Government Debt Auctions

Hayden Griffiths and Ian Harrison discuss whether New Zealand could improve the way it sells Government securities.

Summary

Recently, countries around the world, particularly the United States, have experimented with different auction methods for selling government securities. These experiments have raised questions as to what method would produce the best results? Auction theory does not provide a clear answer. Most of the models use simplifications that do not match conditions found in Government security auctions, so the results are not directly applicable. Looking at the past performance of New Zealand Government security auctions suggests that there is only limited scope for improving the way New Zealand sells Government bonds.

Introduction

For some years government debt has been sold by the Reserve Bank using an auction format. The process itself is relatively straightforward. The quantity of bills or bonds to be sold in a particular tender is fixed and announced to the market. Bidders write down both the quantity of the security they wish to buy, and the yield (the interest rate) they are prepared to purchase them at, and submit their bid to the Bank before a prescribed cut-off time. The bids are then ranked in order, from the lowest to the highest yield bid, and bonds allocated to bidders from the lowest yield, on up until all of the bonds on offer have been allocated. The price that bidders pay for the bonds is determined by the yield bids that they submitted. The lower the yield bid, the higher the price the bidder will pay for the security.

This format is called a discriminatory sealed bid auction. It is discriminatory because bidders pay different prices for the securities according to the yield at which they bid; and sealed because bidders are unaware of the other bidders’ bids when the auction closes. When only one item is being auctioned this format is called a first price sealed bid auction. It is one of four basic auction types that could be used to auction debt. The others are as follows:

1. The English - or ascending bid, open outcry auction. This type of auction starts with a low first bid and the auctioneer solicits increasingly higher bids until the item is sold to the highest bidder at the amount bid.

2. The Dutch or descending price auction. With this auction the price is set at a high level and is progressively reduced by the auctioneer. The item is sold to the first bidder to accept a price, who then pays that price for the item.
3. Second price sealed bid. Bidders submit secret bids. The item is sold to the bidder with the highest bid, who then pays the second to highest bid for the item. When more than one item is on offer it is called a uniform price auction.

English auctions are commonly used to auction goods such as houses and antiques. The Dutch auction, gets its name from a technique used in the Netherlands to sell fresh flowers.

Government debt auctions are restricted to the discriminatory and uniform price sealed bid methods. Countries such as France, Germany, Japan and Australia use the discriminatory system while others, including Denmark and Switzerland, use a uniform price system. Currently the United States is experimenting with uniform price auctions to sell some of its securities.

The English and Dutch auctions can be ruled out as practical options (at least for the time being), for technical reasons. The financial markets would not like the expense and trouble of gathering at a central auction site. While electronic substitutes could be devised there are as yet no working models. However, the uniform price auction is a viable option. The recent decision by the US Government to experiment with this format has awakened interest in this option and the question arises as to whether the current system in New Zealand is the best way to sell government debt or whether a uniform price auction would do better.

The purpose of this article is to look at the arguments for and against the two systems. The first part of this article looks at the theory on the subject. The literature here is extensive, but often difficult and highly theoretical. Rather than give a detailed account of numerous articles, many of which have only limited practical implications, the focus is on a few of the key results.

The second part of the article looks at actual outcomes in New Zealand government bond auctions over 1990-93. It tries to make an assessment from this data as to whether there is much scope for improving the current system, and whether there is support for any of the theoretical results.

**Auction Theory**

Much of the relevant auction theory is organised around a key early result which established that when only a single good is being auctioned, a proposition called "revenue equivalence" holds.¹ That is, given a rather extensive set of assumptions, it can be shown that the expected return to the seller is the same for each of the four basic auction formats. Much of the later theory has involved relaxing one or more of the assumptions underpinning this result and seeing if the equivalence proposition still holds, or whether there is a clear ranking of the alternative methods.

At first sight the revenue equivalence result seems counter-intuitive. For a seller who has the option of using the first price or second price format, it would seem obvious that

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*Reserve Bank Bulletin, Vol 56, No. 4 1993*
the first price is better. If there were two bidders for a good, and one had bid $7.00 dollars and the other $6.00, then surely the seller would want a system that allowed her to take the highest bid. However, this presumes that bidders would have the same bidding strategy with the two systems, which will not be the case.

To see why bidding will be different, first consider what would happen with a second price system. The best strategy for each bidder is to submit a bid equal to their best estimate of the item’s value. If the first bidder thought that the item was worth $7.00 then she would not bid more than that because if she won the auction, say by bidding $8.00, and the second bid was $7.50 then she would end up paying more than she thought the item was worth. Bidding lower (say $5.00) could mean that she could miss out winning the auction, which would instead go to someone who valued it less. If the other bidder actually bid $5.50, then our imaginary bidder would have foregone a profit of $1.50 because they would have received the item at $5.50 if they had bid according to their true estimate of the items worth - $7.00.

With a first price auction, each bidder assumes that they will win the auction but attempts to pay as little as possible for the item. Thus they will try to guess what the second bid will be and submit a bid that is fractionally above that estimate. If, as is assumed by the theory, the winner on average gets that guess right, and the size of the bidding steps is infinitesimally small, then the winning bid under a first price auction will be the same as the second bid under a second price system. The expected return to the seller will therefore be the same. Note that this revenue equivalence result applies to the average outcome over a large number of auctions. For any single event the two auction types could produce quite different results.

Relaxing the Assumptions

The revenue equivalence result depends on a number of assumptions. If these are relaxed, the relative ranking of the first and second price methods can change. The relevant assumptions are as follows:

- bidders have independent and private valuations of the item being sold;
- there are no transaction costs;
- bidders are risk neutral;
- there is only one item sold in the auction.

Bidders have independent valuations
A key assumption is how bidders determine the value of the item being sold. Under the assumption of independent valuations, bidders value the item for themselves and are not influenced by the valuations other bidders make. This assumption might be reasonable if the item being sold is to be purchased purely for your own use. But often the demand shown by other bidders will influence each bidder’s perception of the value of the item, particularly if the item might be re-sold after the auction.
The expected revenue for an item obtained by the first and second price auctioning methods differ when a bidder’s valuation is related, or correlated, with other bidders’ valuations. The reason is attributed to a phenomenon called “The Winner’s Curse”. Consider an auction for a section of land. If you win the auction, you are awarded the section of land at or near the price you bid, depending on the auctioning method used. However, for this to happen you would have had the highest valuation to have submitted the winning bid. This could mean you have a problem, if you bought the section of land with the intention to sell it later. You might have paid too much for the section of land if the lower valuation of the other bidders is indicative of what price it will reach on resale. So you, the winner, could be “cursed” by overpaying.

If bidders take the valuation of other bidders into account in valuing the item, the appropriate response is to bid to win the auction, but to shade this bid to where the bulk of the bidding in the auction is expected to be. It turns out that this process generates a clear ranking of the different auction methods. The highest ranked, in terms of expected revenue to the seller, is the English auction, followed by the second price auction, with the first price and Dutch auctions equal last. The intuition behind this ranking is that with the English auction, the winning bidder receives information about the true state of demand from other bidders during the auction process and can adjust her valuation accordingly. With the other auctions, the bidder gets no information about other bidders’ valuations, but with the second price they know that if they win, the price that they pay will be the second highest price and so closer to the average bid. This gives them some comfort that they will not be too far away from the weight of bidder opinion and they shade their bids less than with a first price system. As all bidders will assume that they have a chance of winning and adopt the same strategy, the effect is to increase the gap between first and second price bids, so that the expected second price bid is higher than the expected first price bid.

While the winner’s curse phenomenon has received some attention in the literature, there is a question as to how important this effect would be in New Zealand debt markets. It is most commonly cited as a major influence when there is a good deal of uncertainty about the true value of the item in question. Oil exploration rights and publishing rights are typical examples. With New Zealand government bonds auctions, however, there is a good deal of certainty about the value of the bonds to be auctioned. Because each bond maturity is auctioned in a series of tranches, over time, there is normally an identical bond trading in the secondary market before the auction begins, so bidders know the price of the bond immediately before the auction. The major uncertainty caused by the auction is the strength of demand in the auction. Auction demand, though, will only have a small effect on market price after the auction, so uncertainty about price effects is limited. This can be seen in Figure 1 which relates to tender coverage (proxying market demand) to the change in market yields before and after an auction. If the coverage increases by a factor of 1, the expected post-tender yield apparently decreases by only 1.7 basis points.  

Another reason why the winner’s curse might not be a very significant factor is that if one auction structure systematically generated higher yields, then somebody, at some point, must make excess returns. The reason is that beyond the short run, when the strength of demand in the tender will affect market yields, the value of the bond will be

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2 Tender coverage is defined as bids received divided by the quantity of bonds on offer.
3 A basis point is one one-hundredth of a percent.
affected by fundamentals such as inflation expectations, government deficits and the world (real) interest rate. If the yields at which bonds were issued in tenders stayed too far away from their fundamental values, this will become evident to potential bidders. Bidders are motivated more by their view of fundamental value, rather than short-run trading opportunities, and they will bid in subsequent tenders, driving yields back down.

**Risk Aversion**

The usual assumption in the literature is that bidders are risk neutral, because the money at risk in any one tender normally constitutes only a small part of the bidder's (say a bank or a pension fund) wealth. However, the agent of the institution who makes the bidding decision may not be risk neutral. Their bonuses, or even their position, typically depend on their performance relative to a benchmark over short time periods. The consequences of bad outcomes may not be trivial for them personally.

With risk aversion and with private values rather than correlated values, it can be shown that the first price auction is superior to the second price.\(^4\) The explanation for this result lies in the effect that risk aversion has on bidding behaviour. As explained above, in a first price auction, a risk neutral bidder will seek to bid just above her estimate of the second price, to maximise her expected profit. The lower the bid however, the higher the probability that the competing bid will exceed hers and she will make no profit at all. Over any particular accounting period, the bidder may have only a few occasions on which they feel confident that they can make good profits in a tender, so rather than risk losing the whole of the profit, she will bid more aggressively. From this bidder's

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*Reserve Bank Bulletin, Vol 56, No. 4 1993*
perspective, it is better to make $100,000 with a probability of say 80 percent (an expected return of $80,000), rather than a $200,000 with a 50 percent probability (a $100,000 expected return). The benefits arising from more aggressive bids accrue to the seller, so the first price format outperforms the second price. The section on the New Zealand experience below suggests that there is some evidence that this type of bidding strategy may occur.

Transactions Costs
There have been some attempts to distinguish between first and second price auctions by introducing positive transactions cost for bidders. One line of argument is that the first price auction increases transaction costs because bidders have to worry about what competing bidders are doing. This requires them to spend additional resources. By contrast, in a second price auction, bidders only have to worry about their own valuation. If, in the long run, the issuer eventually bears the costs of bidding in auctions (because bidders will seek and earn normal profits) then the cost of this additional intelligence gathering will be borne by the seller.

A second argument is that the lower information requirements of the second price system makes direct bidding in a tender more attractive to a wider group of investors and the additional competition increases the winning bid.

Neither of these arguments is very compelling. With respect to the first, most serious bidders have to maintain an analytical capacity to monitor the fundamentals, so that the marginal cost of monitoring the competition is likely to be very small. In any event, under a second price system when values are correlated, there is still an incentive to monitor other bidders.

On the second argument, the New Zealand experience has been that all of the significant domestic market participants are either represented in the bidding, and/or find it efficient to work through an agent who will have a better immediate feel for the market and a capacity to advise on the fundamentals. Very likely their demand is already reflected in tender bids. Because of time-zone differences, foreign bidders generally find it convenient to bid through domestic agents in any event, so it seems unlikely that a second price system would attract significant new demand.

In short, transaction cost arguments do not convincingly distinguish between the two systems.

More than one item on sale
Nearly all of the theoretical work has assumed that only one item is auctioned at a time. This obviously does not describe a New Zealand bond auction, where with $150 million of bonds and a minimum bid of $1 million, there are, in effect, 150 items on offer. Situations where more than one item is being auctioned, but where bidders are restricted to one bid each have been modelled, and it has been shown that the key results of revenue equivalence, with private values, and of the superiority of a second price method with correlated values and risk neutrality still hold.
Unfortunately it is extremely hard to get definitive results where bidders can purchase more than one unit, and there appear to be no authoritative results for multiple bids scenarios. Thus, in terms of formal results, the theory is effectively silent on the choice between the first and second price auctions in real world situations. With respect to the lessons that can be gleaned from the simpler models, the “winners curse” and risk aversion effects point in opposite directions. However, because of the high degree of knowledge about the outcome of auction, it is unlikely that either of these effects will be very strong.

The New Zealand Bond Tender Experience

Looking at actual outcomes in New Zealand, it is impossible to prove definitively that the discriminatory system is better or worse than the uniform system. However, there is some information in bidding patterns which can give a clue as to whether there is significant scope to improve on the current situation.

The most useful evidence on whether New Zealand bond tenders are currently performing well or not, is a data series on the average bids accepted in tender versus a market comparator. Immediately before each tender the Bank collects information on where the bond to be auctioned is trading in the secondary market. This market mid-yield (the mid point between the yields at which market-makers are prepared to buy and sell the bond) provides a benchmark for tender performance, because, notionally, the Crown could transact (for small quantities) in the secondary market rather than sell bonds in the tender.

For the 40 auctions (comprising 112 tranches) from December 1990 to October 1993, the average issue yield in tenders was half a basis point over the pre-market comparator. As Figure 2 shows there was a reasonable spread around this average, with the best result 11 basis points under the comparator and the worst result 7.5 basis points over. The average tender performance is slightly better than this comparison with the market mid-rate would suggest. To actually sell a bond in the market the government would have to accept the bid-yield, which is typically 1.5 basis points above the mid-yield. Adjusting for this factor, tender “performance” is about one basis point better than the pre-tender comparator.

Figure 2 tends to underststate the efficiency of the tender system as an issuing device. The market comparitor figures are for small quantities (from $2.5 million), but if a single agent wished to sell large quantities of bonds, and this was known to the market, then yields would tend to move against the seller, affecting overall performance in a direct sale situation.

Trading Surplus
While the government benefits from holding tenders, so do the tender participants. While the government does one basis point better than its comparator, for purchasers, who want the highest yield possible, their comparator is the pre-market offer-yield, which will average 1.5 basis points below the mid yield. In addition, tenders offer investors who wish to purchase large parcels of bonds, the opportunity to do so without pushing market yields against them. This would tend to happen if they transacted in the secondary market. This ability to undertake large transactions is probably not as valuable to the
market as to the Crown, because the occasions when participants wish to purchase large quantities of bonds are relatively few. By contrast the government is always a large seller.

One way of describing this situation is to say that there are gains from trade in the auction process with the bidders and seller sharing more or less equally. The bidders appear to take the bulk of the three point spread between the bid and offer-yields (two basis points compared to one to the government) but the ability to transact large quantities at market rates is probably more valuable to the government than the market.

These results suggest that there is limited scope to improve performance by changing the auction format. At most the improvement would likely be the bidders’ share of the bid-offer spread, which is about two basis points. Given the size of the government debt programme such an improvement would not be trivial. With an annual programme of $4 billion of bonds with relatively long maturities, the additional revenue could be in the order of $4 million. However, the theoretical discussion above doesn’t give any strong reason to believe that a second price system would indeed improve the situation.

**Risk Aversion**

Indeed there may be some evidence, in bidding behaviour, that the risk averse behaviour discussed above could be at work, which could offset any advantage in a second price system because of the “winners curse” effect. As mentioned above, not all of the bonds in a particular issue are auctioned at once. Rather, they are auctioned in tranches of between $100 - $150 million until the target issue size, now around $2.5 billion, is reached. The small size of individual auction tranches means that it is possible for a
single bidder to successfully bid for all of the bonds on offer. Single successful bidders are at an advantage, because the news that a single bidder has purchased all the bonds generally moves the market in the bidder’s favour when the auction results are released. This is shown in Figure 3 which shows the relationship between the successful bid range and the difference between the average successful bid and the market mid-yield after the tender results are announced. What the figure shows, when the tender is taken out by one bidder (and the successful range is zero), is that rates generally fall below the yield paid in the tender and the bidder makes an initial (albeit book rather than realized) profit.

Figure 3

Difference Between Yields at Market Close and Average Bid Yields vs Successful Bid Yield Range

Thus the aggressive bidder does not have to worry too much about the “winners curse” because they have private information that their own bidding behaviour will tend to move the market in their favour. This is probably not the motivating reason for large purchases, which is probably a view that yields are likely to fall substantially for fundamental reasons which are not yet reflected in market rates, but bidders will gain some comfort if there is the prospect of an immediate gain before their view on the fundamentals is reflected in market rates.

It also appears that the most aggressive bidders are prepared to share some of the gains with the issuer. If the bidder has a view that the prospective returns form taking out the tender are large, then the bidder will not want to risk those gains by missing out to another bidder, and will bid relatively aggressively. Figure 4, which shows the difference between the pre-auction comparator yield and the successful bid range, illustrates this point. With a successful range of zero, the bid is almost always below the pre-market comparator (compared to an average of half a basis point above for all auctions). Table 1 summarises the results in Figure 4. It shows that with a zero successful range, the average difference between the bid and the post-auction yield is 5.6 basis points. This can be thought of as the gain to the bidder. The difference between the pre-auction comparator and the bid is 2.5 basis points - the gain to the auctioneer.
Figure 4

Difference Between Pre-Auction Yields and Average Bid Yields vs Successful Bid Range

Table 1: Trading Surplus

<table>
<thead>
<tr>
<th>Successful Range (Basis Points)</th>
<th>to the Government (Average Diff between Average Bid and Comparative Mid-yield) (basis points)</th>
<th>to Bidder(s) Average Diff. between Market Close Mid-yield and Average Bid (basis points)</th>
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<tbody>
<tr>
<td>0</td>
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<tr>
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</tr>
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Summary

New Zealand Government bond auctions seem to perform well. The scope for improvement appears to be small. Auction theory is too simplistic, and relies on a greater level of uncertainty than that found in New Zealand bond auctions, to provide compelling reasons to change the present auctioning format.