In Search of Successful Strategies in Package Auctions

As one of those who argued strongly in favor of "package auctions" at the Wye Conference, I am delighted that the FCC has modified the rules to allow such bids in the forthcoming auction. I am particularly pleased that the Commission has allowed bidders to design a limited number of packages to suit their own needs. While this may not be critical in the upcoming auction, it is surely important to design an auction which is flexible enough to accommodate both known and unknown complementarities.

I am writing these notes in the hope of starting a discussion on bidding strategies under the new rules. To open this discussion, consider the following simple auction. There are two licenses A and B. A valuation profile for bidder *i* is a triple $\{V_i^A, V_i^B, V_i^{AB}\}$. For simplicity I will assume initially that, while the FCC does not know valuations, the bidders have complete information.

Example 1:

Bidder #	V_i^A	V_i^B	V_i^{AB}
1	120	50	150
2	50	100	150
3	0	0	155
4	0	0	155

For simplicity we will assume that the minimum bidding increment is set at 5 and ignore ceilings on the size of jump-bids. Bidders 3 and 4 choose the package bid. Ignoring the other bidders, the non-cooperative outcome of competition between bidders 3 and 4 is a maximum bid of 150. Recognizing this, bidders 1 and 2 know that they can together win the auction. Thus, before they make their deposits, both have an incentive to form a consortium and enter the auction as a package bidder.[1] They win the auction with a package bid of 155 and then divide the gains.

Setting aside such consortium bidding, consider non-cooperative bidding in the auction. Neither bidder 1 or bidder 2 expects to win more than one item but both have an incentive to make a forcing bid on their opponent's prime license. Thus each has an incentive to begin the auction with a bid of at least 50 on its opponent's prime license. Then, in contrast to the no-package ascending-bid auction, there is a strong incentive for jump-bidding in the early rounds. Moreover, each bidder has an incentive to bid on licenses other than the one it expects to win.

This same argument suggests that even bigger jump bids will be made. Suppose bidder 2 believes that bidder 1 will bid 50 on license B in the first round. Bidder 2's best response is to bid 95 on license A and then bid 55 on licenses B in the second round. Bidder 2 then

[1] This raises the issue of whether the rules might allow "non-competing" regional bidders to form bidding consortiums. If so, how late in the auction process might this be allowed?

stops bidding. Bidder 1 must either withdraw or make a bid. His best response is to bid 100 on license A. The total bids on A and B by bidders 1 and 2 then add to 155 and thus win the auction. I conclude that what has been called the "threshold problem" may sometimes lead to very aggressive bidding and an early close in the auction.

In previous auctions, one advertised advantage was the opportunity for bidders to switch to different groups of licenses as the auction proceeded. With bidders making maximum jumps, the opportunities to build new bundles of individual licenses may be greatly reduced. Clearly allowing bidders to create new packages (as provided under the new rules) will go some way towards offsetting this difficulty.

In the scenario so far, bidder 2 surprises bidder 1 with his forcing jump-bid. For an equilibrium we seek strategies, which opponents can predict in advance. Suppose bidder 2 announces in advance that he will begin with a forcing bid of 95 on item A. If bidder 1 believes this, a best response is to make a minimum raise to 100. Thus the outcome described above is an equilibrium outcome. I conclude that bidders will have equilibrium incentives to make forcing bids above their valuations on licenses that they do not expect to win.

A symmetric argument establishes that bidder 1 has an incentive to announce that he will be aggressive and bid (say) 90 on item B in the first round. The equilibrium outcome then leaves bidder 1 with almost all the profit.

It is easy to see that there are lots of other less extreme equilibria as well. One possible convention that might emerge is an "equal shares" equilibrium. In the example the potential gains to bidders 1 and 2 acting as a consortium is $V_1^A + V_2^B - V_3^{AB} = 70$. Sharing the potential gains equally leaves bidder 1 making a final bid of 85 and bidder 2 a final bid of 65 on license B. Bidder 1 then begins with a forcing bid of 60 on license B and bidder 2 begins with a forcing bid of 80 on license A. Each player's best response is to switch to the other license and makes a minimum raise in round 2.

It would be useful to see how bidders would actually behave in an experimental setting. For the simple example, my prediction is that as bidders gained experience, their bidding strategies would often converge on the equal shares equilibrium.

Of course this is just one simple example. The arguments readily generalize to the case on N licenses. Moreover with restrictions on jump bids, the equilibrium only changes trivially. Instead of a single forcing bid, each bidder makes a maximum forcing bid until the ceiling is reached.

Much more interesting would be an analysis when bidders are unsure of each other's valuations. My conjecture is that without any ceiling on the size of jump bids, there are conditions under which each bidder would be willing to signal his valuation by adopting a pure strategy forcing-bid in the first round. Adding fairly tight ceilings on jump bids would eliminate such first round signaling but might also reduce the possibility of "over-bidding" when both bidder 1 and bidder 2 have unexpectedly high valuations.