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Designing Effective Auctions for Treasury Securities

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Most discussions of treasury auction design focus on the choice between two methods for issuing securities—uniform-price or discriminatory auctions. Although auction theory and much recent research appear to favor the uniform-price method, most countries conduct their treasury auctions using the discriminatory format. What are the main issues underlying the debate over effective auction design?

The widespread growth of public debt in industrial countries in the 1980s has intensified policymakers' concern with implementing effective methods to sell government securities. Treasury auctions—in which a government sells securities to finance its debt—are a natural, but often overlooked, candidate for institutional reform. By broadening participation in treasury auctions and increasing auction revenues, governments could potentially save millions of dollars.

Consider, for example, the savings that might be realized by a country auctioning $1 trillion of securities annually. (In recent years, the U.S. Treasury has auctioned more than $2 trillion of marketable securities annually.) If a more cost-effective design could be identified and adopted, each 0.01 percent reduction in auction yields achieved through the design change would lower that country's annual federal deficit by more than $100 million.

In this edition of *Current Issues*, we examine the two main auction methods in use today to issue treasury securities—discriminatory and uniform-price auctions. Drawing on the theory of auction design and the empirical findings of earlier researchers, we discuss the revenue potential of these two auction methods and their vulnerability to noncompetitive behavior by bidders. We then compare researchers' views of the two methods with the actual practices of forty-two countries holding auctions of treasury securities. Surprisingly, while much of the literature suggests that uniform-price auctions may outperform discriminatory auctions in producing revenues for treasuries and limiting the scope for noncompetitive behavior, most countries conduct their treasury auctions using the more traditional discriminatory format. This split between theory and practice is likely to lead to increased experimentation with new auction formats in the next several years.

Discriminatory and Uniform-Price Auctions

Most treasury auctions fall into one of two categories: discriminatory auctions or uniform-price auctions.[1] In both types of auction, the winning bids are the highest bids that exhaust the whole issue on sale. In a discriminatory auction, however, all winners pay their own bids, while in a uniform-price auction all winners pay a uniform price. This uniform price, the lowest price that exhausts the auction supply, is set at one price unit above the highest losing bid. For instance, suppose that at an auction for two one-dollar treasury bills, participants A, B, C, and D bid $0.99, $0.97, $0.96, and $0.92, respectively, for a single bill. A discriminatory auction would award one bill to A for a charge of $0.99 and one bill to B for a charge of $0.97. By contrast, a uniform-price auction would award the bills to A and B for a common charge of $0.97.

Recently, the relative merits of these two types of auction have been under review. Since introducing its auctions for bills in 1929, the U.S. Treasury has used a discriminatory method to auction most of its securities (except for a short period—in 1973-74—when uniform-price auctions were held for long-term securities). In September 1992, however, the Treasury began to auction two- and five-year notes using a uniform-price method. Similar initiatives were undertaken in Mexico, Italy, and other countries in recent years.

Revenue Implications of Treasury Auction Design

An important criterion in evaluating auction methods is their effectiveness in maximizing revenues. To assess how well the discriminatory and uniform-price methods meet this criterion, we first need to consider the incentives facing auction participants.

Downward Bias in Bids. Most discussions of incentives in the auction literature underscore an important difference between treasury auctions and other varieties of auctions. Treasury auctions, a type of common-value auction, involve the sale of items whose post-auction value is essentially the same for all participants; the value is equal to the secondary-market price of the security. This type of auction contrasts with private-value auctions, in which each participant's valuation of the object on sale is relatively independent of other participants' valuations (as in, for example, the auctions of goods purchased for private consumption, such as artwork or antiques).[2]

Unlike participants in a private-value auction, participants in treasury auctions are likely to agree on the security's value *after* the auction is completed, when the resale value is determined in the secondary market for the security. Nevertheless, they are likely to have different information—or hold different beliefs—about the security's value *before* the auction takes place. This difference influences the outcome of the auction in a crucial way. A bidder that wins the auction by placing the highest bid is effectively making an above-average assessment of the resale price (or "true" value) of the security—a fact that raises the likelihood of a loss in the post-auction market.

Suppose, for example, that the resale price of the security in our earlier example settles at the average valuation attached to it by the four bidders, or $0.96. In a discriminatory auction, bidder A, which placed the highest bid at $0.99, would incur a loss of $0.03 for each security. In contrast, in a uniform-price auction, bidder A would pay $0.97 and thus incur a loss of $0.02 for each security. Thus, with either method, winning involves a loss if auction participants ignore the risk involved in placing bids that exceed consensus. This "winner's curse" will cause auction participants to shade their bids downward relative to their subjective assessment of the security's resale value to counter the risk of incurring a loss in the secondary market for the security.

The Winner's Curse and the Choice of Auction Method. Much of the theoretical research on auctions has focused on determining the auction method that better mitigates the downward bias caused by the winner's curse. A useful introduction to this literature is provided by the early work of Vickrey (1961), which examines private-value auctions of a single object with risk-neutral bidders. Vickrey shows that discriminatory and uniform-price auctions under these conditions would yield the same revenue.

At first glance, this conclusion may seem surprising—in a uniform-price auction, all winners pay the same low bid, whereas in a discriminatory auction, winners appear to pay a higher amount, namely their own bid. In a discriminatory auction, however, the bidder that values the object on sale most would *not* bid its own valuation: a bid just slightly above the second-highest valuation would win the auction. By bidding just enough to overwhelm the second-highest valuation, the bidder can win the auction by paying the same price it would have paid in a uniform-price auction. As a result, the auctioneer's effort to extract the surplus below the demand curve by charging all parties their own bids is frustrated by a downward shift in the demand curve itself.[3] Hence, in this type of private-value auction, auctioneers can expect to earn the same revenue from discriminatory and uniform-price auctions.

The same is not true, however, for common-value auctions such as those of treasury securities. In this type of auction, bidders attempt to forecast the same post-auction price, causing the revenue equivalence of the discriminatory and uniform-price methods to break down. Aware of the winner's curse, bidders will tend to lower their bids to avoid losses, and an auctioneer can expect some downward pressure on revenues, whether the auction is discriminatory or uniform-price. The question then arises: Which of the two methods is likely to cause participants to shade bids downward to a greater extent?

The answer is discriminatory auctions. Because in this format winners pay their own bid, they are charged fully for their errors in overassessing the object's resale value. In contrast, in uniform-price auctions winners pay a price—close to the highest losing bid—that reflects, to some extent, other bidders' view of the object's value. This feature lowers the winners' risk of paying a price that far exceeds consensus and hence encourages more aggressive bidding. Thus, as a means of maximizing revenues, the uniform-price method is likely to outperform the discriminatory method in treasury auctions because it is less vulnerable to the winner's curse.

As we have noted, the strength of the winner's curse rests largely on bidders' uncertainty about a security's

resale price. One way a treasury can reduce uncertainty is by fostering the development of secondary markets and forward (or "when-issued") markets for treasury securities, where investors share views about a security's present and future value. The publication of auction results can also lessen bidders' uncertainty about the behavior of their competitors and of the treasury, especially when the treasury takes an active role in the auction (for instance, by setting undisclosed cutoff prices below which it will not award the securities). We return to this theme later in our analysis.

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Noncompetitive Behavior in Treasury Auctions

A second consideration in evaluating auction methods is their vulnerability to noncompetitive bidding behavior. Lack of competition is likely to reduce investors' participation in a treasury auction and restrict a security's supply in the secondary market, preventing that security's efficient allocation among investors. In the United States, concern over this issue rose sharply in the spring of 1991 when Salomon Brothers effectively violated the 35 percent limit set by the Treasury for each bidder. By controlling the awards for itself and its customers, Salomon gained control of 94 percent of a U.S. Treasury Department two-year note auction (see U.S. Treasury Department et al. [1992]).

Noncompetitive behavior in auctions for government securities arises when a single broker, or a ring of brokers, attempts to gain an unfair—and illegal—competitive advantage in either the primary auction market or in the subsequent secondary market for the security. For instance, a few brokers may collude to gain sufficient market power to win the auction with a lower than competitive bid. Alternatively, a single broker or a ring of brokers may try to overwhelm the competition by tendering a higher than competitive bid in the primary market. In this case, the broker's ultimate goal would be to gain control of the secondary market, where huge profits can be realized by "cornering" those investors that sold the security forward before the auction and are thus committed to purchasing it back in the secondary market.

Of discriminatory and uniform-price auctions, which is likely to be more susceptible to noncompetitive behavior? Unfortunately, there is no clear answer. The argument put forward by Milton Friedman in his 1959 testimony before the Joint Economic Committee and reiterated by him in subsequent years is that the simplicity of uniform-price auctions could reduce participants' costs of preparing bids, broaden their participation in auctions, and reduce incentives to funnel bids through brokers, thus narrowing the scope for brokers to collude and corner markets (Friedman 1959, 1991).

Other researchers, however, have claimed that uniform-price auctions may be more vulnerable to such behavior because they provide fewer incentives for ring members to deviate from the agreed-upon strategy.[4] To understand this viewpoint, consider again the simple case of a uniform-price auction for a single object. A ring formed among bidders could designate a ringleader whose task was to post an overly high bid so as to win the auction on behalf of the ring. In turn, all other ring members would be required to post very low bids so as to keep low the price charged the ringleader. With this agreement in place, ring members would have no incentive to break the ring to win the auction on their own account; to do so they would have to top the ringleader's bid, then pay slightly more than the ringleader's bid to purchase the object, thus incurring a loss. For the same reason, bidders outside the ring could not win the auction except at a loss.[5]

In contrast, these researchers argue, collusion is more difficult to sustain in discriminatory auctions. In these auctions, the only way for a ring to make substantial profits would be to instruct *all* its members to tender bids below the security's true value (higher bids would increase the price charged to winners and erode the ring's profits). This behavior would expose the ring to profitable, collusion-breaking bids that exceed the ring's agreed-upon bid.

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As we see, the guidance provided by the theoretical literature on the best auction method is not unambiguous. Disagreement exists over which auction method is the more resistant to noncompetitive behavior. Furthermore,

certain general features of auctions, such as bidders' aversion to risk, and some specific features of treasury auctions—most notably, the fact that they involve the sale of multiple units of homogeneous securities—make the application of theoretical models to actual treasury auctions difficult. Nonetheless, the view that uniform-price auctions should outperform discriminatory auctions in boosting revenues clearly predominates in the theoretical research.[6]

Empirical Evidence on Auction Methods

According to some researchers, the empirical analyses of auctions cast an even stronger vote in favor of uniform-price auctions as the more effective method. Evidence from the U.S. Treasury's experiment with uniform-price auctions in the 1973-74 period, for example, suggests that the U.S. Treasury may have increased revenues from auctions of long-term securities by up to 0.75 percent.[7] This evidence remains controversial, however, because it relies largely on data from the August 1973 auction, which was undersubscribed and which awarded a large portion of the security to U.S. government accounts.[8] Nevertheless, other evidence supports the finding that uniform-price auctions lead to a rise in revenues. Umlauf (1993), for instance, studies the Mexican Treasury's experience with uniform-price auctions from 1990 to 1993. Comparing returns from these auctions with returns from discriminatory auctions held from 1986 to 1991, he finds evidence of higher revenues from the uniform-price method.

Other studies reach a similar conclusion in a more indirect way—by measuring the spread between auction prices and secondary market or forward prices of a security. A negative spread suggests that bidders are responding to the winner's curse. Following this methodology, Cammack (1991) finds that from 1973 to 1984, auction prices of U.S. Treasury bills were four basis points smaller than their contemporaneous secondary-market prices. She also finds that, consistent with the predictions of auction theory, the gap between auction and secondary market prices increases as investors become more uncertain about the future price of the security. Researchers on the U.S. Treasury staff turn up similar results for discriminatory auctions held in 1991-92 (Malvey, Archibald, and Flynn 1995). They find that yields from these auctions significantly exceeded their contemporaneous forward yields but do not uncover similar evidence for the uniform-price auctions held in 1992-95. To be sure, this evidence is difficult to interpret because of the greater volatility exhibited by revenues in the uniform-price auctions. The Treasury also found, however, that the uniform-price method broadened the public's participation in treasury auctions. In light of its findings, the Treasury decided to extend the uniform-price experiment for two- and five-year note auctions indefinitely.

The empirical evidence relating to other types of auctions also favors the uniform-price method over the discriminatory method. Feldman and Reinhart (1995) study the International Monetary Fund's auctions of gold from 1976 to 1980—a sample consisting of thirty-five discriminatory auctions and ten uniform-price auctions. The authors find that revenues from the uniform-price auctions are significantly higher than revenues from the discriminatory auctions. By studying Zambia's weekly auctions of foreign exchange from 1985 to 1987—conducted first with a uniform-price method and then with a discriminatory method—Tenorio (1993) also concludes that uniform-price auctions yield greater revenues and achieve broader investor participation than discriminatory auctions.

Overall, empirical research on auctions appears to narrow the gap left by more theoretical research on auctions: uniform-price auctions may indeed allow a treasury to finance its debt at a lower cost. If this conclusion about the relative performance of uniform-price and discriminatory auctions is accurate, however, we would expect most treasuries to favor the use of uniform-price auctions over discriminatory auctions. Do the auction practices of treasuries around the world conform to this expectation?

Cross-Country Evidence on the Design of Treasury Auctions

To find the answer, we surveyed the auction practices of seventy-seven countries in early 1994 (the latest date for which we had access to comparable cross-country information). We restricted our analysis to auctions of treasury bills, the most common security issued worldwide. We collected detailed country-specific information from government publications, local treasury officials, and the International Monetary Fund.[9] Industrial countries (including all Group of Seven countries) made up one-quarter of our sample; developing and transition countries made up the remaining three quarters (see Table 1). Treasury auctions were used in forty-two (slightly more than half) of our sample countries. Other, more informal methods of selling treasury securities—such as over-the-counter, or "on tap," sales—were used mostly by the developing and transition countries.

Table 1
Composition of Sample

	Total	Industrial Countries	Developing Countries	Transition Countries
Total number of countries	77	19	41	17
Number of countries with auctions	42	15	21	6

Sources: International Monetary Fund; information gathered from country sources; authors' calculations.

Table 2
Prevalence of Auction Techniques
Number of Countries

	Technique			
Bidding Method	Uniform-Price	Discriminatory	Other	Total
Discount	—	8	—	8
Price	2	21	1	24
Yield	—	10	—	10
Total	2	39	1	42

Sources: International Monetary Fund; information gathered from country sources; authors' calculations.

Our survey of auction techniques in the forty-two countries using auctions indicated that discriminatory auctions were by far the most common—90 percent of the sample relied on this method (Table 2). Denmark and Nigeria were the only two countries using uniform-price auctions. Spain used a mixed uniform-discriminatory format in which bidders posting less than average bids were charged their bid, while remaining bidders were charged a uniform average bid. Interestingly, six countries—Belgium, France, Italy, Gambia, Mexico, and Tanzania—had used uniform-price auctions in the past but returned to discriminatory auctions before the survey was taken. We found no occurrence of a permanent shift from discriminatory to uniform-price auctions.

The data also point to a contrast between theory and practice regarding the publication of auction outcomes. As noted earlier, research suggests that auctioneers in common-value auctions would benefit by publishing auction results. Such efforts could help reduce investors' uncertainty about the behavior of their competitors and of the treasury itself in future auctions and thus reduce uncertainty about future auction outcomes. Of course, publishing too-detailed information on individual bids may make a ringleader's task of monitoring ring members' behavior easier, broadening the scope for collusion. Still, this consideration would not rule out the publication of information on winning bids or on the number of bids and bidders recorded in the auction. We found most countries in our sample, however, to be rather secretive about auction results: 30 percent did not publish the lowest winning bids, 46 percent did not publish the minimum bid accepted at the auction, and 83 percent did not publish the number of bids or bidders in the auction. At the time of the survey, the United States published more information than any other country in the sample.

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Conclusion

Interest in the design of treasury auctions has intensified in recent years, reflecting both the need to devise more effective strategies to finance large public debts and the desire to minimize noncompetitive behavior in auctions. To assess the relative merits of the uniform-price and discriminatory auction methods, the U.S. Treasury began using uniform-price auctions for the sale of two- and five-year notes in 1992. Although early evidence from the Treasury's experience with uniform-price auctions is far from clear-cut, it has encouraged the Treasury to continue its initiative with this group of securities.

Further experimentation with treasury auction design, particularly in countries where the need for a cost-effective allocation of public debt is even more acute than in the United States, is warranted. While much of the research on auctions appears to favor the uniform-price method, discriminatory auctions are overwhelmingly prevalent worldwide. This contrast between theory and practice raises challenges for both scholars and policymakers: On the one hand, researchers of auctions may need to consider the disparity between their findings and the actual conduct of treasury auctions worldwide. More accurate and comprehensive models of treasury auctions may emerge from this appraisal. Policymakers, on the other hand, may need to reevaluate the effectiveness of the auction formats in use in their countries. Only further direct evidence on the performance of auction methods is likely to reveal the best course for government treasuries to take.

Notes

1. The term "discriminatory" reflects the choice involved in charging different prices to different bidders. When a single object is on sale, discriminatory auctions are also known as first-price auctions; under the same conditions, uniform-price auctions are sometimes called second-price auctions.

2. Treasury auctions often require bidders to tender yields or discounts rather than prices, so that the winning participants are those tendering the lowest yields or the lowest discounts. This article does not focus on this minor distinction and discusses auctions as if bids were always tendered in terms of prices.

3. If a bidder does not know the other bidders' valuations, it will try to guess other bidders' valuations and, if behaving rationally, will make a correct guess on average.

4. See Milgrom (1987) and Back and Zender (1993) for a review of these issues.

5. A limitation of many collusion models of auctions is that they focus on collusive outcomes and overlook other possible outcomes. In the example, for instance, a bidder outside the ring could try to disrupt the ring's quest by posting a bid between the ring's high and low bids. While this sort of collusion-disrupting behavior entails no immediate gain for the ring breaker and thus cannot be relied upon, auctioneers often adopt a similar strategy to mitigate collusion by posting cutoff prices below which the objects are not sold.

6. See, for instance, the survey by McAfee and McMillan (1987).

7. For a discussion, see Friedman (1991).

8. See Malvey, Archibald, and Flynn (1995).

9. The full results of the survey are published in Bartolini and Cottarelli (1997).

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