Competition for Underwriting: Implications for Information Production and Insurance *

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Abstract

We examine a novel two-stage mechanism for selling securities. in stage 1, the security is underwritten but the underwriting is auctioned using a discriminatory auction. First stage winners join the second stage auction in which the security is sold. Here, winning underwriters have dual roles, as bidders and as insurers who must absorb excess security supply. While the government uses first-stage underwriting to insure against auction failure, we argue that it has important effects on bidding and information generation relevant to security pricing. Using proprietary data on treasury auctions in India between 2006 and 2012, we show that the underwriting auction is powerful in explaining auction outcomes including devolvement, bid shading, and post-auction price movements in the secondary market price. The direct costs of underwriting appear to be offset by its indirect benefits to the auction process, thereby lowering issuer cost of capital. We show that the winner's curse risk of unsold inventory is a critical driver of our results. We confirm the importance of this channel by exploiting policy changes that induce natural variation in inventory costs differentially across bidders.

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1 Introduction

Cost of underwriting is a significant contributor to the cost of capital. Underwriters enjoy significant market power and demand economic rents for their market power, asymmetric information and the specialized services they offer (see Aggarwal (2000), Hoberg (2007) and Ritter (2011)). The selection of the underwriters and their fees generally happen via search and bargaining where underwriters enjoy significant bargaining power and limited competition. In this paper we empirically examine a novel mechanism of underwriting competition via auction among the primary dealers of treasury securities. While increased competition is expected to reduce the fees for underwriting, it is an empirical question whether, due to reduced economic rents and incentives, competition also leads to a decrease in information production and other benefits of underwriting services. While the former will lower the cost of capital, the later will increase the cost of capital.

We use a novel proprietary dataset of a two stage auction mechanism, whereby the government securities are sold in India to analyze the costs and benefits of underwriting competition. The auction has a two stage structure. The first stage is a novel variant of traditional auction mechanisms. In this stage, the debt manager, the Reserve Bank of India, auctions the *underwriting* of the debt issue. The underwriting auction determines the number of underwriters, the amount each entity underwrites, and the fees paid for providing underwriting services to the Government. Upon completion of the underwriting auction, the results are announced. The second stage is the actual auction of the debt. Here, bidders place bids to buy securities. The bidders can include the underwriters who win in the first stage underwriting. All bidders submit price-quantity pairs. The winners are allocated treasury securities. The second stage auction has been single-price or discriminatory while the first stage is a discriminatory auction. The two-stage mechanism raises several questions of economic interest about the information production, bidding, and pricing of securities. These economics are our principal focus.

The first-stage auction of the right to underwrite an auction is of interest in its own right. Underwriting is common, for instance, in initial public offerings of shares or debt. It is an important source of fees and prestige for investment bankers. Descriptions of IPOs identify underwriter choice as a critical point in the IPO process. Surprisingly, however, the right to underwrite is rarely allocated through open market mechanisms such as auctions. Instead,

underwriters are chosen by issuers through informal "pitches" made by investment banking firms. Alternatively, and less frequently, new issues are sometimes offered on a best efforts basis without underwriting.

Our analysis informs the auctions literature. The existence of an underwriting stage, the overlap between participants in the underwriting and the next-stage bidding stage, and the resulting effects on bid-shading, or equivalently the underpricing of the issues, are the second set of issues we address. This brief list is not intended to be an exhaustive list of questions. Rather, it represents the focus of the current study. We analyze the two-stage auction process to understand its likely economic effects and present some results that are the implications of our model.

The framework that informs our analysis is relatively straightforward. Asking for underwriting requires fees to be paid to underwriters and thus increase issuance costs. In return, the government gains an option. This is, of course, the option to put any residual supply back to bidders in the event of unsatisfactory second stage outcomes such as insufficient demand for treasury securities. The possibility of such a devolution drives underwriters to be conservative in bidding and in particular, to shade their bids for actual purchases of securities.

Devolution is the lack of sufficient demand generated in the second stage auction at desired reservation yields. In this case, the auctioneer "puts" the devolved amount, i.e., the residual supply, back to the underwriters who win the first stage auction. An interesting question is whether the information produced in the first stage explains the observed devolvements in the second stage and how. We show that underwriting outcomes predict the nature of the second-stage selling outcomes. This point adds not to the broad auction literature and to the IPO literature in finance, which stress information production by bidders in the actual auctions that involve security sales. Our point is that underwriting also yields useful information. We study the relation between the information produced in the first stage underwriting auction and measures of the strength of demand such as the bid to cover ratio and bid shading in the second stage auction.

A feature of our dataset is that we can trace bidders through the different stages of the auction and potentially through the sample period across auctions. The auctions happen about weekly so we learn about economic responses of agents over relatively short horizons. A different advantage is that we not only observe outcomes of auctions but also prices *after*

auction outcomes. These prices can be different than the auction identified price, as the IPO literature emphasizes. Using the post-auction market prices of the Government securities allow us to compute refined measures of bidding and the volatility of pre-auction and post-auction prices.

We briefly describe the results. We show that the the pre-auction prices are systematically higher than the equilibrium prices at which the second stage auctions clear the supply. In addition, the post-auction prices are systematically higher than the equilibrium prices in the second stage auction. This leads to a "V" shape reminiscent of the results in the auctions concessions literature. They also suggest the presence or underpricing in Government auctions. 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.

We find that the primary dealers shade their bid in the second round main auction in proportion to the amount underwritten in the first round. Measures of information produced in the first stage auction are also economically significant in explaining the probability of devolvements 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. These auction-related variables trump measures constructed from secondary market information such as volume of trading prior to bidding.

The form of auction "underpricing" described earlier 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

[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.

auction are associated with a greater degree of bid-shading in the main auction.

We obtain other results. A one standard deviation increase in the amount underwritten increases bid shading by about 3.4%. An interesting question is the extent to which expected inventory holding costs make the primary dealers shade their bid in the second round. The impact of expected inventory risk is higher if the aggregate information released in the underwriting auction is worse. This creates an inventory risk channel of underwriting which increases the cost of capital. In equilibrium, by backward induction, primary dealers should anticipate their second round bidding behavior while bidding for the underwriting rights. We use a novel policy experiment which relaxed the portfolio budget constraint of a subset of primary dealers to further identify the nature of the inventory risk channel.

Overall we find the underwriting auction is highy infomrative about the main auction and subsequent secondary market movements despite lower fees due to competition.

Intuitively the two stage auction structure generates enough incentives for the primary dealers to truthfully reveal their signals. This overcomes the problem of moral hazard in delegated underwriting. The economic intuition for truthful revealtion of information in the underwriting stage goes as follows: suppose that the underlying issue could be of either good (successful) or bad (devolve) quality. Moreover assume that all the primary dealers receive a perfect signal about the underlying quality of the issue before the underwriting auction and it is common knowledge. Their message space is that they can quote either high commission or low commission rate as a fair price for insurance provided. If everybody else is truthfully revealing their (say bad) signal (i.e. bid high commission rate) then it is a best response for the primary dealer to reveal his own (bad) signal truthfully (hence bid high commission). If he deviates (by bidding low commission rate) then only he would end up winning (as lowest bidder wins) the underwriting rights for the issue which is going to devolve (as it is of bad quality) and hence he will loose (since he bid less than the fair price). Similar argument holds if the underlying issue is of good quality. Hence truthful telling is a best response when others are truthful. This argument should go through for imprecise signals too as the underwriting auction has pay off relevance due to the arguments given above. Hence monotonic bidding is an equilibrium outcome due to pay off relevance in the underwriting stage (see Ye(2007)).

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 describes the auction process. . Section 4 states our formal hypotheses. Section 5 describes

the data and provides summary statistics. It also discusses definitions of the variables used in our analysis and documents the V-shaped pattern of prices around the auction in the raw data. Section 6 describes our results. Section 7 describes what we can identify from a policy experiment. Section 8 concludes.

2 Related Literature

The literature on auction theory and empirical work is extensive. Our paper studies the underwriting mechanism and its implications for auction outcomes. Our study thus adds to the IPO literature, specifically the mechanism design issues in the literature and the relation to underpricing. A particular point we make is about the value of the underwriting stage in information gathering. The soft information in the back and forth when selecting an underwriter is hardened into quantitative information in the underwriting bids, which explain auction outcomes in economically substantive and meaningful ways.

Our paper is also related to the auction theory as applied to treasuries. The 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. 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 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. Weber (1977), Milgrom and Weber (1982) analyze these issues. A number of papers extend 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 these economics by lowering the demand curve.

Empirical papers have 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. We do not tread the same familiar ground here. We focus on the the interaction between the

information produced in the first stage underwriting auction and the equilibrium outcomes in the second stage auction. We exploit the bidder-specific data and address econometric issues relating to "champion's plague" in ongoing work.

Our paper also makes contribution to the implications of strategic competition and asymmetric information on government bond market. Empirical work on these lines in government securities includes Pasquarilo and Vega (2007, 2009) based on theoretical models of Kyle (1985) and Foster and Vishwanathan (1996). This work brings together two market frictions, viz., imperfect competition and information heterogeneity among informed traders. The work focuses on the on-the-run liquidity phenomenon in government bonds (Brandt 2004). Endowment shocks, from recently completed auctions, ameliorate adverse selection problem in on the market and the market maker in turn improves liquidity for on the run market.

Unlike Pasquarilo and Vega (2007, 2009), we do not explain the 'on the run' run phenomenon. We focus on strategic competition and the endowment shocks which arise as equilibrium outcome from the auction process. Put differently, endowment shocks. arise due to the underwriting auction and do so in equilibrium conditional on the private information of dealers. Whether and the extent to which underwriting-related endowment shocks specifically generates on-the-run premiums – and do so in equilibrium with a next-stage auction, which is a significant and non-trivial issue – is an interesting and larger issue. We leave this to future work.

Our paper is also related to the literature on role of inventories of financial intermediaries in asset pricing (Comerton- Forde et al (2010), Hendershot and Seasholes (2007)) who examine the joint dynamics of price and inventories in the stock market and the role of financing constraints induced by trading revenues of specialist inventory positions, respectively. Our focus is on the underwriting stage induced informational and inventory constraints it induces given that the underwriter also participates in and helps determine the outcome in a next stage auction. In our setting, these underwriting concerns lead to bid-shading and affect the market price.

3 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, which is thus usually a Thursday. 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. This will lead to "devolvement" of 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.

3.1 The Underwriting Auction

The underwriting part of the auction has two components. 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.[3]. The MUC is chosen such that when 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 are 17 primary dealers. Thus, the typical MUC was around 3% of the notified amount per dealer.[4]

The second stage is the actual auction of securities. All primary dealers are required to submit bids for *additional competitive underwriting* or ACU for the remaining 50%. A bid is a quantity-commission pair denoting the commission rate, i.e., the compensation that the dealer wants for underwriting the specified quantity. Each dealer may submit multiple bids. The dealer thus submits an underwriting supply curve. However, 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. It is 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 is around 3% of the notified amount. In addition, there is a maximum cap. The total bid submitted by a dealer cannot exceed 30% of the notified amount.

The underwriting commissions are worked out separately for the MUC and ACU. 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.[5]

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 ACU. The total ACU

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

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

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

is, of course, the amount not underwritten by the MUCs. Because 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 to the nature of the bids.

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 ACU bids. All other dealers receive a commission on their MUC equal to the weighted average rate of the three lowest bids in the ACU. This mechanism incentivizes bidding in ACU.

3.2 The Second-Stage Main Auction

The main auction of the notified amount is fairly standard 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 more prevalent in the data during our period of study. The uniform price auctions account for just under three-quarters of all auctions (420 out of 565).

As in many treasury auctions worldwide, the auction can be for the issue of a new security or for the "reissue" of an existing 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 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). There is, however, a wrinkle in the auction format in our setup. 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. Because 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. Thus, there is always adequate demand in the main auction to take up the entire notified amount.

The RBI retains the right to devolve any balance amount to the primary dealers according to their underwriting commitments at a price to be determined ex-post. A total of 49 auctions in our study period are devolved. These represent 8.7% of the total. They are split roughly proportionately between uniform price auctions. 38 auctions, 9% of all uniform price auctions, and 11 discriminatory auctions, 9% of the universe, devolved.

4 Hypothesis Development

As the previous section described; the two stage auction process generates a clear feedback channel of information production. The underwriting auction was designed to give full insurance against possible devolvement of the main auction. Our first sets of hypotheses are therefore on aggregate information production in the underwriting auction (first stage) about the main (second stage) auction. The information about the second stage can be classified into three broad categories: information about possible devolvement (tail risk) of the main auction; information about overall demand in the main auction and information about the post auction secondary market price movements relative to the auction identified price.

The primary dealers in the underwriting auction faces a trade-off: on one hand they want to be aggressive in the underwriting auction to earn the highest possible commission by bidding low commission rates; whereas on the other hand, they do not want to be too aggressive for an issue which may possibly be devolved due to its quality as in that case they have to absorb the devolved amount. The equilibrium outcome of this trade-off should be reflected in the underwriting auction outcomes like the underwriting auction cut-off commission rate; the aggressiveness of the primary dealers measured as the slope of the aggregate (underwriting) supply curve and the variability of bids across the underwriters.

If the auction is a re-issue then the pre-auction secondary market trading information

may also be informative about the main auction outcomes. We have our first hypothesis about the information production about the risk of devolvement as below:

- *Information Hypothesis 1 (Devolvement)* The underwriting auction produces information about the possible risk of devolvement. Aggregate aggressiveness of the primary dealers should predict the probability of devolvement. Moreover conditional on pre-auction secondary market information underwriting auction have more information about the probability of devolvement.

The second information hypothesis is related to information production about the aggregate demand in the main auction.

- *Information Hypothesis 2 (Aggregate Demand)* The underwriting auction produces information about the aggregate demand of the second stage auction. The underwriting auction is incrementally more informative about aggregate demand relative to the information available from the pre-auction secondary market activities.

The next sets of information hypotheses are about the post auction secondary market outcome relative to the auction identified price. The post auction secondary market has three sources of information: the pre auction secondary market information, the underwriting auction information and the main auction information.

- *Information Hypothesis 3 (Post Auction Secondary market Information)* The underwriting auction produces information about post auction secondary market price movements relative to pre-auction secondary market prices. The underwriting auction is more informative relative to pre-auction secondary market trading activities or from the main auction.

- *Information Hypothesis 4 (Underpricing)* The amount of auction underpricing should be dependent on the information produced in the underwriting auction.

One common variable of interest in treasury auction literature is the amount of bid shading by various types of bidders. In the Indian treasury auction besides providing the underwriting service; the primary dealers also participate in the main auction. The equilibrium outcome of the main auction therefore depends on the individual bid shading by the primary

dealers. While submitting their bids in the main auction the primary dealers have access to three sources of information: the pre-auction secondary market information, their private information and the aggregate information from the outcomes of the underwriting auction.

- *Information Hypothesis 5 (bid-shading by Primary dealers)* The bid shading by a primary dealers are positively dependent on their pre underwriting auction information.

As the primary dealers face a trade-off between providing insurance and the commission rates; they want adequate compensation for providing the insurance. They get a direct compensation in terms of the underwriting commission. This is the direct cost of insurance. However a particular primary dealer may have a cap on the position that he may want to have in a particular issue due to various risk management and portfolio driven considerations. The amount of the issue insured by a particular primary dealer in an underwriting auction therefore increases his expected inventory position in a particular issue. In case of a possible devolvement the primary dealer has to absorb that amount on top of the amount that he has won in the main auction. Therefore the amount of the issue underwritten by a primary dealer acts as a constraint (albeit in an expected sense in case of a devolvement) in his bidding behavior. Ceteris paribus, this may make the primary dealer less aggressive in the main auction.

Given that the primary dealers are required to submit at least the amount insured in the main auction they may shade their bid more due to this expected inventory effect. Since the primary dealers are major players in the main auction market and constitute a large part of the aggregate demand, this extra inventory motivated bid-shading in turn reduces the equilibrium auction identified price and hence lowers the revenue. Since this is purely driven by the extra bid shading due to insurance provision of the underwriting auction we term this as the indirect cost of insurance. Our next of hypothesis is related to this indirect cost of insurance. As outlined earlier the inventory effect of the bid=shading is referred is our first hypothesis of indirect of insurance.

- *Cost of Insurance Hypothesis (Inventory Effect)* The bid shading by a primary dealer in the main auction should depend on the amount of the insurance provided by them in the underwriting auction. Moreover this dependence should be increasing with the expectation of the probability of devolvement of the main auction.

There is a clear degree of asymmetry among the primary dealers in terms of the amount of insurance provided by them depending on whether they are a bank primary dealer or not. A bank primary dealer have the opportunity to take the amount of bonds won in the main auction towards maintaining their statutory liquidity ratio (SLR) requirement set by the RBI. This therefore relaxes their budget constraint and a bank primary dealer should be less aggressive in the main auction and shed their bid less.

- *Balance Sheet Hypothesis* A bank primary dealer should shed their bid less in the main auction relative to a standalone primary dealer.

Given the common value nature of the bonds; due to winner's curse the bidding behavior of the primary dealers should be very sensitive to the dispersion of information in the secondary market as well as among the primary dealers. Therefore all the equilibrium outcomes should be sensitive to a measure of degree of information.

- *Information Hypothesis 6 (Winner's Curse)* The volatility of secondary market prices as a proxy for winner's curse should affect the equilibrium outcomes of all the hypotheses above.

5 Data Description and Summary Statistics

5.1 Data

Our data come in two parts, the primary market auction data and secondary market trading data. 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. The secondary market data contains intra-day trading information (prices and quantities) for each trade for each bond.

For each primary 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. 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 565 auctions of government securities over the period 2006-2012 plus the underwriting auction data for each auction; we have secondary market trading price and volume information for 416 of these.

As described in Section 3, the minimum underwriting commitment ("MUC") 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 two revenue outcomes. One is the the "additional competitive underwriting" (ACU) commission. In addition, the underwriting auction also sets the commission for their mandatory MUC. We observe the complete supply curve (commission rate-quantity pairs) submitted by each dealer in the ACU auction. Thus, we observe the cut-off commission rate at which the entire auctioned quantity is underwritten. We also observe the commissions received by each primary dealer as ACU commission and MUC commission.

Our sample comprises 565 second-stage auctions of which 420 are uniform price auctions and the remaining are discriminatory. For each auction, we observe the entire demand curve (price-quantity pairs) submitted by each bidder. We observe the cut-off auction price, which is the highest price at which demand equals or exceeds supply. For the 49 devolved auctions, we also observe the devolvement price and the quantity devolved to each primary dealer.

5.2 Summary Statistics

Table 1 gives basic summary statistics across the auctions in our data set. Between 16 and 18 primary dealers are active in our sample period. Table 2 provides the names of the primary dealers who are currently active. The primary dealers are classified as standalone (Standalone PD) or bank primary dealer (Bank PD). Bank PDs are primary dealers who also provide other banking services in India. We do not observe dealer names associated with each bid but we know whether the dealer was a Bank PD or a Standalone PD. We use this field as a source of dealer heterogeneity. Bank PDs can use the amount of government bonds won towards meeting "statutory liquidity ratio" reserve requirements that commercial banks must meet.

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

Source: https://www.rbi.org.in/scripts/AboutUsDisplay.aspxpg=PrimaryDealer.htm

5.3 Secondary Market Prices

In Figure 1, we present secondary market data, or prices prevalent in the after-market subsequent to the auction's conclusion. We compare the average value-weighted prices in the pre- and post-auction secondary market relative to the auction identified price for the same bond. The point corresponding to Pre-Auction Price represents the average value weighted prices in the secondary market two days before the auction, averaged across all auctions. Similarly, "Post Auction Price" corresponds to the average value weighted price in the secondary market two days after the auction, averaged across all auctions. The Auction Price is the average of the auction-identified price of all auctions. The bands represent the mean price $\pm$ 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 pre- and post-auction secondary market prices.

Table 3 provides an aggregate picture of the "money left on the Table" by the underpricing taken over all the auctions in our data set. We compute two sets of numbers, one using he post-auction secondary market prices and one using the pre-auction secondary market prices. The first measure, the "Ex-post money left on the Table" measure, is calculated as

$$\frac{\text{Post-Auction Price} - \text{Auction Price}}{100} \times \text{Notified Amount.}$$

"Ex-ante money left on the Table" is calculated similarly using the pre-auction market price.

The top half of Table 3 describes the ex-post measure. The total "ex-post money left on the Table" amounts to about INR 31.48 billion, roughly 18.6 basis points of the aggregate amount auctioned in these 416 auctions of INR 16860 billion. The ex-ante measure has a slightly lower median and standard deviation, but is overall very similar, with a total underpricing "loss' of INR 30.74 billion (about 16.3 basis points). Unsurprisingly, auctions that were eventually devolved showed a weaker auction demand and so more money left on the Table.

5.4 Variable Definitions

In this section, we identify the main variables of interest (dependent and independent)consistent with our hypotheses that are used in the analysis in the rest of this paper. Our main focus

Figure 1: 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.

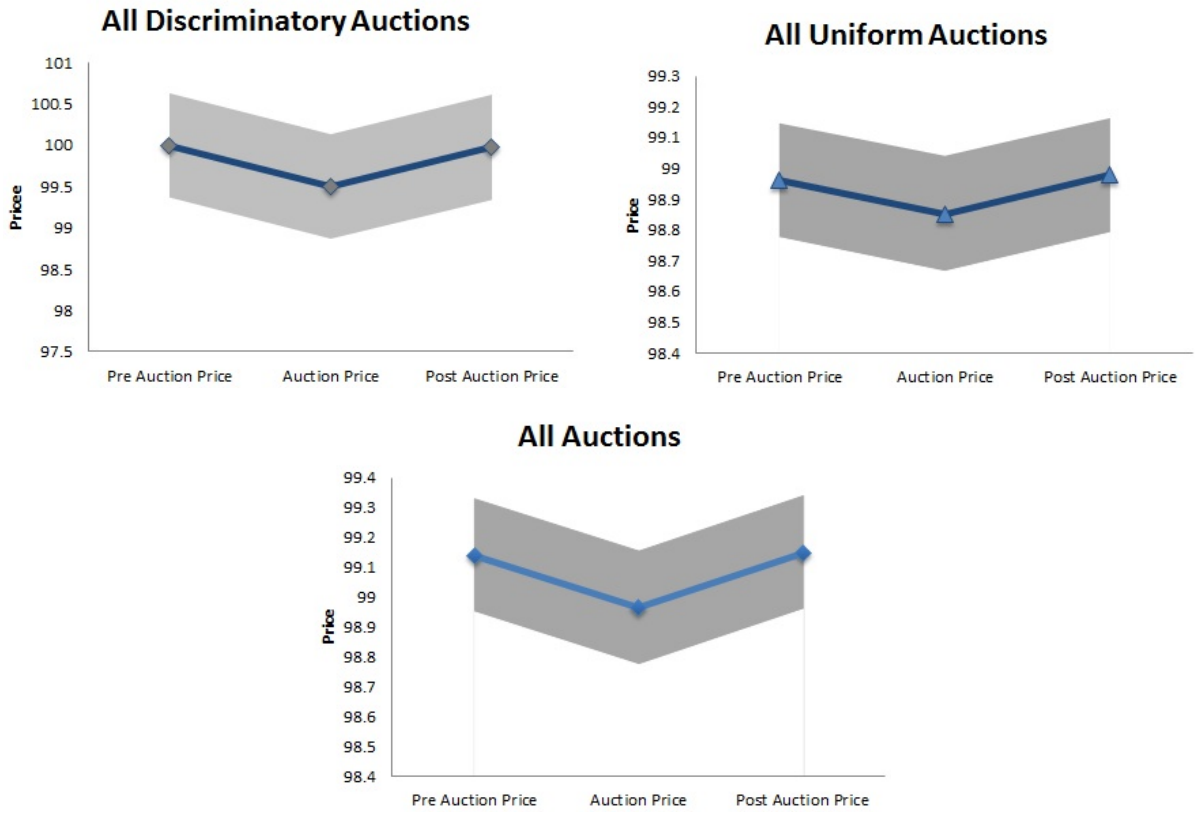

Table 3:

Auction Underpricing: Money Left on Table

Ex-post measure of Money Left on the Table

	Mean	Median	Stdev	Total	# Auctions	Notified Amt
All Auctions	0.08	0.04	0.26	31.48	416	16860
All Successful Auctions	0.07	0.04	0.23	28.45	387	15650
All Devolved Auctions	0.11	0.04	0.51	3.04	29	1210
All Discriminatory Auctions	0.21	0.12	0.47	14.78	72	3260
All Uniform Auctions	0.05	0.03	0.17	16.71	344	13600
All Successful Uniform	0.05	0.03	0.17	15.88	320	12570

Ex ante measure of Money Left on the Table

	Mean	Median	Stdev	Total	#Auctions	Notified Amt
All Auctions	0.07	0.03	0.15	30.74	416	16860
All Successful Auctions	0.07	0.03	0.14	27.75	387	15650
All Devolved Auctions	0.11	0.04	0.51	3.04	29	1210
All Discriminatory Auctions	0.22	0.15	0.21	15.50	72	3260
All Uniform Auctions	0.04	0.02	0.12	15.24	344	13600
All Successful Uniform	0.04	0.02	0.10	12.87	320	12570

throughout is on understanding the part played by the underwriting auction—inter alia, the information it generates for devolvement, its relation to underpricing, and its impact and influence on secondary market price formation.

5.4.1 Price and Demand Outcomes

Our first task is to construct variables useful in addressing the above questions. Four quantities are of immediate interest to test hypotheses 1 through 4

- *Tail risk*, measured as the probability of devolvement of the main auction.
- *Aggregate demand*, the total demand for bonds in the second stage auction relative to available supply.
- *Secondary market price movements*, measured as the log of the ratio of post-auction price to pre-auction price.
- *Underpricing* or "money left on the Table" in the main auction, measured as the log of the ratio of the post-auction price to the auction cut-off price.

5.4.2 Underwriting Cost Outcome

The underwriting auction decides compensation of primary dealers for taking on the risk of devolvement. The direct cost of the insurance they provide is measured by the total commission paid in the underwriting auction. The insurance provided of the primary dealer can lead to an indirect cost through the alteration of the bidding behavior of a primary dealer in the second stage of the auction. This indirect cost can be measured as the extent to which a primary dealer "shades" its bid. We construct various measures of bid shading in the second stage auction by a generic primary dealer. We thus measure the cost of the underwriting as

- Direct cost: The commissions for minimum compulsory underwriting (MUC) and additional competitive underwriting (ACU).
- Indirect cost: Captured by bid shading by the primary dealers in the main auction in proportion of the amount underwritten (insured) in the first stage.

We gather all of the above variables and their formal definitions in Table 4. Tables 5 and 6 provide summary statistics of these variables. The first is a breakup across auction types. The second is divided across devolved auctions and those that do not devolve. Our numbers show that the aggregate demand is lower in devolved auctions. The discriminatory price format leads to lower post-auction price change relative to the uniform price format. Primary dealers shade their bids more in discriminatory auctions than in other definitions of bid shading. Their bid shading is also much higher in auctions that are later devolved.

Table 4: Variable Definitions: Dependent Variables

Dependent Variables	Definitions
devolved	A dummy=1 if the auction ended up devolving
bid_cover	Total competitive demand/notified amount
Ret_2day	log(value weighted Pt+2/value weighted Pt-2)
Underpricing	log(value weighted Pt+2/auction cut_off price)
bid_shading_member	1-(value weighted bid by a PD/value weighted Pt+2)
nobids_bidder	No of bid points in the demand curve by a PD
bidvar_bidder	Std Dev of bids by a PD

5.4.3 Information Production and Bidder Aggressiveness

We now turn to information production variables. We classify three different categories of determining factors: pre-auction secondary market information, underwriting auction information and second stage auction (of government bonds) information. In the Table below we define the variables used in the subsequent analysis. We use two pre-auction variables from the secondary market trading: the volume traded as a proxy for liquidity and the volatility of the secondary market prices as a proxy for winner's curse. The notified amount in the auction is used to control for the supply of the issue. We use three underwriting auction information. The cut-off of underwriting auction is used as a proxy for the quality of the issue and primary dealers' aggressiveness.

We fit a log linear aggregate supply function for each underwriting auction and use the estimated intercept as a proxy for primary dealers' aggressiveness: higher the value of this intercept, higher the base level of compensation primary dealers demand for underwriting the issue. We also use the normalized bids (commission rates) in the underwriting auction as a

Table 5: Summary Statistics of Dependent Variables I

All Auctions

	MEAN	MEDIAN	STDEV
bid_cover	2.37	2.30	0.70
Underpricing	0.00	0.00	0.01
Ret_2day	-6.30	-6.25	1.16
bid_shading_member	0.009	0.005	0.02
nobids_bidder	4.500	4.000	3.79
bidvar_bidder	0.455	0.290	1.22

Uniform Price Auctions

	MEAN	MEDIAN	STDEV
bid_cover	2.27	2.22	0.47
Underpricing	0.00	0.00	0.00
Ret_2day	-6.46	-6.34	1.04
bid_shading_member	0.008	0.005	0.01
nobids_bidder	3.957	3.000	2.93
bidvar_bidder	0.408	0.276	0.87

Discriminatory Price Auctions

	MEAN	MEDIAN	STDEV
bid_cover	2.27	2.22	0.47
Underpricing	0.01	0.00	0.01
Ret_2day	-5.48	-5.47	1.43
bid_shading_member	0.019	0.01	0.03
nobids_bidder	7.348	6.00	5.90
bidvar_bidder	0.669	0.37	2.20

Table 6: Summary Statistics of Dependent Variables II

Devolved Auctions			
	MEAN	MEDIAN	STDEV
bid_cover	1.86	1.72	0.67
Underpricing	0.00	0.00	0.01
Ret_2day	-6.46	-6.25	0.95
bid_shading_member	0.014	0.01	0.02
nobids_bidder	4.309	3.00	3.96
bidvar_bidder	0.727	0.45	1.27

Successful Auctions			
	MEAN	MEDIAN	STDEV
bid_cover	2.42	2.34	0.68
Underpricing	0.00	0.00	0.01
Ret_2day	-6.29	-6.25	1.18
bid_shading_member	0.009	0.01	0.02
nobids_bidder	4.518	4.00	3.77
bidvar_bidder	0.430	0.28	1.21

measure of dispersion of information among the primary dealers. We use various second stage auction specific variables to proxy for information production in the second stage auction. The number of bidders and proportion of standalone and bank primary dealers out of total bidders are used as a proxy and sources of competition. The bid cover from all bidders as well as that from the primary dealers are used as proxy for aggregate demand and its source in the second stage auction.

The numerical slope of the aggregate demand curve in the second stage auction is used as a proxy for aggressiveness of bidders. The slope of only the primary dealers' demand curve in the second stage auction is used as the aggressiveness of the primary dealers in the second stage auction. A dummy for whether the bid is coming from a bank primary dealer is aimed to test whether the bank primary dealers have a different objective function and hence bid differently relative to a standalone primary dealer. We define these variables in Table 7 below and explain their role in Table 8.

In Table 9 we report the descriptive statistics of all the independent variables across different auction formats as well as whether the auction was devolved or not.

Table 7: Variable Definitions

Variable Names	Variable Descriptions
uniform_dum	dummy=1 if uniform auction, 0 if discriminatory
PD	Primary Dealers
UW	Underwriting
vol2daydaypre_buy	Volume of bonds traded (INR billion) 2 days prior to the auction
stdev2daypre_buy_norm	The Std dev of 2 day pre secondary market prices
NTFD AMT	Notified amount (in INR billion)
devolved	A dummy=1 if the auction ended up devolving
acubid_var_norm	Std dev of ACU bids normalized by value weighted price two days pre auction
UW SS Curve Intercept	The intercept from the estimated log supply curve in the UW auctions
log_uwcutoff	The log of the cutoff price in the underpricing auction
no of bidders in an auction	No of bidders in the second stage auction
prop_BKPD_bidder_auction	Proportion of Bank PD bidders relative to total bidders in the main auction
prop_stdalonePD_bidder_auction	Proportion of Standalone PD bidders relative to total bidders in the main auction
bid_cover	Total competitive demand/notified amount
bid_cover_pd	Total competitive PD demand/notified amount
bid_var_norm	Std dev of bond auction bids normalized bythe 2 day pre Value weighted price
bid_varPD_norm	Std dev of PD bids normalized bythe 2 day pre Value weighted price
slope_auction_avg	Average slope of the aggregate demand curve in the main auction
slope_auction_pd_avg	Average slope of the PD demand curve in the main auction
log_aucP_norm	Auction cutoff price normalized by the two day pre value weighted price
alloc_amtprop_bidder	The ACU amount won by a PD bidder in UW auction normalized by NTFD
BKPD_dum	A dummy=1 if the bidder is a bank PD

Table 8: Independent Variables and Their Potential Impact

Variable Names	Economic Impact
Uniform Dum	Empirical question
vol2daydaypre_buy	Proxy of pre auction liquidity
stdev2daypre_buy_norm	Proxy for pre auction winner's curse
NTFD AMT	The supply of govt bonds in the auction
devolved	Proxy for bad information about demand in the auction
acubid_var_norm	Proxy for UW auction winner's curse, also a proxy for information produced in UW auction
UW Supply Curve Intercept	Proxy for aggressiveness in the UW auction: More aggressive means they demand more commission to underwrite the issues;
log_uwcutoff	Same as above
no of bidders in an auction	Proxy for competition
prop_BKPD_bidder_auction	Proxy for competition from Bank PDs
prop_stdalonePD_bidder_auction	Proxy for competition from standalone PDs.
bid_cover	A proxy for aggregate demand in the second stage
bid_cover_pd	A proxy of PD demand in the second stage; Is the PD demand more informative for secondary market prices?
bid_var_norm	Proxy of winner's curse in the main auction
bid_varPD_norm	Proxy of winner's curse amongst PDs in the main auction
slope_auction_avg	A proxy of demand in the second stage; Steeper slope means less aggressive demand
slope_auction_pd_avg	A proxy of PD demand in the second stage
log_aucP_norm	Proxy for information content of the auction about ex post secondary market
alloc_amtprop_bidder	Proxy for the cost of insurance. Higher amount underwritten may lead to more bid shading in the second stage
BKPD_dum	Does the bank PDs have a different objective function and hence less aggressive in the main auction?
Bid_shading by primary dealers	Indirect cost of insurance: a component of money left on Table

Table 9: Summary Statistics of Independent Variables I

	All Auctions		
VARIABLES	MEAN	MEDIAN	STDEV
vol2daY Post_buy	13.42	2.36	22.91
vol2day_pre_buy	13.54	5.30	19.34
stdev2daypre_norm	0.01	0.00	0.07
ntfdamt	40.04	40.00	14.53
No_of Trades_2 Day Post	165	66	217
No_of Trades_2 Day Pre	134	56	174
acubid_var_norm	0.03	0.02	0.03
UW SS Curve Intercept	0.65	0.80	2.42
log_uwcutoff	-8.91	-9.12	1.21
no_bidder_auction	46.92	46.00	10.35
prop_BKPD_auction	0.27	0.26	0.06
prop_stdalonePD_in auction	0.17	0.16	0.04
bid_cover_pd	1.44	1.38	0.34
bid_var_norm	0.02	0.00	0.04
bid_varPD_norm	0.01	0.00	0.03
slope_auction_avg	0.00	0.00	0.05
slope_auction_pd_avg	0.00	0.00	0.00
log_aucP_norm	0.00	0.00	0.04

6 Results

We provide empirical evidence next. We can classify the hypotheses into two categories, one about the information production in the underwriting auction and the other concerning the costs of insurance of the underwriting auction.

6.1 Information Production in the Underwriting Auctions

We have four information production hypotheses. One is about information production in the underwriting auction relative to the probability of devolvement and to the strength of the demand in the second stage auction. The third and fourth concern the post-auction secondary price movements and the V-shaped ex-post secondary market price relative to the auction identified price. We test these hypothesis first.

6.2 Devolvement

In Table 10, we analyze the role of the underwriting auction in predicting the probability of devolvement. In the logistic regression, the dependent variable is 1 if the auction devolves and is zero otherwise. The results provide strong support for Hypothesis 1. We find that the underwriting auction is the sole determinant of the probability of devolvement tail risk. It subsumes other explanatory variables that we include.

The first column in Table 10 accounts for only pre-auction information. If underwriting auction information is not taken into account then only the pre auction traded volume (weakly) predicts the probability of devolvement. Higher traded volume represents higher demand and liquidity in the pre-auction secondary market and leads to lower chance of devolvement.

Greater volatility of bids in the underwriting auction ($acubid_var_norm$) could signal higher degree of winner's curse among primary dealers and hence higher chance of devolvement. This is consistent with information hypothesis 6. If the primary dealers expect the auction to potentially devolve then they will be more aggressive in demanding a higher base rate of commission (as proxied by the estimated by the UW Supply Curve Intercept). The auction identified cut-off rate appears to contain better information about the probability of

devolvement and supersedes any other information. The bottom line is that the underwriting auction is informative about later auction outcomes. To mitigate risks, underwriters are incentivize to produce information and incorporate it into their underwriting bids.

6.3 Aggregate Demand

In Table 11 we analyze the role of the underwriting auction in predicting the aggregate demand in the second stage auction. The aggregate demand is proxied by the bid cover (total competitive amount bid relative to the notified amount) in the second stage auction. We regress the bid cover on pre auction and underwriting auction variables. Once again, the underwriting auction process plays a significant role in predicting the aggregate demand in the second stage auction. In the first two columns of Table 11 we use the bid to cover from all (successful and devolved) auctions. In the last two column we represent bids cover from only successful auctions. We discuss the results next.

The first column in Table 11 only has pre-underwriting auction information. Both liquidity (as proxied by trading volume) and winner's curse (as proxied by volatility of traded prices) in the pre-auction secondary market are significant determinants of the demand in the second stage auction with an adjusted R-square of about 20% with a significant constant term indicating possible other determinants. The introduction of underwriting auction information increases the adjusted Rsquare by 25% from 0.20 to 0.25.

The introduction of underwriting information also makes the constant insignificant. This suggests that the underwriting auction provides incrementally more information about auction aggregate demand relative to the information available from the pre-auction secondary market trades. This strongly supports hypothesis 2. Only the pre-auction winner's curse still matters in predicting aggregate demand supporting information hypothesis 6 about winner's curse. Higher underwriting cut-off prices are a significant determinant of lower demand.

Interestingly, greater aggressiveness of primary dealers as estimated by the underwritingsupply curve estimate also predicts greater demand. This finding may highlight the preference for commissions in the objective function of the underwriters. The steepness of the supply curve may lead to higher cut-off price although the intercept remains the same. Therefore, the underwriting cut-off price may give a better picture about the aggregate demand. The primary dealers may bid in such a way that they earn higher commission (hence

Table 10: Devolvement Regression

	Devolvement Regressions		
uniform_dum	0.32	1.29	-0.12
	-0.24	-0.92	-0.08
NTFD AMT	0.03	0.03	0.01
	-1.12	-1.10	-0.24
stdev2daypre_buy_norm	-1.54	-0.15	1.53
	-0.34	-0.03	-0.34
vol2daydaypre_buy	-0.11	-0.10	-0.05
	(1.86)*	-1.47	-0.61
acubid_var_norm		12.02	1.41
		(2.10)**	-0.18
UW SS Curve Intercept		0.31	-0.46
		(2.00)**	-1.39
log_uwcutoff			1.29
			(2.70)***
2008bn.auc_yr	-2.38	-3.06	9.49
	(1.81)*	(2.55)**	(2.06)**
2009.auc_yr	-1.64	-2.96	8.98
	-1.24	(2.23)**	(2.02)**
2010.auc_yr	-3.54	-4.20	8.03
	(2.51)**	(3.09)***	(1.78)*
2011.auc_yr	-2.26	-3.08	8.84
	(1.68)*	(2.38)**	(1.98)**
2012.auc_yr	-4.39	-4.97	7.17
	(2.93)***	(3.40)***	-1.63
N	439	404	404

Logistic regression modeling success or devolvement of auction.
Robust t-statistics in the parentheses. *p< 0.1; ** p<0.05; *** p<0.01

Table 11: Information Production about 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. The * represents levels of significance *p< 0.1; ** p<0.05; *** p<0.01

	All Auctions		Successful Auctions	
uniform_dum	-0.26	-0.20	-0.32	-0.26
	(1.69)*	-1.25	(2.10)**	-1.59
vol2daydaypre_buy	0.00	0.00	0.00	0.00
	(2.13)**	-1.64	-1.37	-1.25
stdev2daypre_buy_norm	-3.89	-4.16	-4.08	-4.21
	(5.21)***	(6.14)***	(5.41)***	(5.99)***
NTFD AMT	-0.01	0.00	-0.01	0.00
	(5.14)***	-0.42	(4.45)***	-0.53
acubid_var_norm		-0.96		-0.89
		-1.39		-1.14
UW SS Curve Intercept		0.12		0.12
		(3.52)***		(3.18)***
log_uwcutoff		-0.20		-0.17
		(4.88)***		(3.87)***
Constant	2.94	0.57	2.89	0.81
	(18.19)***	-1.02	(17.15)***	-1.34
Year Fixed Effects	Y	Y	Y	Y
AdjustedR^2	0.20	0.25	0.21	0.24
N	450	447	414	412

higher supply curve intercept). Overall, Table 11 strongly supports hypothesis 2 about the informative role of the underwriting auction about aggregate demand.

6.4 Underwriting Versus Main Auction in Predicting Post-Auction Prices

In Table 12 we analyze the role of information production in the underwriting auction relative to the second stage auction about post auction secondary market price movements. In this Table we provide evidence supporting Hypothesis 3. The dependent variable is the log of the 2-day post auction value weighted price divided by the value weighted price two days prior to the second stage auction. We call this variable as market return. We test whether the underwriting and second stage auction contain information about the relative difference between the two shoulders in the V-shaped price patterns.

We find both the underwriting and the second stage auction have significant information content about post auction price movements. The first column only has only pre auction information. Only pre auction the winner's curse proxy (as volatility of pre auction secondary market prices) affects the return. As expected higher winner's curse leads to higher return. This effect is strongly maintained throughout whether we have underwriting and second stage auction information incorporated or not (across all the columns).

The underwriting auction information (in the second column) has more information about two-day price change as the adjusted R-squared increases. Greater underwriting cutoffs lead to greater two day return, perhaps due to its serving as a signal of lower quality. Higher volatility in the bids in the underwriting auction leads to lower returns, consistent with greater information production in the underwriting auction. Interestingly the second stage auction provides *less* information than underwriting auction. The adjusted R-squared is about lower than in column 2. Only the demand related information from the second stage auction matters. Higher aggregate demand (bid cover) leads to higher price change.

Higher primary dealer demand (proxied by bid cover pd and prop stdalonePD bidder auction) leads to lower price change. This may signify flipping behavior of the primary dealers in the secondary market. Higher demand by the primary dealers in the auction will lead them to win more in the auction which they would like to flip in the secondary market. Given that there is a V-shaped price pattern described earlier they will make a profit through

such strategies. Higher flipping (selling) activity by primary dealers in the secondary market post auction will lead to lower prices. Interestingly when all information is incorporated (pre-auction, UW auction, second stage auction); adjusted Rsq goes down (0.22) relative to only when UW auction information were incorporated (0.25). This signifies the information production role of the underwriting auction. Overall Table 12 strongly supports information hypothesis 3.

6.5 Underpricing Relative to Post-Auction Prices

We next turn to the underpricing in the second stage relative to the post auction secondary market price. We measure underpricing as the difference between the post auction value weighted price relative to the auction identified price. Table 13 reports the results. We first introduce pre-auction information, then the underwriting auction information.

The pre auction information (first column) is mostly insignificant in predicting the underpricing with a significant constant. The introduction of underwriting auction information (second column) makes the constant insignificant. Higher underwriting cut-off leads to higher underpricing. As we saw earlier higher undrwriting cut-off predicts lower demand in the second stage auction. Lower demand in the second stage will lead to lower auction identified price and hence higher underpricing. This sign is consistent throughout in all other specifications except the last one.

Among the second stage auction information variables, we find that demand from primary dealers in the main auction information (third column) is significant in predicting underpricing. Greater the slope of the primary dealer's demand curve, lower the underpricing. Because the slope is a negative number, greater slope leads to less aggressiveness of the primary dealers (thus a flatter demand curve) and hence higher auction identified price, which leads to less underpricing. The sign of this relation is also consistent with a flipping argument. Flatter (less aggressive) demand curves by primary dealers leads them to win less in the auction and hencethey have less desire to flip post auction. They will therefore put less selling pressure post auction and hence lower post auction price. This sign is consistent in all other specifications. Overall ,Table 13 strongly supports information hypothesis 3.

Table 12: Information production about post auction price change

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

	Return Regressions				
uniform_dum	-0.46	-0.22	-1.21	0.28	0.27
	-0.77	-0.41	(2.03)**	-0.50	-0.53
vol2daydaypre_buy	0.003			0.004	0.004
	-0.71			-0.81	-0.71
stdev2daypre_buy_norm	192.45			177.93	158.31
	(2.41)**			(3.75)***	(2.38)**
NTFD AMT	0.00	0.01	0.01	0.00	0.00
	-0.07	-0.77	-0.77	-0.12	-0.02
devolved	0.10	-0.05	0.22	0.18	0.18
	-0.38	-0.16	-0.78	-0.58	-0.57
acubid_var_norm		-8.89		-6.60	-5.98
		(2.06)**		-1.41	-1.32
UW SS Curve Intercept		0.02		0.02	0.03
		-0.25		-0.17	-0.28
log_uwcutoff		0.40		0.30	0.25
		(3.30)***		(2.41)**	(1.88)*
no of bidders in an auction			-0.01395	0.04	0.05
			-0.55	-1.62	(1.77)*
prop_BKPD_bidder_auction			2.41	9.48	10.15
			-0.53	(2.09)**	(1.91)*
prop_stdalonePD_bidder_auction			-11.11	-8.72	-7.71
			(1.94)*	-1.62	-1.39
bid_cover			0.49	0.47	0.49
			(2.32)**	(2.12)**	(2.11)**
bid_cover_pd			-0.95	-0.71	-0.66
			(3.03)***	(2.00)**	(1.85)*
bid_var_norm			2.11	0.63	-0.21
			-0.83	-0.27	-0.08
bid_varPD_norm			4.25	2.88	3.33
			-1.02	-1.26	-1.49
slope_auction_avg			-5.95	-15.71	-22.21
			-0.15	-0.44	-0.58
slope_auction_pd_avg			-1.49	-3.80	-1.67
			-0.29	-0.72	-0.31
log_aucP_norm					-69.00
					-1.43
Constant	-6.32	-2.83	-4.68	-6.59	-8.19
	(18.24)***	(1.83)*	(2.64)***	(3.02)***	(3.24)***

Table 13: Underpricing in the Auction

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

	Underpricing Regressions				
uniform_dum	-0.0007	-0.0001	-0.0007	0.0003	0.0020
	-0.1500	-0.0100	-0.1400	-0.0700	-0.4400
vol2daydaypre_buy	0.0000			0.0000	0.0000
	(1.69)*			-0.8000	-0.6000
stdev2daypre_buy_norm	0.4149			0.2576	-0.1038
	-1.1900			-0.6400	-0.2500
NTFD AMT	0.0000	-0.0001	0.0000	0.0000	-0.0001
	-0.2600	-0.6600	-0.2700	-0.4400	-0.6400
devolved	0.0010	0.0003	0.0006	-0.0002	0.0004
	-0.4400	-0.1500	-0.2900	-0.0800	-0.1900
acubid_var_norm		-0.0078		-0.0112	-0.0043
		-0.6500		-0.8400	-0.3900
UW SS Curve Intercept		-0.0003		-0.0005	-0.0005
		-0.4900		-0.6700	-0.7000
log_uwcutoff		0.0016		0.0014	0.0010
		(2.85)***		(2.46)**	-1.6500
no of bidders in an auction			-0.00018	-0.0001	0.0000
			(1.72)*	-0.4400	-0.0800
prop_BKPD_bidder_auction			-0.0102	0.0048	-0.0064
			-0.5200	-0.2200	-0.2600
prop_stdalonePD_bidder_auction			-0.0161	-0.0133	0.0125
			-0.6700	-0.5000	-0.4000
bid_cover			0.0005	0.0005	0.0005
			-0.4200	-0.3200	-0.3000
bid_cover_pd			-0.0018	-0.0011	-0.0009
			-1.4900	-0.6900	-0.5900
bid_var_norm			0.0144	0.0098	0.0163
			-0.8700	-0.5700	-0.9300
bid_varPD_norm			0.0006	-0.0004	0.0036
			-0.0300	-0.0200	-0.1700
slope_auction_avg			0.0293	0.0410	0.0724
			-0.1700	-0.2400	-0.4000
slope_auction_pd_avg			-0.1211	-0.1209	-0.1029
			(3.46)***	(3.44)***	(2.82)***
log_aucP_norm					-0.6357
					(2.43)**
Constant	-0.0135	0.0027	-0.0025	0.0034	-0.0047

6.6 Cost of the Underwriting Auction

A major role of the underwriting auction is to provide insurance against possible devolvement of the second stage auction. The primary dealers provide that insurance in return of a premium. There are two components of that premium. One is the direct cost of the premium. The second is the indirect effect on the second stage bid caused by the need for underwriters to provide stage 1 insurance. The fact that they provide insurance may lead underwriters to share bids in the later stage and lead to lower auction prices. We term this as indirect cost of insurance and refer this as cost of insurance hypothesis.

6.6.1 Direct Cost of the Underwriting Auction: Commissions

In Tables 14, 15 and 16 below we give the summary statistics on commissions paid and its components for the underwriting auctions. Total commissions charged by primary dealers are about INR 9.2 billion. Substantially higher commissions were charged per devolved auctions (total :INR 0.058 billion, ACU: 0.015) relative to successful auctions (total 0.013, ACU: 0.005). Primary dealers had better information about the possible devolvement.

In Table 15 we give the break up of commissions charged for different format of second stage auctions.Substantially higher commissions were charged per discriminatory auctions (total :INR 0.051 billion, ACU: 0.015) relative to uniform auctions (total 0.009, ACU: 0.004). The break up of commissions charged across devolved and successful auctions and different auction types are given below.

It is interesting to note that discriminatory auction format warranted more commissions for both successful and devolved second stage auctions relative to uniform format. The relative performance of uniform versus discriminatory auction is an empirical question as theory in this setting is not unambiguous. In the Indian treasury auctions, the uniform price auction is ranked higher than the discriminatory auction both in terms of the insurance premium (commissions) paid and (as we show below), the bid shading by primary dealers. These findings are indicative rather than firm, and suggest an interesting avenue for further research.

Table 14: Direct Cost of Insurance: Underwriting Premium

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 15: Direct Cost of Insurance: Underwriting Premiums Across Auction Types

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

6.6.2 Indirect Cost of the Underwriting Auction: Bid Shading by Primary Dealers in the Second Stage

In this section we provide evidence supporting the cost of insurance and balance sheet hypothesis. The V-shaped price pattern that was described earlier crucially depends on how the bidders shed the bids in the second stage auction and hence suppress the auction-identified price. A substantial part of the demand in the second stage auction comes from the primary dealers. If the primary dealers shade their bids more, we may find a deeper V-shaped pattern and hence more auction underpricing and money left on the table.

Due to various risk management requirements the primary dealers may have an objective to hold a target amount of bond in an expected sense through the auction process. They can get the bonds in two different ways through the auction. First, they may bid and win in the second stage auction. Second, they may end up winning additional amounts depending on the occurrence of a devolvement and the amount insured by the dealers against such devolvement.

Table 16: Direct Cost of Insurance: Underwriting Commissions

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.

Variables	Mean	Median	Stdev	Total	# Auctions
Successful Uniform Second Stage Auctions					
Total Commission	0.007	0.002	0.03	2.94	429
Total ACU Commission	0.003	0.001	0.01	1.26	429
Total MUC Commission	0.004	0.001	0.02	1.68	429
Devolved Uniform Auctions					
Total Commission	0.034	0.008	0.09	1.18	35
Total ACU Commission	0.011	0.004	0.02	0.366	35
Total MUC Commission	0.023	0.004	0.07	0.818	35
Successful Discriminatory Second Stage Auctions					
Total Commission	0.04	0.011	0.11	3.53	88
Total ACU Commission	0.013	0.003	0.04	1.18	88
Total MUC Commission	0.027	0.008	0.08	2.35	88
Devolved Discriminatory Second Stage Auctions					
Total Commission	0.129	0.101	0.1	1.54	12
Total ACU Commission	0.029	0.027	0.02	0.343	12
Total MUC Commission	0.1	0.073	0.08	1.2	12

The upshot is that if a particular primary dealer ends up insuring more in the first stage underwriting auction, bid shading may increase to meet a target bond holding. We call this (expected) inventory effect. We also term it an indirect cost of insurance since the motivation of extra bid shading arises due to the provision of insurance by the primary dealers. If this argument is true, this inventory effect will be stronger for auctions which has higher chance of devolvement. In the following sets of regressions reported in Table 17 we test the above hypothesis and quantify the bid shading component by the primary dealer related to his insured amount as indirect cost of insurance.

In these set of regressions we look at the bidding behavior of the primary dealers in the main auction and the determinants of their bid shading. We find strong support for our hypothesis in Table 17. The amount of insurance coverage provided by each primary dealer relative to the total issue size (alloc amtprop) significantly increases bid shading. As in Table 6.2 the underwriting cut-off commission is the best predictor of the probability of devolvement. The interaction of the insurance cover and the underwriting cut-off rate (alloc cutoff) is also significantly increases bid shading suggesting that higher the chance of devolvement makes the inventory effect stronger. This strongly supports the cost of insurance hypothesis.

Other factors could lead the primary dealers to shed their bids. Higher winners curse proxied by volatility of pre auction secondary market prices lead to higher bid shading supporting information hypothesis 6. Higher pre auction trading volume signifying higher secondary market liquidity and demand leads to less bid shading. Higher values of the underwriting auction cut-off price and the intercept of the underwriting supply curve both signals lower demand and leads to more bid shading. The volatility of the underwriting bid (commission rates) prices (acubid var) may signify more information production in the underwriting auction and hence leads to less bid shading. The bank primary dealers can use part of the amount won in the auction towards meeting their SLR reserve requirement and thus face more relaxed financing constraints. This may lead bank PD's to shade their bid less relative to a standalone primary dealer.

Table 17: Indirect Cost of Insurance:Bid Shading by Primary Dealers

The following are the OLS regressions on determinants of the bid shading by primary dealers in the second stage auction. The dependent variable is (1-value weighted bids /Pt+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

	Bid shading Regressions			
uniform_dum	-0.01	-0.01	-0.01	-0.01
	(5.15)***	(4.32)***	(7.69)***	(2.19)**
vol2daydaypre_buy	0.00			0.00
	(7.82)***			(2.84)***
stdev2daypre_buy_norm	2.63			1.47
	(10.77)***			(5.54)***
NTFD AMT	0.00	0.00		0.00
	(4.60)***	(11.03)***		-1.26
alloc_amtprop_bidder		0.01		0.01
		(3.94)***		(3.68)***
log_uwcutoff		0.00		0.00
		(8.72)***		(2.08)**
acubid_var_norm		-0.01		-0.02
		(2.38)**		(3.12)***
BKPD_dum			-0.001	-0.001
			(2.79)***	(3.17)***
UW SS Curve Intercept			0.002	0.002
			(14.27)***	(3.57)***
no of bidders in an auction			0.00023	0.00
			(2.65)***	(3.21)***
prop_BKPD_bidder_auction			0.04	0.01
			(2.01)**	-0.33
prop_stdalonePD_bidder_auction			0.01	0.09
			-0.31	-1.32
Constant	0.00	0.03	-0.02	-0.03
	(2.87)***	(7.98)***	(3.70)***	(3.80)***
Year Fixed Effects	Y	Y	Y	Y
AdjustedR2	0.14	0.10	0.15	0.12
N	7,595	6,796	8,052	6,598

6.7 Benefits of the Underwriting Auction

A major role of the underwriting auction is to provide insurance coverage if there is not enough demand in the main auction above the reservation price set by the RBI. In Table 18 we report a simple measure of this benefit as benefit of the underwriting auctions. Specifically for each devolved auction we compute the difference between the reserve price and the price that would have otherwise prevailed based on the actual demand in those auctions. For example, the increase in revenue is about INR 5.39 billion from all uniform price devolved auctions relative to the otherwise market identified auction price.

Table 18: Benefit of Insurance

Underwriting benefit (INR billion)				
Variables	Mean	Median	Stdev	Total
All Auctions	0.17	0.12	0.17	9.44
Uniform Auction	0.13	0.10	0.11	5.39
Discriminatory	0.31	0.21	0.24	4.05

7 Natural Variation From Policy Experiments

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. More competition lowers the underwriting commission and encourages 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. This is because 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. Thus, the bidder should bidsin the first round anticipating the equilibrium outcome of the second round via backward induction. Thus, the actual underwritten amount in the first round (allocated amount to a primary dealer in the ACU auction) can be viewed as a product of such an equilibrium. We exploit variation in a natural experiment to shed light on these economics. In our setting, subset of primary dealers experienced a shift in the cost of holding the inventory, reducing its cost of hedging, hence their winner's curse.

On September 1, 2009, the Reserve Bank of India eased the cost of hedging the government securities by allowing a subset of primary dealers (the standalone primary dealers) to hedge their interest rate risk via exchange traded interest rate futures on their own account.[6]

The policy change reduces the inventory holding costs for standalone primary dealers by allowing them to hedge the interest rate risk via interest rate futures. Because the change affects the standalone primary dealers only (as noted in the circular), we have the opportunity to examine whether this subset of institutions changes behavior, and how. We examine this issue via a difference-in-difference regression.

This policy experiment should affect the second round bidding behavior of the standalone primary dealers in two ways. First is a direct effect where the standalone primary dealers

[6] " ... Primary Dealers are allowed to transact in Exchange Traded Interest Rate Futures for the purpose of hedging the interest rate risk of their underlying government securities portfolio and hold trading positions in Interest Rate Futures...." It subsequently added "... it is clarified that stand-alone Primary Dealers (PDs) are allowed to deal in Interest Rate Futures (IRFs) for both hedging and trading on own account ..". See, RBI circular # IDMD PDRD 1056 03 64 00 2009.

shade their bids less in the second round main auction. This effect arises because the cost of inventory holding decreases. There is an effect on second round bid shading via the actual amount underwritten in the first round auction.

Strategic bidding behavior generates the second effect. Primary dealers are aware that the cost of inventory holding for all standalone bidders decrease. Thus, ex-post, winning generates more bad news in the winner's curse sense. Everybody else chose to bid lower despite having lower inventory holding cost hence they must have received even worse signal. Thus, the winner's curse effect is now worse. In equilibrium, standalone primary dealers should actually shade their second round bid even more in proportion to the amount underwritten in the first round. The empirical implication follows. The interaction effect of the policy with the amount underwritten for the standalone primary dealers should increase bid shading by primary dealers in the second round.

We find evidence of both the above effects in a difference-in-difference setting. 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. This is precisely what we find, as shown below in Table 19.

Table 19: Policy Experiment: Difference in Difference Regression

The following are results from the difference-in-difference regressions of bid-shading using the policy experiment of changes in the interest rate future for hedging purpose. The dependent variable is bid shading by a primary dealer in the main auction. Robust t-statistics are in the parentheses. The * represents levels of significance *p< 0.1; ** p<0.05; *** p<0.01

	Bid Shading Regressions			
Policy Exmt Dummy		-0.0016	0.0007	0.0004
		-0.51	-0.18	-0.11
Policy Expt Dum x Standalone PD dum			-0.005	-0.005
			(2.17)**	(2.39)**
Plcy Dum x Std PD dum x alocamt_prp_bdr				0.02
				(3.75)***
uniform_dum	-0.005	-0.004	-0.005	-0.004
	(2.18)**	(1.85)*	(1.94)*	(1.93)*
duration	0.0002	0.0002	0.0002	0.0002
	(6.26)***	(6.47)***	(6.48)***	(6.39)***
logntfd	-0.001	-0.002	-0.002	-0.002
	-0.18	-0.34	-0.32	-0.35
vol2daydaypre	-0.00003	-0.00003	-0.00003	-0.00003
	(3.00)***	(3.12)***	(3.08)***	(3.10)***
stdev2daypre_norm	1.44	1.41	1.39	1.40
	(5.32)***	(5.13)***	(5.11)***	(5.14)***
log_uwcutoff	0.001	0.001	0.001	0.001
	(1.92)*	-1.64	(1.68)*	(1.67)*
acubid_var_norm	-0.02	-0.02	-0.02	-0.02
	(4.00)***	(3.91)***	(3.89)***	(3.93)***
UW SS Curve Estimate	0.0007	0.0004	0.0005	0.0004
	-0.95	-0.42	-0.43	-0.39
BKPD_dum	-0.001	-0.001	-0.006	-0.006
	(4.35)***	(4.30)***	(2.61)***	(2.60)***
No of Bidders	0.00004	0.00004	0.00004	0.00004
	-1.63	(1.69)*	(1.72)*	(1.69)*
alloc_amtprop_bidder	0.10	0.10	0.10	0.10
	(2.44)**	(2.41)**	(2.43)**	(2.50)**
logUW cutoff x alloc_amtprop_bidder	0.01	0.01	0.01	0.01
	(2.37)**	(2.35)**	(2.36)**	(2.64)***
Year Fixed Effects	Yes	Yes	Yes	Yes
Constant	0.00	0.00	0.01	0.01
	-0.17	-0.10	-0.17	-0.20
AdjustedR2	0.14	0.14	0.15	0.15
N	6,780	6,780	6,780	6,780

8 Conclusion

The usual mechanism to select underwriter and their fees to sell securities is via search and bargaining. The underwriters enjoy substantial bargaining power in these negotiations to charge a hefty fees which adds to the cost of capital. They in turn provide useful services in pricing and marketing the issue and extends their full commitment to sell the underlying security. The underwriting industry is at best characterized by a local oligopoly which leads to substantial rent seeking for the services provided.

In this paper we analyzed a unique two stage auction process to promote underwriting competition to underwrite and sell government securities. While competition is expected to reduce the fees for underwriting; it is an empirical question whether they also lead to a decrease in information production and other benefits of underwriting services. While the former will lower the cost of capital, the later will increase the cost of capital.

We use a novel proprietary dataset of selling government securities via two stage auction process. The second stage is a standard treasury auction. The selection of the underwriters and their fees happen via a discriminatory auction mechanism in the first stage.

We find that the first stage auction of underwriting provides significant information about the possible devolvement (tail risk) of the main auction It alsoproduces more information about post auction secondary market prices relative to pre-auction variables and the main auction selling securities. The insurance paid by the government has a direct cost, that of commissions, and an indirect effect through the bidding, but the insurance provision is beneficial in mitigating devolution risks and the steps that underwriters must take to avoid devolution. We provide empirical evidence of these components. Overall the benefits of competition outweighs the cost of competition and substantially reduces the cost of capital.

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