Supply Reduction in the Broadcast Incentive Auction*

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Abstract

The FCC's Broadcast Incentive Auction incorporated a reverse auction for the voluntary clearing of broadcast stations. While the reverse auction aimed to be obviously strategy proof, it maintained the fiction that stations were owned individually, when many were part of station groups. We introduce two stylized models of the clearing environment. In them, we demonstrate that the reverse auction design generates severe supply reduction incentives, while true (weighted) Vickrey-Clarke-Groves mechanisms avoid these incentives and still allow price discrimination. Further, the bidding data together with *ex post* resale data provide compelling empirical evidence that supply reduction actually occurred.

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1. Introduction

[To be expanded]

The FCC's Broadcast Incentive Auction incorporated a reverse auction for the voluntary clearing of broadcast stations. While the reverse auction aimed to be obviously strategy proof (Milgrom and Segal, 2019), it maintained the fiction that stations were owned individually, when many were part of station groups. This created the possibility of strategic supply reduction, which could increase clearing costs.

In Section 2 of this paper, we introduce two stylized models of the Broadcast Incentive Auction's clearing environment that are useful for understanding the problem. They yield the same feasibility constraint and, therefore, are equivalent for studying the problem. In Section 3, we describe a Deferred Acceptance auction, an individual ownership weighted VCG mechanism, and a joint ownership bidder-weighted VCG mechanism. The first two are closely related to one another, while the third has very different strategic properties. In Section 4, in a special case of the stylized model, we construct equilibria of both the Deferred Acceptance auction and the joint ownership bidder-weighted VCG mechanism. In particular, in equilibria of the Deferred Acceptance auction, station groups drop out in some of their stations at the opening price. In Section 5, we provide the first analysis that has been done of the Incentive Auction's bidding data. The bidding data, together with *ex post* resale data, provide evidence of supply reduction. In particular, Table 2, detailing OTA Broadcasting's bidding in the Pittsburgh market, may provide the most compelling empirical evidence of supply (or demand) reduction in the literature to date.

2. Two Models of the Reverse Auction

This section describes two stylized models of the reverse auction. While the first model assumes one tower and the second model assumes two towers, they will yield identical feasibility constraints.

2.1 The Single Tower model

There is a single city, and all stations transmit from the same tower.[1] There are two types of television stations, with the following associated interference patterns:

- *Full-power stations*: If a full-power station is situated on a given television channel, no other station can use the same or an adjacent channel.
- *Low-power stations*: If a low-power station is situated on a given television channel, no other station can use the same channel, but another low-power station can use an adjacent channel.

There are currently n_H full-power stations and n_L low-power stations in total transmitting from the tower. The auctioneer is running an auction in order to "repack" these stations into just $2k$ television

[1] Chicago comes extremely close to satisfying this assumption: all Chicago stations transmit from either 875 North Michigan Avenue (the building formerly known as the John Hancock Building) or the Willis Tower (the building formerly known as the Sears Tower). These two 100+ story broadcast towers are less than two miles apart. Similarly, most major stations in the Los Angeles DMA transmit from Mount Wilson, and the remaining stations broadcast from the adjacent Mount Harvard.

channels.[2] The channels are ordered in the natural way from 1 to $2k$, so that channels c and d are adjacent if and only if $|c - d| = 1$. The stations view all $2k$ channels as equivalent.

Since this is a reverse auction, the "winners" in the auction are those stations that win the competition to relinquish their broadcast licenses and are paid the relevant clearing price. The "losers" in the auction are those stations that lose the competition to relinquish their licenses, retaining their broadcast licenses and remaining on-air. Let m_H ($0 \le m_H \le n_H$) and m_L ($0 \le m_L \le n_L$), respectively, denote the number of full-power stations and low-power stations that remain on-air. The feasibility constraint in the Single Tower model is thus:

$$2m_H + m_L \le 2k\,. \tag{2.1}$$

2.2 The Two Towers model[3]

There are two cities, located sufficiently close to each other that a full-power station in one city would interfere with a station on the same channel in the other city.[4] All stations in a given city transmit from the same tower.[5] Thus, there are two towers. There are two types of television stations, with the following associated interference patterns (somewhat different interference patterns are assumed than in the preceding Single Tower model):

- *Full-power stations*: If a full-power station is situated on a given television channel in one city, the same channel cannot be used in the other city.
- *Low-power stations*: Two low-power stations, one in each city, can co-exist on the same television channel.

There are currently n_H full-power stations and n_L low-power stations in total transmitting from the two towers. The auctioneer is running an auction in order to "repack" these stations into just k television channels. For the sake of simplicity, we will assume that the values of a given type of station in the two cities are drawn from the same distribution and that a low-power station remaining on-air is indifferent between being assigned to either tower (i.e., city).

As in the Single Tower model, the "winners" in the auction are those stations that win the competition to relinquish their broadcast licenses; the "losers" are those stations that retain their licenses. Again, let m_H ($0 \le m_H \le n_H$) and m_L ($0 \le m_L \le n_L$), respectively, denote the number of full-power stations and low-power stations that remain on-air. Observe that the feasibility constraint in the Two Towers model is exactly the same as in the Single Tower model, i.e., inequality (2.1).

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[2] We limit our attention to even integer numbers of channels, as this is required to make the feasibility constraints of the Single Tower and the Two Towers models the same.

[3] The authors wish to acknowledge their gratitude to J.R.R. Tolkien for this terminology.

[4] The reader can think of New York and Philadelphia (slightly more than 80 miles apart) as examples of such cities.

[5] See footnote 1.

2.3 Information Structure

All of the full-power stations j (j = 1 , … , n_H) have values v_i to their current owners (in either city), where v_j is drawn from a common distribution $F(\cdot)$ with support $[0,\overline{v}]$. All of the low-power stations j ($j = n_H+1$, … , $n_H + n_L$) have values v_j to their current owners (in either city), where v_j is drawn from a common distribution $G(\cdot)$ with support [0,1]. We will consider each of two possible information structures in this paper:

- *Perfect correlation*: All full-power stations have the same values, $v_1 = \ldots = v_{n_H}$, and all low-power stations have the same values, $v_{n_H+1} = \ldots = v_{n_H+n_L}$. The single draw of the full-power v and the single draw of the low-power v are independent.
- *Independence*: The values, $v_1, \ldots, v_{n_H}$, of all full-power stations and the values, $v_{n_H+1}, \ldots, v_{n_H+n_L}$, of all low-power stations are drawn independently.

In our analysis, we will be considering scenarios where two or more full-power stations are commonly owned and/or where two or more low-power stations are commonly owned. We examine the perfect correlation information structure as it is the simplest to analyze; we examine the independence information structure as it may be regarded by the literature to be the most "natural". These information structures are the boundary cases of a family of information structures considered in a somewhat different context by Ausubel and Baranov (2019).

3. Reverse Auction Mechanisms

In this paper, we will consider a number of different possible mechanisms for the reverse auction.

3.1 Deferred Acceptance auction

Associated with each station j = 1, … , J is a *weight* $w_j > 0$. The starting price, $p_j(0)$, for station j is $w_j \overline{p}$, where $\overline{p}$ is chosen to be sufficiently large that $w_j \overline{p}$ is never less than the top of the support of v_j. At each later time, the prices of all stations drop continuously and proportionately. We write:

$$p_j(t) = w_j(1-t)\overline{p} \quad , \quad \text{for all } j = 1, \ldots, J \text{ and for all } t \in [0,1]. \tag{3.1}$$

There is a feasibility constraint associated with the clearing problem; the feasibility constraint is inequality (2.1) for the models of Section 2. Each station is initially "in" at the starting price and the feasibility constraint is initially satisfied. Each station has the choice at all times whether to remain in the auction or to exit, so long as its exit would not cause the feasibility constraint to be violated. Exit from the auction is irrevocable; following exit, the station retains its broadcast license and is paid zero. If station j remains "in", it faces a descending price of $p_j(t)$ at every time t. Station j is deemed to "win" at the first time, t_j, that its departure would cause the feasibility constraint to be violated. A winning station j relinquishes its broadcast license and is paid a price of $p_j(t_j)$.[6] In the event that two or more

[6] In the Broadcast Incentive Auction, the state when a station's exit would cause the feasibility constraint to be violated was referred to as "frozen". A currently frozen station could be unfrozen at a later stage of the auction,

stations attempt to exit simultaneously, their exit requests are processed sequentially in a randomly-selected order, and each station's exit is permitted only if the feasibility constraint would continue to be satisfied without this station (and without all stations that have previously been allowed to exit).

When stations are individually owned, it is well understood that truth-telling is a dominant strategy of the Deferred Acceptance auction (Milgrom and Segal, 2019); moreover, the mechanism is obviously strategy proof (Li, 2017). Conversely, when two or more stations are jointly owned, the Deferred Acceptance auction is no longer a dominant strategy nor an obviously strategy proof mechanism.

In the specific models considered in this paper, there are only two types of stations. We let the weight of a low-power station be $w_L = 1$ and we let the weight of a full-power station be $w_H > 1$. The price equation (3.1) for the two types of stations, and using the lowest allowable value for $\bar{p}$, then reduces to:

$$p_H(t) = w_H(1-t)\max\left\{1, \tfrac{\bar{v}}{w_H}\right\}, \quad p_L(t) = (1-t)\max\left\{1, \tfrac{\bar{v}}{w_H}\right\}, \quad \text{for all } t \in [0,1]. \tag{3.2}$$

3.2 Individual ownership weighted VCG mechanism

The individual ownership weighted VCG mechanism is defined similarly to the standard VCG mechanism, except for: (1) the use of weights; and (2) the treatment of stations as individually owned, regardless of their actual ownership structure. It is developed as follows.

Each station $j = 1, \ldots, J$ reports a value, $\hat{v}_j$, representing the minimum payment that the station would accept in order to relinquish its license. Let $x_j = 1$, if a station "wins" in the auction (i.e., if the station is paid to relinquish its license), and $x_j = 0$, otherwise. Let $x = (x_1, \ldots, x_J)$ denote the allocation vector. The feasible set, X, is the set of all allocations satisfying the feasibility constraint, i.e., all allocation vectors x such that the set of stations retaining their broadcast licenses can be repacked into the available channels. As before, associated with each station $j = 1, \ldots, J$ is a *weight* $w_j > 0$. We let $\frac{1}{w}\hat{v}$ denote the weighted vector of value reports, i.e., $\frac{1}{w}\hat{v} = \left(\frac{1}{w_1}\hat{v}_1, \ldots, \frac{1}{w_J}\hat{v}_J\right)$. The auctioneer determines the outcome by computing a weighted value-minimizing allocation:

$$x^* \in \arg\min\left\{x \cdot \tfrac{1}{w}\hat{v} \mid x \in X\right\} \text{ and } \alpha = \min\left\{x \cdot \tfrac{1}{w}\hat{v} \mid x \in X\right\}. \tag{3.3}$$

Paralleling the development of the VCG mechanism, the auctioneer also minimizes value under the assumption that station j is absent from the auction (and station j retains its broadcast license):

$$\alpha_j = \min\left\{x \cdot \tfrac{1}{w}\hat{v} \mid x \in X \text{ and } x_j = 0\right\}. \tag{3.4}$$

The *individual ownership weighted VCG mechanism* is the mechanism that establishes the allocation x^* and pays p_j to each station such that $x_j^* = 1$, where:

$$\frac{p_j}{w_j} = \alpha_j - \left(\alpha - \frac{\hat{v}_j}{w_j}\right). \tag{3.5}$$

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when the number of channels is increased. However, in the current models being considered, the state of being frozen is irrevocable and therefore "frozen" is equivalent to "winning".

With weights $w_j = 1$, for all $j = 1, \ldots, J$, the weighted VCG mechanism coincides with the standard VCG mechanism when stations are individually owned—and therefore it is a dominant strategy mechanism. The usual VCG reasoning implies the same result when weights are nondegenerate. We have:

PROPOSITION 1. When stations are individually owned, truth-telling is a dominant strategy of the individual ownership weighted VCG mechanism.

The reader should observe at this point that the individual ownership weighted VCG mechanism is almost, but not quite, a collapsed version of the Deferred Acceptance auction. The difference is that the Deferred Acceptance auction implicitly utilizes a greedy algorithm, while the individual ownership weighted VCG mechanism utilizes full optimization. Thus, the Deferred Acceptance auction is an obviously strategy proof mechanism, while the individual ownership weighted VCG mechanism is not. At the same time, if bidders play their dominant strategies, then the individual ownership weighted VCG mechanism will generate greater social surplus than the Deferred Acceptance auction utilizing the same weights, because it fully optimizes the weighted objective.

3.3 Joint ownership bidder-weighted VCG mechanism

The joint ownership bidder-weighted VCG mechanism is defined similarly to the standard VCG mechanism, except for: (1) the use of weights; and (2) disallowing package bidding (i.e., a bidder who owns multiple stations is obliged to submit a separate bid for each station). Note that in the Single Tower and Two Towers models specified in Section 2, multi-station owners have additive preferences over stations, and so the latter limitation does not preclude them from truthful bidding. The joint ownership bidder-weighted VCG mechanism is developed as follows.

Each station $j = 1, \ldots, J$ reports a value, $\hat{v}_j$, representing the minimum payment that the station would accept in order to relinquish its license. Let $x_j = 1$, if a station "wins" in the auction (i.e., if the station is paid to relinquish its license), and $x_j = 0$, otherwise. Let $x = (x_1, \ldots, x_J)$ denote the allocation vector. The feasible set, X, is the set of all allocations satisfying the feasibility constraint, i.e., all allocation vectors x such that the set of stations retaining their broadcast licenses can be repacked into the available channels.

Associated with each bidder $i = 1, \ldots, I$ is a bidder weight $\omega_i > 0$ and a set of stations S_i owned by the bidder. The weight of each station $j = 1, \ldots, J$ is given by the weight of the bidder who owns this station, i.e., $w_j = \omega_i$ for all $j \in S_i$. We let $\frac{1}{w}\hat{v}$ denote the weighted vector of value reports, i.e., $\frac{1}{w}\hat{v} = \left(\frac{1}{w_1}\hat{v}_1, \ldots, \frac{1}{w_J}\hat{v}_J\right)$. The auctioneer determines the outcome by computing a weighted value-minimizing allocation:

$$x^* \in \arg\min\left\{x \cdot \tfrac{1}{w}\hat{v} \mid x \in X\right\} \text{ and } \alpha = \min\left\{x \cdot \tfrac{1}{w}\hat{v} \mid x \in X\right\}. \tag{3.6}$$

Paralleling the development of the VCG mechanism, the auctioneer also minimizes value under the assumption that bidder i is absent from the auction (and all stations in S_i retain their broadcast licenses):

$$\alpha_i = \min\left\{x \cdot \tfrac{1}{w}\hat{v} \mid x \in X \text{ and } x_j = 0 \text{ for } \forall j \in S_i\right\}. \tag{3.7}$$

The *joint ownership bidder-weighted VCG mechanism* is the mechanism that establishes the allocation x^* and pays p_i to each bidder such that $x_j^* = 1$ for at least one station in S_i, where:

$$\frac{p_i}{\omega_i} = \alpha_i - \left(\alpha - \sum_{j \in S_i \text{ and } x_j^* = 1} \frac{\hat{v}_j}{w_j} \right). \tag{3.8}$$

With weights $\omega_i = 1$, for all i = 1, … , I, the bidder-weighted VCG mechanism coincides with the standard VCG mechanism (except for package bidding)—and therefore it is a dominant strategy mechanism here. The usual VCG reasoning implies the same result when weights are nondegenerate. We have:

PROPOSITION 2. When stations are jointly owned, truth-telling is a dominant strategy of the joint ownership bidder-weighted VCG mechanism.

4. Equilibrium Analysis of Examples

When stations are individually owned or in a joint ownership bidder-weighted VCG mechanism, the equilibrium analysis is straightforward, as truth-telling is a dominant strategy. However, for other scenarios or mechanisms, the equilibrium analysis can be quite formidable and there will necessarily be an absence of fully general results. Still, the consideration of several instructive cases can be quite illuminating.

Throughout this section, we will focus on a particular special case of the models of Section 2—the case where the number n_H of full-power stations is 2, the number n_L of low-power stations is 4, and k = 2, i.e., there are four available channels in the Single Tower model or two available channels in each city of the Two Towers model. In addition, we will assume that the distribution F from which the value of a full-power station is drawn is the uniform distribution on $[0, \overline{v}]$, where $\overline{v} > 1$, and that the distribution G from which the value of a low-power station is drawn is the uniform distribution on [0,1].

4.1 Bidder 1 owns two full-power and bidder 2 owns four low-power stations, each with perfectly-correlated values

Consider a scenario where bidder 1 is a station group that owns both full-power stations, while bidder 2 is a station group that owns all four low-power stations. For simplicity, we also assume perfect correlation: both full-power stations have the same values, $v_1 = v_2 \equiv v_H$, and the four low-power stations have the same values, $v_3 = v_4 = v_5 = v_6 \equiv v_L$. In this scenario, in the Deferred Acceptance auction or the individual ownership weighted VCG mechanism, the incentives and equilibrium results are strikingly reminiscent of Examples I – III of Ausubel, Cramton, Pycia, Rostek and Weretka (2014, p. 1371).

In particular, in the individual ownership weighted VCG mechanism (and equivalently in the Deferred Acceptance auction),[7] the following[8] can easily be seen to be an equilibrium:[9]

[7] Whether the outcome of the individual ownership weighted VCG mechanism is equivalent to that of the Deferred Acceptance auction depends on the convention that we adopt for the highest allowable report in the mechanism—whether, for example, the highest report by bidder 2 is 1 or whether bidder 2 is able to report as high as $\frac{\overline{v}}{w_H}$ in the event that $w_H < \overline{v}$.

$$\begin{aligned}&\text{Bidder 1 reports } (\hat{v}_1,\hat{v}_2)=\left(v_H, w_H \max\left\{1,\tfrac{\bar{v}}{w_H}\right\}\right) \text{ and}\\ &\text{Bidder 2 reports } (\hat{v}_3,\hat{v}_4,\hat{v}_5,\hat{v}_6)=\left(v_L, v_L, \max\left\{1,\tfrac{\bar{v}}{w_H}\right\}, \max\left\{1,\tfrac{\bar{v}}{w_H}\right\}\right).\end{aligned} \tag{3.9}$$

The expected value of the relinquished stations (i.e., the expected social cost of clearing) in this equilibrium of the Deferred Acceptance auction is $1+\frac{1}{2}\bar{v}$; and the auctioneer's expected clearing cost is $(2+w_H)\max\left\{1,\frac{\bar{v}}{w_H}\right\}$.

By contrast, in the joint ownership bidder-weighted VCG mechanism, truth-telling is a dominant strategy (see Proposition 2, above). Somewhat painful calculations establish that the expected value of the relinquished stations in the joint ownership bidder-weighted VCG mechanism is:

$$EV(\text{relinquished stations}) = \begin{cases} \dfrac{2\bar{v}^2 w - \bar{v}^2 + 12w^2}{6w^2}, & \text{if } \dfrac{\bar{v}}{2w} < 1, \\ \dfrac{3\bar{v}^2 - 4w^2 + 8w}{3\bar{v}}, & \text{if } \dfrac{\bar{v}}{2w} \geq 1, \end{cases} \tag{3.10}$$

and that the auctioneer's expected clearing cost in the joint ownership bidder-weighted VCG mechanism is:

$$E(\text{clearing cost}) = \begin{cases} \dfrac{\bar{v}^2 w + \bar{v}^2 - 6\bar{v}w^2 + 12w^3}{6w^2}, & \text{if } \dfrac{\bar{v}}{2w} < 1, \\ \dfrac{3\bar{v}^2 - 6w\bar{v} + 4w^3 + 4w^2}{3w\bar{v}}, & \text{if } \dfrac{\bar{v}}{2w} \geq 1. \end{cases} \tag{3.11}$$

Figures 1 and 2 illustrate the comparison of the expected value of the relinquished stations and the auctioneer's expected clearing cost between the Deferred Acceptance auction and the joint ownership

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[8] Obviously, there are also payoff-equivalent equilibria in which the bidders reduce their supplies on different stations. For example, bidder 1 might supply-reduce on station 1 and bid truthfully on station 2.

[9] To see that this is an equilibrium, first observe that it is weakly dominant for bidder 1 to bid one full-power station truthfully and for bidder 2 to bid two low-power stations truthfully. Then consider bidder 1's problem of choosing $\hat{v}_2$ (i.e., how to bid its second station). If $\hat{v}_2/w_H > v_L$, bidder 1 wins one unit and the payment is $\hat{v}_2$; If $\hat{v}_2/w_H < v_L$, bidder 1 wins two units and the payment for each unit is $w_H v_L$. Therefore, bidder 1's expected payoff is:

$$\pi(\hat{v}_2) = \begin{cases} \dfrac{\hat{v}_2}{w_H}\left(\hat{v}_2 - v_H\right) + 2\int_{\hat{v}_2/w_H}^{1} \left(w_H v_L - v_H\right) dv_L = w_H\left[\left(1-\dfrac{v_H}{w_H}\right)^2 + \dfrac{v_H}{w_H}\left(\dfrac{\hat{v}_2}{w_H} - \dfrac{v_H}{w_H}\right)\right], & \text{if } \hat{v}_2 \leq 1, \\ \dfrac{\hat{v}_2}{w_H}\left(\hat{v}_2 - v_H\right), & \text{if } \hat{v}_2 > 1. \end{cases}$$

Clearly, choosing $\hat{v}_2 = w_H \max\left\{1,\frac{\bar{v}}{w_H}\right\}$ is optimal. Similarly, it can be verified that choosing $(\hat{v}_3,\hat{v}_4,\hat{v}_5,\hat{v}_6) = \left(v_L, v_L, \max\left\{1,\frac{\bar{v}}{w_H}\right\}, \max\left\{1,\frac{\bar{v}}{w_H}\right\}\right)$ is optimal for bidder 2.

bidder-weighted VCG mechanism for a variety of weights. In Figure 1, $\bar{v} = 2$, and so the expected value of a full-power station is two times the expected value of a low-power station (the same ratio as the extra space that a full-power station occupies). In Figure 2, $\bar{v} = 4$, and so the expected value of a full-power station is four times the expected value of a low-power station (so a social planner would tend to find it optimal to clear low-power stations).

Figure 1. Comparison of Deferred Acceptance auction and joint ownership bidder-weighted VCG mechanism

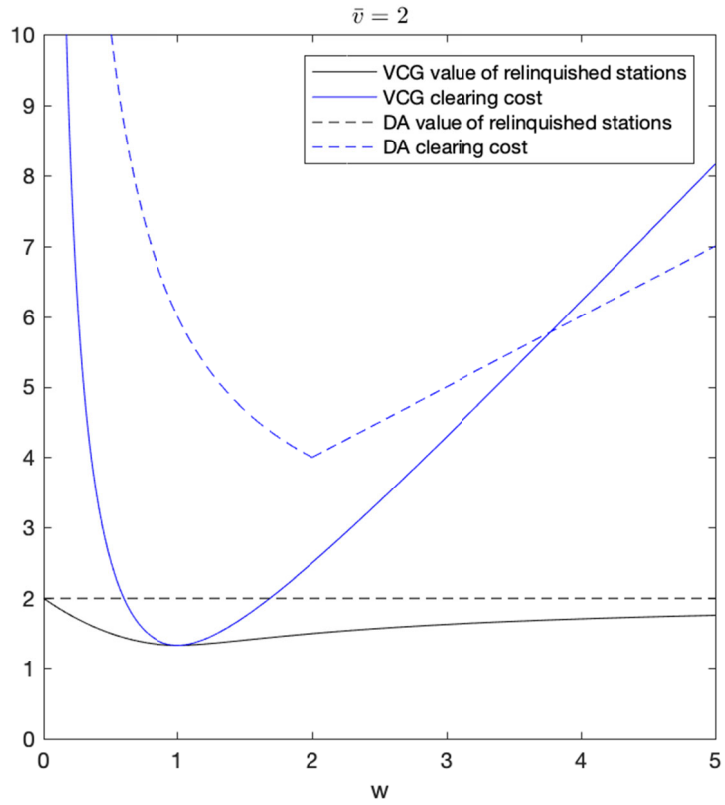
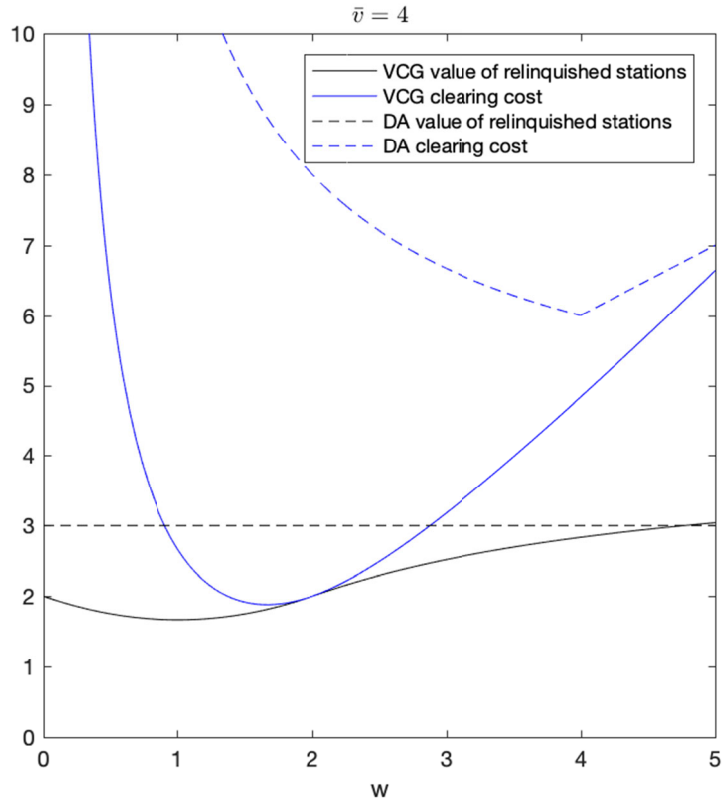


Figure 2. Comparison of Deferred Acceptance auction and joint ownership bidder-weighted VCG mechanism



Observe that the Deferred Acceptance auction's expected clearing cost is minimized at w_H = 2 when $\bar{v} = 2$, and at w_H = 4 when $\bar{v} = 4$. In each case, the cost-minimizing weight for the joint ownership bidder-weighted VCG mechanism is lower: w_H = 1 when $\bar{v} = 2$, and w_H = 1.6648 when $\bar{v} = 4$. The most striking conclusion is that the expected clearing cost, evaluated at the optimal weight, can be radically lower for the joint ownership bidder-weighted VCG mechanism than for the Deferred Acceptance auction. As seen in Table 1 below, the Deferred Acceptance auction's minimized clearing cost is 4, while the joint ownership bidder-weighted VCG mechanism's minimized clearing cost is just 1.3333, when $\bar{v} = 2$. The Deferred Acceptance auction's minimized clearing cost is 6, while the joint ownership bidder-weighted VCG mechanism's minimized clearing cost is just 1.8815, when $\bar{v} = 4$.

Table 1. Comparison of Deferred Acceptance auction and joint ownership bidder-weighted VCG mechanism

	Expected Value of Relinquished Stations		**Expected Clearing Cost**	
	Optimal Weight	Value at Optimal Weight	Optimal Weight	Value at Optimal Weight
$\bar{v} = 2$				
Deferred Acceptance	[constant]	2	2	4
Joint ownership VCG	1	1.3333	1	1.3333
$\bar{v} = 4$				
Deferred Acceptance	[constant]	3	4	6
Joint ownership VCG	1	1.6667	1.6648	1.8815

4.2 Other Examples

[To be added]

5. Empirical Evidence

The possibility of supply reduction in the Broadcast Incentive Auction has been mentioned in previous studies. Doraszelski et al. (2017) documented the significant purchases of licenses by private equity firms in the run-up to the auction and showed that multi-license holders would be able to earn large rents from a supply reduction strategy. Ausubel et al. (2017) provided evidence of potential supply reduction in the reverse auction based on the auction results that the FCC published at the conclusion of the auction, in April 2017. In this section, we provide stronger evidence of supply reduction based upon the bidding data from the auction.

5.1 Drop-out prices versus resale prices

The strongest evidence of supply reduction is provided by OTA Broadcasting (OTA), a private equity firm founded by Michael Dell's MSD Capital. OTA acquired a number of TV licenses before the auction, including 11 stations in the Pittsburgh market. OTA participated in the auction with 23 stations, but only sold ten of these stations in the auction. Out of its 11 Pittsburgh stations, OTA only sold five in the auction.

OTA then sold almost all of the remaining stations shortly after the conclusion of the auction. Sales contracts documenting the prices at which those stations were sold along with the bidding data strongly suggest that OTA employed supply reduction strategies.

Table 2. Pittsburgh stations sold by OTA Broadcasting in November 2017

DMA	Station	Purchase Price	Drop-Out Price	Resale Price
Pittsburgh, PA	WWKH-CD	In May 2013, OTA purchased these five stations along with six other Pittsburgh stations[10]	$76,594,362	The five station were resold as a group
Pittsburgh, PA	WKHU-CD		$37,567,171	
Pittsburgh, PA	WWLM-CD		$88,361,791	
Pittsburgh, PA	WMVH-CD		$33,016,048	
Pittsburgh, PA	WJMB-CD		$28,456,574	
	Total	**$7,250,000**	**$263,995,946**	**$275,000**

Table 2 above provides information about the five Pittsburgh stations that OTA sold a few months after the conclusion of the auction. The sum of the prices at which OTA dropped these five Pittsburgh stations out of the auction is about $264 million. If OTA were bidding truthfully, its valuation for these five stations would be close to $264 million. However, shortly after the auction, OTA sold those stations for about 1/1,000 of that value. This suggests that OTA dropped those stations out of the auction in order to increase the likelihood that its other Pittsburgh stations would freeze sooner and thus obtain higher prices in the auction.

[10] This was the purchase price for the 11 Pittsburgh stations.

Further evidence of supply reduction is provided by the fact that OTA bid to drop out of the auction for exactly one Pittsburgh station in each round, for rounds 2, 3, and 4 of the auction. It seems extraordinarily unlikely that these dropout bids would be connected to OTA's valuations for the stations. More likely, this was an attempt to freeze the other stations that OTA owned in the Pittsburgh market. OTA did not succeed in freezing its other stations in the first few rounds of the auction. It then stopped dropping out stations until round 22. In rounds 22 and 23, OTA bid to drop out for two more of its Pittsburgh stations.

Table 3. Seattle stations sold by OTA Broadcasting in October 2017

DMA	Station	Purchase Price	Drop-out Price	Resale Price
Seattle-Tacoma, WA	KFFV	3,450,000	23,717,150	13,100,000
Seattle-Tacoma, WA	KVOS-TV	2,900,000	9,459,692	

Table 3 above provides information about two other stations that OTA sold in October 2017, suggesting that OTA employed supply reduction strategies in the Seattle market. It is particularly suspicious that the bid to drop out for KFFV in Seattle occurred in the first round of the auction, when the prices were still very high.

5.2 Drop-outs in early rounds of the auction

Bids to drop out in the early rounds of the auction are likely to be related to supply reduction in cases where the bidder also had other stations in the same market in the auction. In this section we provide a few examples of such bids.

Entravision Holdings participated in the auction with 23 stations. In the first round of the auction, it bid to drop out for eight of those stations. For each of those eight stations, there were one or more other stations that Entravision still had in the auction, suggesting that Entravision employed a supply reduction strategy.

NRJ TV is a private equity firm that acquired TV licenses before the Broadcast Incentive Auction. NRJ TV participated in the auction with 14 stations, including three stations in the Los Angeles market, two stations in the San Francisco market, and two stations in the Philadelphia market. In the second round of the auction, even though the prices were still very high, NRJ TV bid to drop out for a station in the Los Angeles area and a station in the San Francisco area, presumably trying to freeze other stations that NRJ TV owed in California. Indeed, one of its other Los Angeles stations and its San Diego station became frozen after the round.

LocusPoint, another private equity firm participated in the auction with nine stations. Two of those stations were in Florida. In the first round of the auction, LocusPoint bid to drop out for one of those stations, presumably attempting to freeze its other Florida station.

It is not only the large bidders or the private equity firms that appear to have employed supply reduction strategies in the auction. For example, Central Michigan University participated in the auction with five stations (all in the state of Michigan), and bid to drop out for four of those stations in the first round of the auction, presumably as an attempt to freeze its fifth station. As another example, Spanish Broadcasting System Holding Company participated in the auction with three stations (all in Puerto Rico), and bid to drop out for two of those stations in the first round of the auction, presumably as an attempt to freeze its third station.

6. Conclusion

[To be added]

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