bid shading by 0.14 basis points, while a similar increase in the standard deviation of secondary market prices increases the degree of bid shading by 0.25 basis points.

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). As noted earlier, we measure the degree of underpricing by

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

Table 4 provided summary statistics on underpricing in our data set. The average level of underpricing across all auctions is around 0.21 basis points (i.e., INR 0.0021 per INR 100 face 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 $\pm$ 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 10 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

Table 11 and 12 summarize the direct cost and direct realized benefit of the underwriting auction from the RBI's standpoint. 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. 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. 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.

Details to be filled in here.

6 A Robustness Check

As argued earlier, competition in underwriting has a trade-off: on the one hand, it lowers the cost of capital by increasing the competition for the underwriting services by lowering the underwriting commission and encouraging information production. On the other hand it increases the cost of capital by lowering primary dealers' incentive to bid more aggressively in the main auction as

winning the underwriting rights against more bidders increases the winner?s curse. The winner?s curse effect is also accentuated via the expected inventory holding cost and increases bid shading in proportion to the amount underwritten in the first round auction. In equilibrium a rational primary dealer anticipates this winner?s curse effect on his underwritten amount and bids accordingly in the first round anticipating the equilibrium outcome of the second round via backwards induction. This inherently creates a possible endogeneity bias in the bid-shading regression: the actual underwritten amount in the first round (allocated amount to a primary dealer in the ACU auction) must be an equilibrium outcome where the primary dealer have anticipated the amount of expected bid shading by him in the second round and bid accordingly in the first round underwriting auction. Hence in equilibrium the underwritten amount will depend on the actual bid shading in the second round. We answer this endogeneity concerns in this section by exploiting one policy experiment which affected a subset of primary dealer?s cost of holding the nventory by reducing its cost of hedging and a natural experiment via political uncertainty which affected economy wide uncertainty and hence the winner?s curse for all bidders.

On September 1, 2009, the RBI eased the cost of hedging government securities in India by allowing a subset of primary dealers (the standalone primary dealers) to hedge their interest-rate risk using exchange-traed interest rate futures on their own account. This reduces the inventory holding costs for standalone primary dealers by allowing them to hedge the interest rate risk via interest rate futures for any amount own in the underwritten (which may be subsequently devolved) or in subsequent main auction. Since this policy change affects the standalone primary dealers only (as noted in the circular) it gives us an opportunity to identify its effect on the standalone primary dealers via a difference-in-difference regression. This policy experiment should affect the second round bidding behavior of the standalone primary dealers in two ways: a direct effect where the standalone primary dealers shade their bids less in the second round main auction as the cost of inventory holding goes down and an effect on second round bid shading via the actual amount underwritten in the first round auction. The strategic bidding behavior affects the arguments for equilibrium outcome in the second effect. Note that all the standalone primary dealers know that the cost of inventory holding for all standalone bidders have gone down. Hence winning expost generates more bad news in the winner?s curse sense as it gives the news ?everybody else chose to bid lower despite having lower inventory holding cost hence they must have received even worse signal?; this makes the winner?s curse effect even worse. Hence in equilibrium standalone primary dealers should actually shade their second round bid even more in proportion to the amount underwritten in the first round. Hence the interaction effect of the policy with the amount underwritten for the standalone primary dealers should actually increase their bid shading in the second round.

We find evidence of both effects in the regressions reported in Table 13. The variable of interest for the first effect is the interaction between a dummy variable for standalone primary dealers with a time dummy, which takes value one for the policy change. The coefficient of this

variable in the bid-shading regression should be negative. The variable of interest for the second effect is the triple interaction between a dummy variable for standalone primary dealers with a time dummy for the policy change interacted with the amount underwritten by an individual primary dealer. The coefficient of this variable in the bid-shading regression should be positive. We find evidence in table below with desired sign.

7 Conclusion

In this paper we analyzed a unique two stage auction process to underwrite and sell the government securities. We found that the first stage auction of underwriting provided a significant information about the possible devolvement (tail risk) of the main auction as well as produced more information about post auction secondary market prices relative to pre auction or the main auction. We also found that the insurance provision role of the underwriter in the first stage auction process increases the indirect cost of capital of the government securities through the inventory effect channel.

Figures and Tables

Figure 1: The Auction: An Example

This figure describes the auction of INR 50 billion on September 12, 2008, 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.

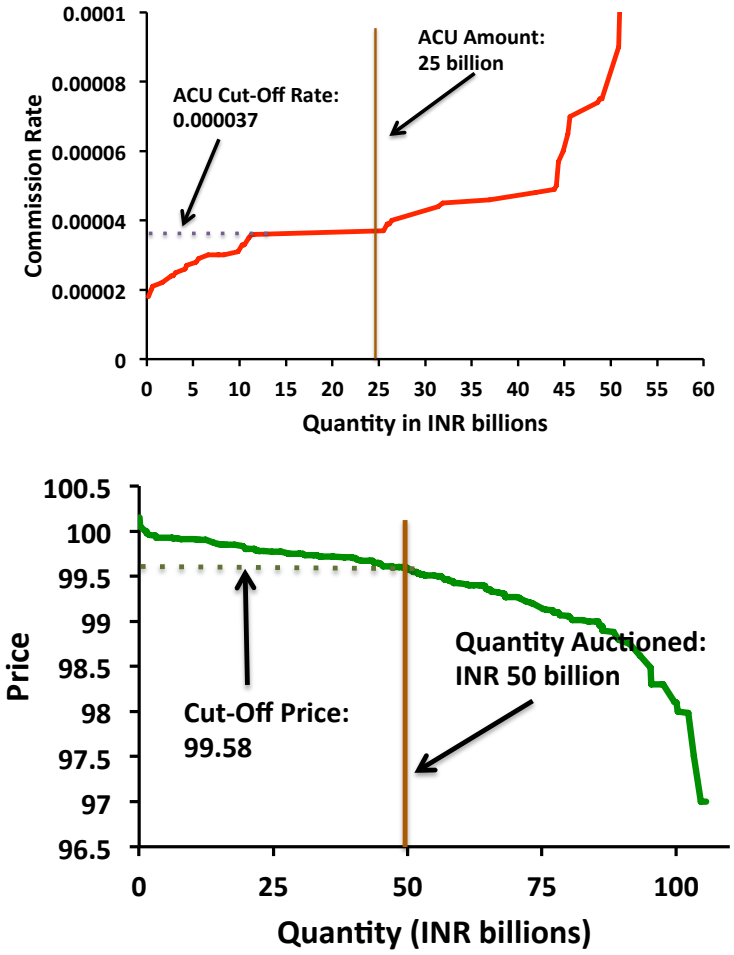

Figure 2: Price Behavior around Auction Day

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.

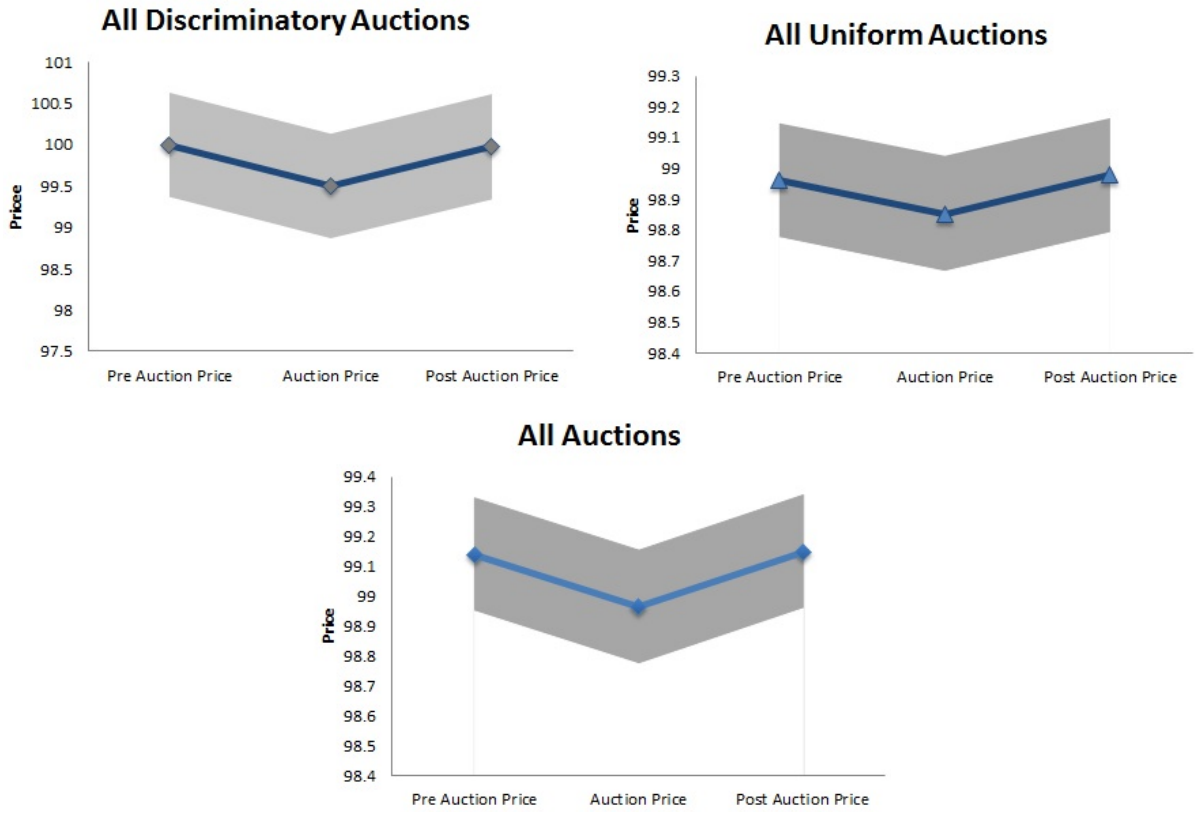

Table 1: Summary Statistics of All Auctions

Auction Type	Uniform	Discriminatory	Total
Number of Auctions	420	145	565
Average Notified Amount (INR Billion)	38.8	43.4	40.4
Number of Devolved	38	11	49
Average of Auction Identified Price	98.07	99.09	98.33
Duration	14.02	12.87	13.73
Underwriting Commission Cut off	0.0002	0.0013	0.0004

Table 2: List of Primary Dealers in India: June 13, 2014

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 3: Variable Definitions: Dependent Variables

This table provides definitions of the dependent 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.

Dependent 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 4: 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 3.

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 5: 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	Definition
ACUBids_Var	Standard deviation of ACU bids normalized by P_{t-2}, the value-weighted price 2 days before the main auction
ACU_AmtWon	ACU amount won by a primary-dealer bidder in underwriting auction normalized by notified amount
log_UWCutOff	(Natural) log of the cutoff price in the underpricing auction
log_Ntfd-Amt	(Natural) log of the notified amount (i.e., the amount being auctioned) measured in INR billions
No of bidders (main auc)	The number of bidders in the main (i.e., the second-stage) auction
Ntfd-Amt	The notified amount (i.e., the amount being auctioned) measured in INR billions
Stdev_2daypre	Std dev of secondary market prices 2 days pre-auction computed using all trades and normalized by P_{t-2}
Time-to-maturity	Time to maturity of the bond being auctioned (measured in years)
UW_SupplyCurveIntercept	intercept *A* from the estimated log supply curve log *Q* = *A* + *B* log *P* in the underwriting auction (estimated separately for each auction).
Volume_2daypost	The volume of secondary market trading (measured in INR billions) 2 days after the auction
Volume_2daypre	The volume of secondary market trading (measured in INR billions) 2 days before the auction

Table 6: Summary Statistics of Independent Variables

This table provides summary statistics for the independent variables used in our analysis. The variables are defined in Table 5.

	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 7: 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.

Logistic regression. Dependent variable: 1 if devolvement, 0 otherwise			
uniform_dummy	0.236	1.813	1.346
	(-0.23)	(-1.4)	(-0.87)
log_Ntfd-Amt	-0.027	-0.095	-0.145
	(-0.21)	(-0.53)	(-0.73)
Stdev_2daypre	-2.048	-1.158	0.643
	(-0.74)	(-0.52)	(-0.27)
Time-to-maturity	-0.013	-0.073	-0.058
	(-0.49)	(1.85)*	(-1.46)
Volume_2daypre	-0.072	-0.096	-0.059
	(-1.12)	(-1.33)	(-0.95)
ACUBids_Var		14.11	4.85
		(2.49)**	(-0.69)
log_UWCutOff			1.437
			(3.28)***
UW_SupplyCurveIntercept		0.463	-0.480
		(2.56)**	(-1.43)
Year fixed effects?	Y	Y	Y
Pseudo R-squared	0.12	0.20	0.24
No of observations	446	409	409

Table 8: 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.

OLS Regressions. Dependent variable: Bid-Cover ratio

	All Auctions		Successful Auctions	
uniform dummy	-0.232	-0.199	-0.295	-0.257
	(-1.53)	(-1.22)	(1.94)*	(-1.55)
log_Ntfd-Amt	-0.561	-0.113	-0.493	-0.074
	(5.61)***	-0.41	(4.81)***	-0.25
Stdev_2daypre	-3.793	-4.097	-3.962	-4.139
	(5.30)***	(6.11)***	(5.43)***	(5.93)***
Time-to-maturity	-0.003	-0.001	-0.001	-0.001
	(-0.81)	(-0.35)	(-0.36)	(-0.19)
Volume_2daypre	0.003	0.003	0.002	0.002
	(2.30)**	(1.80)*	(-1.54)	(-1.42)
ACUBids_Var		-1.20		-1.07
		(1.80)*		-1.45
log_UWCutOff		-0.158		-0.130
		(3.09)***		(2.39)**
UW_SupplyCurveIntercept		-0.09		-0.09
		(1.74)*		-1.60
Constant	4.56	1.55	4.28	1.64
	(10.51)***	-1.05	(9.69)***	-1.05
Year fixed effects?	Y	Y	Y	Y
Adjusted R-squared	0.21	0.24	0.22	0.24
No of observations	453	450	418	416

Table 9: 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.

OLS regressions. Dependent variable: Dealer bid-shading

uniform_dummy	-0.01	-0.01	-0.01	0.00
	(5.41)***	(3.85)***	(6.15)***	(2.15)**
log_Ntfd-Amt	-0.00188		-0.00339	-0.00001
	(1.77)*		(3.66)***	0.00
Stdev_2daypre	2.30			1.43
	(9.01)***			(5.29)***
Time-to-maturity	0.0003		0.0003	0.0002
	(6.88)***		(8.88)***	(6.23)***
Volume_2daypre	-0.00008			-0.00003
	(7.46)***			(3.05)***
ACUBids_Var		-0.04		-0.02
		(5.14)***		(3.93)***
log_UWCutOff		0.003		0.001
		(10.17)***		(2.10)**
UW_SupplyCurveIntercept		0.00		0.00
		(15.55)***		(1.11)
ACU_AmtWon			0.17	0.10
			(5.07)***	(2.40)**
BankPD_Dummy			-0.001	-0.001
			(4.09)***	(3.88)***
No of bidders (main auc)			-0.00006	0.00004
			(2.75)***	(1.89)*
log_UWCutOff x ACU_AmtWon			0.02	0.01
			(5.02)***	(2.24)**
Constant	-0.01	0.02	0.00	-0.01
	(-1.32)	(6.42)***	(-0.91)	(-0.25)
Year fixed effects?	Y	Y	Y	Y
Adjusted R-squared	0.15	0.14	0.13	0.14
No of observations	7,595	7,715	7,268	6,780

Table 10: 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.

OLS Regressions. Dependent Variable: Ex-post Underpricing

uniform_dummy	-0.00090	0.00012	0.00002	-0.00002
	(0.19)	(0.03)	(0.01)	(0)
log_Ntfd-Amt	0.00212	0.00072	-0.00001	0.00030
	(1.5)	(0.84)	(0)	(0.06)
Stdev_2daypre	0.24984			0.14764
	(0.68)			(0.37)
Time-to-maturity	0.00014	0.00012	0.00012	0.00012
	(2.12)**	(2.31)**	(2.41)**	(2.08)**
Volume_2daypre	-0.00004			-0.00003
	(2.01)**			(1.73)*
devolved_dummy	0.00110	0.00057	0.00069	0.00060
	(0.49)	(0.27)	(0.32)	(0.27)
ACUBids_Var		-0.01077	-0.01019	-0.01041
		(0.8)	(0.81)	(0.81)
log_UWCutOff		0.00114	0.00127	0.00122
		(2.11)**	(1.90)**	(1.82)*
UW_SupplyCurveIntercept			-0.00016	-0.00029
			(0.19)	(0.35)
Constant	-0.02361	-0.00738	-0.00576	-0.00725
	(3.81)***	(1.47)	(0.25)	(0.31)
Year fixed effects?	Y	Y	Y	Y
Adjusted R-squared	0.13	0.14	0.13	0.13
No of observations	382	391	388	379

Table 11: The Total Underwriting Insurance Costs - I

The following are 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 expect the number of auctions are in INR billion.

			ALL AUCTIONS:		
Variables	Mean	Median	Stdev	Total	No of Auctions
Total Commission	0.016	0.003	0.06	9.2	564
Total ACU Commission	0.006	0.002	0.02	3.15	564
Total MUC Commission	0.011	0.001	0.05	6.05	564
			All Successful Second Stage Auctions		
Variables	Mean	Median	Stdev	Total	No of Auctions
Total Commission	0.013	0.003	0.06	6.47	517
Total ACU Commission	0.005	0.002	0.02	2.44	517
Total MUC Commission	0.008	0.001	0.04	4.03	517
			All Devolved Second Stage Auctions		
Variables	Mean	Median	Stdev	Total	No of Auctions
Total Commission	0.058	0.016	0.1	2.73	47
Total ACU Commission	0.015	0.008	0.02	0.709	47
Total MUC Commission	0.043	0.007	0.08	2.02	47

Table 12: The Total Underwriting Insurance Costs - II

The following are 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 expect the number of auctions are in INR billion.

All Uniform Second Stage Auctions					
Variables	Mean	Median	Stdev	Total	No of Auctions
Total Commission	0.009	0.003	0.04	4.12	464
Total ACU Commission	0.004	0.002	0.01	1.62	464
Total MUC Commission	0.005	0.001	0.03	2.5	464
All Discriminatory Second Stage Auctions					
Variables	Mean	Median	Stdev	Total	No of Auctions
Total Commission	0.051	0.014	0.12	5.08	100
Total ACU Commission	0.015	0.004	0.04	1.52	100
Total MUC Commission	0.036	0.009	0.08	3.56	100

Table 13: Robustness Check: A Policy Experiment

The following are the OLS regressions about impact of the underwriting and auction process on the post auction price movement relative to auction identified price. The dependent variable is the log(Pt+2/Auction identified Price) in each auctions. Robust t-statistics are in the parentheses. The * represents levels of significance *p< 0.1; ** p<0.05; *** p<0.01.

OLS Regressions. Dependent variable: Degree of BidShading				
uniform_dummy	-0.005	-0.004	-0.004	-0.004
	(2.15)**	(1.75)*	(1.87)*	(1.85)*
log_Ntfd-Amt	-0.00001	-0.00184	-0.00173	-0.00186
	0.00	-0.30	-0.28	-0.30
Stdev_2daypre	1.43	1.39	1.37	1.38
	(5.29)***	(5.07)***	(5.05)***	(5.07)***
Time-to-maturity	0.0002	0.0002	0.0002	0.0002
	(6.23)***	(6.46)***	(6.47)***	(6.40)***
Volume_2daypre	-0.00003	-0.00003	-0.00003	-0.00003
	(3.05)***	(3.20)***	(3.17)***	(3.17)***
ACUBids_Var	-0.02	-0.02	-0.02	-0.02
	(3.93)***	(3.94)***	(3.88)***	(3.89)***
log_UWCutOff	0.001	0.001	0.001	0.001
	(2.10)**	(1.86)*	(1.88)*	(1.87)*
UW_SupplyCurveIntercept	0.0008	0.0005	0.0005	0.0004
	-1.11	-0.44	-0.46	-0.43
ACU_AmtWon	0.10	0.10	0.10	0.10
	(2.40)**	(2.37)**	(2.43)**	(2.46)**
log_UWCutOff * ACU_AmtWon	0.01	0.01	0.01	0.01
	(2.24)**	(2.22)**	(2.28)**	(2.49)**
BKPD_dum	-0.001	-0.001	-0.006	-0.006
	(3.88)***	(3.84)***	(2.86)***	(2.87)***
No of bidders (main auc)	0.00004	0.00	0.00	0.00
	(1.89)*	(1.97)**	(1.98)**	(1.96)**
Policy Experiment Dummy		-0.0021	0.0004	0.0002
		-0.70	-0.12	-0.06
Policy Experiment Dummy * Standalone PD dummy			-0.01	-0.01
			(2.51)**	(2.72)***
Policy Experiment Dummy * Standalone PD dummy * ACU_AmtWon				0.01
				(3.30)***
Constant	-0.01	0.00	0.01	0.01
	-0.25	-0.12	-0.20	-0.22
Year fixed effects?	Y	Y	Y	Y
Adjusted R-squared	0.14	0.14	0.14	0.14
No of observations	6,780	6,780	6,780	6,780

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