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## The 'Google effect' in the FCC's 700 MHz auction

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### ABSTRACT

We describe and interpret bidding behavior in FCC Auction 73 for the C-block licenses. These licenses were initially offered subject to an open platform restriction, which was highly valued by firms such as Google. Google entered bids until its bids reached the C-block reserve price, thereby ensuring that the open platform restriction would be applied to the licenses. Later in the auction, other bidders outbid Google, so Google was able to trigger the open platform restriction without having to purchase any of the licenses.

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### 1. Introduction

In the US Federal Communications Commission's Auction 73 for 700 MHz spectrum licenses, which began on January 24, 2008 and ended on March 18, 2008, the licenses were offered with substantial restrictions. The FCC committed to re-auction the licenses without many of the restrictions in the event that the reserve prices were not met. The apparent motivation for adopting this selling procedure, which has been referred to as a "contingent re-auction" in the press<sup>1</sup>, is that the FCC believed the contemplated restrictions were in the public interest, but did not want to sacrifice too much revenue in exchange for their imposition.

In this paper, we provide a formal analysis of the contingent re-auction format. We focus on the C-block licenses, which were initially offered subject to an open platform restriction, described below. The licenses were to be re-auctioned without the open platform restriction

in the event that the aggregate reserve price for the block was not met. The FCC believed that the open platform restriction was in the public interest, but recognized that the restriction would reduce the value of the licenses to the typical bidder. However, one bidder, Google, was not typical: the press characterized Google as not being interested in owning spectrum licenses, but rather as having its own private value for the open platform restriction being imposed on the C-block licenses.

Aiming at providing a formal analysis of actual bidding behavior in this auction, we develop a formal game-theoretic model that allows for bidders such as Google. After presenting a detailed description of how the bidding in the C-block progressed during the auction, we use our model as a guide for understanding the observed bidding behavior in the C block. The analysis of the model together with an examination of the bid data allows us to make some suggestions for how future auctions might be improved.

The paper proceeds as follows. Section 2 provides the relevant background on Auction 73. Section 3 presents our model and discusses the related literature. Section 4 describes some auction procedures that are relevant for understanding the data. Section 5 provides a description and analysis of the bidding in the C block. Section 6 concludes.

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## 2. Background on Auction 73

The set of licenses offered in Auction 73 was partitioned into five blocks: A, B, C, D, and E.

The A-block licenses are 12 MHz licenses defined over 176 medium-sized geographic areas, referred to as Economic Areas or EAs.

The B-block licenses are 12 MHz licenses defined over 734 small geographic areas, referred to as Cellular Market Areas or CMAs.

The C-block licenses are 22 MHz licenses defined over 12 large geographic areas, referred to as Regional Economic Area Groups or REAGs. The bidders were also allowed to submit bids on three packages of licenses in the C block: the nationwide package of the eight REAGs covering the 50 US states; the Atlantic package of the two REAGs covering Puerto Rico, the US Virgin Islands, and the Gulf of Mexico; and the Pacific package of the two REAGs covering Guam, the Northern Mariana Islands, and American Samoa. In the analysis of Section 5, we focus on the nationwide package and the eight individual licenses contained in it.

The D block was organized as a single 10 MHz nationwide license, but was subject to conditions relating to a public/private partnership. It was the only block not explicitly using a contingent re-auction format and is not a focus of our analysis.<sup>2</sup>

The E-block licenses are unpaired 6 MHz licenses defined over the 176 EAs.

Each block had a reserve price. The FCC used block-specific aggregate reserve prices: block A, \$1.81 billion; block B, \$1.38 billion; block C, \$4.64 billion; block D, \$1.33 billion; block E, \$0.90 billion.<sup>3</sup> The FCC stated that “Because of the value-enhancing propagation characteristics and relatively unencumbered nature of the 700 MHz Band spectrum, we believe these are conservative estimates”.<sup>4</sup>

For blocks A, B, C and E, the FCC ordered that significant performance requirements be attached to the licenses. However, if the reserve price for a block was not met, the FCC ordered that the block would be re-auctioned with less stringent requirements, at the same reserve price. As described in the service rules order for the auction<sup>5</sup>, the performance requirements include the use of interim and end-of-term benchmarks, with geographic area benchmarks for licenses based on CMAs and EAs<sup>6</sup>, and population benchmarks for licenses based on REAGs.<sup>7</sup> Failure to meet the performance requirements can result in a reduction in the li-

cense term, forfeiture of a license, or the loss of authorization for unserved portions of the license area.<sup>8</sup>

In addition, for the C-block licenses (and only the C-block licenses), the FCC “will require licensees to allow customers, device manufacturers, third-party application developers, and others to use or develop the devices and applications of their choice, subject to certain conditions”.<sup>9</sup> We refer to this as the ‘open platform’ restriction. The FCC views this requirement of open platforms for devices and applications as being for the benefit of consumers.<sup>10</sup>

This auction provides a window of opportunity to have a significant effect on the next phase of mobile wireless technological innovation, and on the evolution of market and institutional arrangements – such as arrangements regarding open platforms for devices and applications to the benefit of consumers – that will go along with that innovation. As a result, in light of the evidence suggesting that wireless service providers are blocking or degrading consumer-chosen hardware and applications without an appropriate justification, we believe that it is appropriate to take a measured step to encourage additional innovation and consumer choice at this critical stage in the evolution of wireless broadband services, by removing some of the barriers that developers and handset/device manufacturers face in bringing new products to market. By fostering greater balance between device manufacturers and wireless service providers in this respect, we intend to spur the development of innovative products and services.<sup>11</sup>

In the event that the reserve prices for the A, B, C, or E blocks were not met, the FCC committed to offer less restricted licenses “as soon as possible” after the first auction.<sup>12</sup> In particular, the C-block licenses would be offered

<sup>2</sup> Second Report and Order (FCC 07-132), paragraph 153.

<sup>3</sup> Second Report and Order (FCC 07-132), paragraph 195.

<sup>4</sup> Second Report and Order (FCC 07-132), paragraph 195. As stated in paragraph 198, “Although wireless broadband services have great promise, we have become increasingly concerned that certain practices in the wireless industry may constrain consumer access to wireless broadband networks and limit the services and functionalities provided to consumers by these networks”. And as stated in paragraph 199, “We are also concerned that wireless service providers appear to have required that equipment manufacturers disable certain capabilities in mobile devices, such as Wi-Fi capabilities. . . . Despite these technological possibilities and potential consumer advantages, wireless handsets with Wi-Fi capabilities have been largely unavailable in the United States for reasons that appear unrelated to reasonable network management or technological necessity”. Paragraph 200 continues: “We have not found, however, that competition in the CMRS marketplace is ensuring that consumers drive handset and application choices, especially in the emerging wireless broadband market. For example, while it is easy for consumers to differentiate among providers by price, most consumers are unaware when carriers block or degrade applications and of the implications of such actions, thus making it difficult for providers to differentiate themselves on this score. As a result, while many commenters assert that market forces require that wireless providers support handsets and applications that consumers want, there is evidence that wireless service providers nevertheless block or degrade consumer-chosen hardware and applications without an appropriate justification”.

<sup>5</sup> Second Report and Order (FCC 07-132), paragraph 201.

<sup>6</sup> Second Report and Order (FCC 07-132), paragraph 307. No definitive resolution was proposed for the D block should its reserve price not be met.

<sup>2</sup> It was clear that the D block would be re-auctioned at some point if its reserve price was not met, but it was not clear when that would occur nor to what extent the conditions on the block would be changed.

<sup>3</sup> FCC Public Notice (DA 07-3415), paragraph 53.

<sup>4</sup> FCC Public Notice (DA 07-3415), paragraph 54.

<sup>5</sup> Second Report and Order (FCC 07-132), paragraph 153.

<sup>6</sup> Specifically, paragraph 157 states that “licensees must provide signal coverage and offer service to: (1) at least 35% of the geographic area of their license within 4 years of the end of the DTV transition, and (2) at least 70% of the geographic area of their license at the end of the license term”.

<sup>7</sup> Specifically, paragraph 162 states that “licensees must provide signal coverage and offer service to: (1) at least 40% of the population of the license area within four years, and (2) at least 75% of the population of the license area by the end of the license term”.

without the open platform restriction.<sup>13</sup> In the end, the reserves for the A, B, C and E blocks were met, so the second auction was not triggered.

Although the typical bidders for spectrum licenses, such as Verizon and AT&T, opposed the open platform restrictions on the C block, firms such as Skype Communications and Google lobbied for those restrictions.<sup>14</sup> Although Google apparently played a role in the FCC's decision making regarding open platform restrictions, analysts viewed Google as unlikely to win any of the licenses.<sup>15</sup> Its main interest instead was in forcing other wireless providers to open their networks to a broader array of telephone equipment and Internet applications, rather than in providing wireless services itself. "Google's intent was to win the open access rule, and that's what its bidding is about," said Blair Levin, a former senior F.C.C official who is now an analyst at Stifel Nicolaus". As reported in the *New York Times*, "Google was not expected to post a winning bid".<sup>16</sup>

### 3. The model

#### 3.1. Basic setup and related literature

The key elements of the problem faced by the FCC can be described as follows: It has spectrum licenses that can be sold with or without usage restrictions.<sup>17</sup> These restrictions are viewed as being in the public interest, but they lower the willingness to pay of a typical bidder, and thus can reduce auction revenues. We assume that if the restricted licenses are sold, there is a public benefit of  $B$  in addition to the sale price. We normalize the public benefit from the unrestricted license to zero.

There are  $n + 1$  bidders,  $n$  typical and 1 atypical. Each typical bidder values the unrestricted licenses more than the restricted licenses. The atypical bidder, bidder  $g$ , has zero value for the licenses themselves, but receives private benefit  $B_g$  if the restriction is imposed.

To keep the model simple, we assume that a single license is offered in a contingent re-auction. The license is first put up for sale in restricted form in an ascending-bid auction with reserve price  $r$ . In the event that no bidder bids at or above  $r$ , the object is put up for sale in another ascending-bid auction, this time in unrestricted form, with the same reserve price. To avoid unnecessary complications, we assume that the reserve price is below the lowest possible value for the unrestricted object and so is not binding in the second auction. This is consistent with the

stylized facts of Auction 73, since the reserve prices were viewed as conservative with respect to the unrestricted licenses.

We assume that the identity of the current high bidder is not observable at any point during the auction (although the current high bid is). We abstract away from issues of eligibility requirements, although we return to those in the discussions of Sections 4.1 and 5.

We assume the resale market is efficient and that a bidder winning the license can resell it after the contingent re-auction at a price equal to the highest value among the remaining bidders.<sup>18</sup> However, if the seller initially sold the license in restricted form, then those restrictions continue to apply if the license is resold.

In Brusco et al. (2008) we provide a comprehensive theoretical analysis of contingent re-auctions, but in that model we do not allow for atypical bidders benefiting from the restriction, such as our bidder  $g$ . The present model allows for this additional type of bidder, but to keep the analysis simple assumes complete information about bidders' values.

There is a related literature on auctions with resale. Horstmann and LaCasse (1997) show that, in a common value environment, a seller may choose not to sell an object even if it receives bids above the announced reserve price, and then to re-auction the item after a delay in order to signal its private information about the value of the object. In contrast, in the environment we consider, the seller has no private information. McAfee and Vincent (1997) consider a model in which a seller cannot commit not to re-auction an object if the announced reserve price is not met. They show that when the time between auctions goes to zero, the seller's expected revenues converge to that of a static auction with no reserve price, and they characterize the optimal dynamic reserve price policy of the seller. Our model differs in that the object offered at the second auction is different from the one offered at the first auction. In addition, we assume that the reserve price is not binding in the second auction, so no additional auctions are possible.

There is also a literature on auctions with resale, which focuses on environments in which bidders that win objects at an auction can then resell them after the auction.<sup>19</sup> Since we focus on a model in which bidders' values are complete information, many of the complications common in this literature do not arise.

Mares and Swinkels (2008) consider a procurement environment in which the buyer receives an external benefit if a particular supplier is chosen to supply the object. Their paper is closely related ours. In their model, the buyer's choice of supplier determines whether it receives an external benefit. This preference by the buyer affects the equilibrium bidding strategies of the suppliers. As

<sup>13</sup> Second Report and Order (FCC 07-132), paragraph 311. As discussed in paragraph 312, the band plan for the reaucted C-block would also be modified.

<sup>14</sup> See "Petition to Confirm a Consumer's Right to Use Internet Communications Software and Attach Devices to Wireless Networks", filed in FCC proceeding RM-11361 on behalf of Skype Communications, S.A.R.L., on February 20, 2007. See also "Airwaves Auction Imminent," *New York Times*, January 22, 2008, p. C1.C8.

<sup>15</sup> "Airwaves Auction Imminent", *New York Times*, January 22, 2008, p. C1.C8.

<sup>16</sup> "Auction of wireless spectrum brings US \$19 billion", *New York Times*, March 19, 2008, p. C2.

<sup>17</sup> In the model we only consider two quality levels, restricted and unrestricted, although clearly the unrestricted licenses would still have some obligations associated with them.

<sup>18</sup> The price depends on how the resale market is organized. We make the simplifying assumption that a bidder that owns the object can make a take-it-or-leave-it offer to the bidder that has the highest valuation. With other assumptions the analysis would be similar, although of course the exact statements of the conditions would change.

<sup>19</sup> See, e.g., Gupta and Lebrun (1999), Haile (2000, 2001, 2003), Zheng (2002), Garratt and Tröger (2005), Garratt et al. (2006), Lebrun (2007), Pagnozzi (forthcoming), and Krishna and Hafalir (2008).

shown in their paper, a variant on a second-price auction outperforms any of a class of first-price mechanisms. In contrast, in our model the seller's choice of whether to allocate the license in restricted or unrestricted form determines whether it receives an external benefit. Conditional on the form in which the license is allocated, bidders compete in symmetric fashion.

In our model of a contingent re-auction, bidders may have an incentive to behave strategically in the first auction in order to influence whether the license is allocated in restricted or unrestricted form. In addition, we show that the presence of a bidder that itself has a benefit associated with the license being allocated in restricted form can affect the outcome of the auction even when that bidder does not win the auction.

### 3.2. Details of the model and results

Let  $N = \{1, \dots, n\}$  denote the set of typical bidders. Each buyer  $i \in N$  has values  $l_i$  and  $h_i$  for the restricted and unrestricted license, respectively. The minimum and maximum low values are  $\underline{l}$  and  $\bar{l}$ , and the minimum and maximum high values are  $\underline{h}$  and  $\bar{h}$ . For simplicity we assume  $\bar{l} < \underline{h}$  and, as mentioned above, we restrict attention to  $r \leq \underline{h}$  so that the reserve price is never binding in the second auction.

$$r = \begin{cases} l_{(1)} - (h_1 - h_2), & \text{if } l_1 = l_{(1)} \text{ and } h_2 \leq B + \max\{l_{(2)}, l_{(1)} - (h_1 - h_2)\} \\ l_{(1)}, & \text{if } l_1 \neq l_{(1)} \text{ and } h_2 \leq B + l_{(1)} \\ \underline{h}, & \text{otherwise} \end{cases}$$

We assume that the bidders' values are common knowledge, with  $h_1 > h_2 > \dots > h_n$ . We do not want to assume that the ranking of the values for the restricted license are the same as those for the unrestricted license, so we let  $l_{(j)}$  denote  $j$ -th highest value among  $l_1, \dots, l_n$ . For example,  $l_{(1)} \equiv \max\{l_1, \dots, l_n\}$ .

Bidder  $g$  has  $l_g = h_g = 0$  and receives benefit  $B_g$  if the restricted license is sold, regardless of which bidder purchases it. The seller cares about the sales revenue and receives an additional benefit of  $B$  if the license is sold in restricted form.

As a preliminary observation, note that, in any equilibrium with undominated strategies, if the second auction takes place, bidder 1 wins the unrestricted license and earns  $h_1 - h_2$ .

#### 3.2.1. Equilibrium without bidder $g$

Consider the first auction. As a first step, suppose that bidder  $g$  is not present, so that only the  $n$  typical bidders participate in the auction. In this case the license remains unsold if the reserve exceeds all bidders' values. If instead  $r \leq l_{(1)}$ , the outcome depends on whether bidder 1 is also the bidder with the highest value for the restricted license: if  $l_1 < l_{(1)} = l_j$  for  $j \neq 1$ , then bidder  $j$  wins the restricted license and pays  $\max\{r, l_{(2)}\}$ ; if instead  $l_{(1)} = l_1$ , then bidder 1:

- does *not* make an initial bid if  $l_{(2)} < r$  and  $l_1 - r < h_1 - h_2$ , since in that case bidder 1 is better off waiting for the second auction;
- otherwise, makes an initial bid and stays in the auction until the price reaches  $l_1$ . If  $l_{(2)} > r$ , the first auction would start anyway. If  $l_1 - r > h_1 - h_2$ , then even if no other bidder is willing to start the first auction, it is better for bidder 1 to win the first auction at a price  $r$  rather than the second auction at a price  $h_2$ .

Thus, bidder 1 suppresses its bid in the first auction whenever it has the highest value for the restricted license ( $l_1 = l_{(1)}$ ), faces no competition for the unrestricted license ( $l_{(2)} < r \leq l_{(1)}$ ), and earns more by winning the unrestricted license at price  $h_2$  than by winning the restricted license at price  $r$  ( $h_1 - h_2 > l_1 - r$ ).

**Proposition 1.** *In the absence of bidder  $g$ , the unrestricted license is sold in the second auction if*

- $l_{(1)} < r$ , or
- $l_{(2)} - r < 0 \leq l_1 - r < h_1 - h_2$ .

*Otherwise the restricted license is sold in the first auction. The reserve price that maximizes the seller's surplus is*

**Proof.** The first part of the proposition is proven in the text. To determine the optimal reserve price, note that the seller's surplus is  $h_2$  if (1) holds and  $\max\{l_{(2)}, r\} + B$  otherwise. The seller can guarantee that (1) holds by setting  $r = \underline{h}$ , which exceeds all possible values for the restricted license.  $\square$

As shown in Proposition 1, in some cases the seller prefers to set a reserve price sufficiently high that bidders are shut out of the first auction.

Proposition 1 implies that, for some parameter values, demand reduction reduces the seller's surplus relative to what it would be if the bidders bid truthfully in each of the two auctions. Under truthful bidding, the optimal reserve price is  $l_{(1)}$  if  $h_2 \leq B + l_{(1)}$  and  $\infty$  otherwise, so seller surplus is  $\max\{B + l_{(1)}, h_2\}$ . But if  $B + l_{(1)} > h_2$  and  $l_1 = l_{(1)}$ , then demand reduction results in seller surplus of only  $B + \max\{l_{(2)}, l_{(1)} - (h_1 - h_2)\}$ , which is less than  $B + l_{(1)}$ .

**Corollary 1.** *Demand reduction can reduce seller surplus at a contingent re-auction.*

It is worth pointing out that the demand reduction effect in the contingent re-auction is different in nature from the one described by Ausubel and Cramton (2002), who

consider auctions of multiple objects. In their environment, demand reduction has a collusive flavor, requiring that all bidders reduce their demand and buy fewer objects in order to pay a lower price. In our case, there is only one license for sale, and demand reduction occurs only when there is a bidder that is effectively a monopsonist for the restricted license and thus can refuse to buy the restricted license in order to force the seller to re-auction the unrestricted license.

### 3.2.2. Equilibrium with bidder $g$

We now modify our model to allow for the presence of one atypical bidder, bidder  $g$ .

Suppose first that the values of the parameters are such that the object would be sold in the first auction if only the bidders in  $N$  were to participate, i.e. both (a) and (b) in (1) above fail. In the absence of participation costs, an undominated strategy for bidder  $g$  would be to bid up to the reserve price and then drop out. In the out-of-equilibrium case in which bidder  $g$  won, it would resell the license at price  $l_{(1)}$ . In equilibrium, bidder  $g$  does not win and the presence of  $g$  does not change the outcome of the auction. Bidder  $g$ 's payoff from this strategy is  $B_g$ . By not participating in the auction, bidder  $g$  would also get  $B_g$ . Thus  $g$  is indifferent between participating or not participating. We will assume that in this case  $g$  chooses not to participate (this can be justified assuming a small cost of participation or a small imperfection in the resale market).

Suppose next that the values of the parameters are such that the object would not be sold in the first auction if only bidders in  $N$  participated, that is (1) holds. There are two cases:

- (a)  $l_{(1)} < r$ : In this case  $g$  can win the restricted object at price  $r$  and then resell it at  $l_{(1)}$ , for a net benefit of  $B_g - r + l_{(1)}$ . Thus, bidder  $g$  participates (and wins) in the auction for the restricted object if and only if  $B_g > r - l_{(1)}$ .
- (b)  $l_{(2)} - r < 0 \leq l_1 - r < h_1 - h_2$ : In this case  $g$  can make an initial bid of  $r$  and let bidder 1 win the auction<sup>20</sup>, for a total benefit of  $B_g$ .

Thus, if (1) holds, the necessary and sufficient condition for the object to be sold in the first auction is  $B_g > r - l_{(1)}$  (this condition is automatically satisfied in the second case, since  $B_g > 0 > r - l_{(1)}$ ). It is an undominated strategy for bidder  $g$  to bid up to  $r$  if  $B_g > r - l_{(1)}$  and for it not to participate otherwise.

To summarize, we have

**Proposition 2.** *The object is sold in the first auction (in restricted form), if  $B_g > r - l_{(1)}$ . Otherwise it must be the case that  $l_{(1)} < r$ , so the object is sold in unrestricted form.*

Thus, the object is sold in restricted form whenever  $l_{(1)} \geq r$  (in that case bidder  $g$  can trigger the first auction at no cost) or whenever  $l_{(1)} < r$  but bidder  $g$  has a sufficiently high benefit associated with the restriction on the

license to make it willing to pay the price  $r - l_{(1)}$  (the difference between what it has to pay to get the object and the price that it can obtain in the resale market). Bidder  $g$  has no incentive to bid above  $r$ .

This model suggests that we should either see no bids by Google for the C block, or we should see Google bid up to the C-block reserve price and then stop bidding. Once Google bids the reserve price, then other bidders should bid up to their values for the licenses since at that point there is no longer any incentive for demand reduction geared towards triggering a second auction for the unrestricted license.

## 4. Auction procedures

As preparation for our examination of the bid data from Auction 73, it is useful to review some of the relevant auction procedures, including eligibility and activity rules, rules for withdrawn and dropped bids, and procedures for determining bid increments.<sup>21</sup> In Section 5, we will see reflections of these procedures in the data.

The FCC defines various types of bids, including *provisionally winning bids* and *high bids*. A provisionally winning bid is a bid that would win if there were no further bids. A high bid for a license is the highest active bid for a license<sup>22</sup>, but a high bid need not be provisionally winning when a license is part of a package. For example, if the high bid on the nationwide package exceeds the sum of the high bids on REAGs 1–8, then the high bids on REAGs 1–8 are not provisionally winning bids.

### 4.1. Eligibility and activity rules

The eligibility and activity rules for Auction 73 are described in the FCC's Public Notice DA 07-4171 (October 5, 2007) "Auction of 700 MHz Band Licenses Scheduled for January 24, 2008: Notice and Filing Requirements, Minimum Opening Bids, Reserve Prices, Upfront Payments, and Other Procedures for Auctions 73 and 76" (Procedures PN). The descriptions of these rules given below are drawn from the Procedures PN.

The FCC's activity rule is designed to force bidders to bid actively throughout the auction, rather than wait until late in the auction before participating.

Each license is assigned a specific number of bidding units that do not change as prices rise during the auction. A bidder's upfront payment determines its initial bidding eligibility, the maximum number of bidding units on which a bidder may be active. A bidder's activity level in a round is the sum of the bidding units associated with any licenses covered by new and provisionally winning bids from the previous round. A bidder can submit bids on licenses as long as its activity level does not exceed its eligibility.<sup>23</sup> If a minimum level of activity is not maintained, the bidder must use an activity rule waiver or face a reduction in its

<sup>21</sup> For additional details of the auction rules, particularly the implementation of anonymous bidding, see Bajari and Yeo (2008).

<sup>22</sup> As described below, bids can potentially be withdrawn or dropped. Withdrawn or dropped bids cannot be high bids.

<sup>23</sup> An exception for the case with package bidding is discussed below.

<sup>20</sup> If  $l_1 = r$ , then bidder  $g$  wins the license with its bid of  $r$ , but it can resell the license to bidder 1 at price  $r$ , leaving bidder  $g$  with benefit  $B_g$ .

eligibility. Bidders have three activity rule waivers. Use of an activity rule waiver preserves the bidder's current bidding eligibility despite the bidder's activity in the current round being below the required minimum activity level.

With package bidding in the C block, it is possible that a bidder may have activity that exceeds its eligibility if a non-provisionally-winning bid placed in a previous round later becomes provisionally winning. If this occurs, the bidder's current bidding eligibility will not increase to accommodate the additional activity. In subsequent rounds, the bidder will not be permitted to place new bids above its eligibility level.

#### 4.2. *Dropped and withdrawn bids*

The Procedures PN also describes conditions under which bidders could withdraw or drop bids. In blocks other than the C block, bidders were allowed one round in which they could withdraw provisionally winning bids, subject to potential penalties. Bidders were not permitted to withdraw provisionally winning bids in the C block.

Because of the package bidding in the C block, a high bid for an individual C-block license might not be provisionally winning at the time it was placed, but subsequent bids on the other licenses included in the package could cause it to become provisionally winning later in the auction. Because of this, bidders were allowed one round in which they could "drop" non-provisionally winning bids on individual C-block licenses from further consideration in the auction. When a bid is dropped, all of the bidder's previous bids on that license or package are removed from consideration. In addition, a number of restrictions were imposed related to dropped bids.<sup>24</sup>

#### 4.3. *Bid increments*

The Procedures PN also describes how bid increments are calculated. Generally speaking, the bid increments are larger when the bidding activity on a license is high and lower when the bidding activity is low.

For non-C-block licenses and for packages of C-block licenses, bidders could increase the bid by one bid increment in each round, where the increment started at 10% of the prior bid and was adjusted at the discretion of the FCC. For individual C-block licenses, the auction allowed three acceptable bid amounts per license (the minimum acceptable bid amount and two additional bid amounts). However, multiple-increment bids were rarely submitted, and never after round 16.

With only one bid increment, ties within a round are to be expected. The FCC used random numbers to break ties.

## 5. Data

We now analyze the bid data from Auction 73. We use the data compiled by the Center for the Study of Auctions,

Procurements and Competition Policy, available at: <http://econ.la.psu.edu/CAPCP/>. We focus on the eight C-block licenses covering the 50 United States and the nationwide package. The eight licenses covering the 50 states are labeled REA001–REA008 in the data. The REAG license areas are identified in Fig. 1.

#### 5.1. *C-block bidding*

Bidders for the licenses we consider are shown in Table 1. (See Table A.1 in the Appendix for the full bidder names.) The table shows the maximum bid placed by each bidder for each license. In parentheses following the maximum bid is the round in which that bid was placed and then the round in which the bid was dropped if applicable. Winning bids are highlighted. As you can see from the table, Verizon won all of the licenses except REA007 covering Alaska.<sup>25</sup>

Google was the only bidder to bid on the nationwide package. It submitted bids during 11 of the first 17 rounds of the auction with a maximum bid of \$4,713,823,000, which is slightly more than the C-block reserve price of \$4.64 billion.

Google's second-to-last bid, which was below the C-block reserve price, was submitted in round 13, which was the first round on Wednesday, January 30, 2008. If Google had bid again in round 14, it would have had to bid \$4,865,795,000 since that was the minimum acceptable bid for the nationwide package in round 14. But instead Google waited until round 17, which was the first round on January 31, 2008, by which time the lack of activity in the C block during rounds 14–16 had caused the minimum acceptable bid to fall to \$4,713,823,000.

In Tables 2 and 3, we show the individual bids during rounds 1–17 and after round 17, respectively. Table 2 shows Google's bids on the nationwide package and bids by Alltel, Cricket, MetroPCS, King St, Cell South, Bluewater, Vulkan, Copper, and SAL on the individual licenses during rounds 1–17. Table 3 shows that a different set of bidders entered after round 17: Verizon, AT&T, Qualcomm, SAL, Triad, and Cox. Only SAL bid both before and after round 17. SAL was active early in the auction bidding for the Alaska and Hawaii licenses, and entered one bid late in the auction for the Alaska license.

Initially, Google's bid for the nationwide license was at least as great as the sum of the high bids (or minimum opening bid if there is no high bid) on the eight licenses included in the package and so was considered provisionally winning. For example, in round 1 the high bids on the eight licenses included in the package summed to \$1,036,247,000. There was no bid on the Alaska license, but for the purpose of determining whether the package bid or individual license bids are provisionally winning, the FCC attributed a bid slightly less than the minimum opening bid amount to any licenses on which there were no bids.<sup>26</sup> The minimum opening bid amount for the Alaska license was \$1,301,000 (see Table 4 below), so Google's

<sup>24</sup> The provisionally winning bidder on a package was not permitted to drop bids on licenses included in the package. A bidder dropping its bids on a license or package was not permitted to submit further bids on that license or package. A bidder dropping its bids on a license was not permitted to submit any bids on packages containing that license.

<sup>25</sup> We discuss this in more detail below.

<sup>26</sup> See the Procedures PN at p. H-1, footnote 449.

## Regional Economic Area Groupings (REAGs)



Fig. 1. Map of REAGs (Source: FCC).

Table 1

C-block maximum bid amounts by bidder (in 1,000 s of dollars). In parentheses are the round that the maximum bid was made and the round it was dropped if applicable. Winning bids are in *italics*.

Bidder	Pkg 50 States	REA001	REA002	REA003	REA004	REA005	REA006	REA007	REA008
Google	\$4,713,823 (17)								
Cricket		\$324,585 (1,5)		\$205,720 (2,5)					
Alltel		\$604,624 (8,9)		\$445,270 (5,9)			\$333,833 (3,9)		
Verizon		\$502,774 (29)	\$424,224 (30)	\$1,109,715 (30)	\$1,625,930 (27)	\$723,228 (27)	\$319,798 (30)	\$1,668 (30)	\$36,138 (30)
MetroPCS			\$306,117 (4,6)			\$120,042 (2,6)			
AT&T			\$637,183 (19,20)		\$602,118 (18,20)				
King St				\$933,360 (9)	\$241,365 (6)				
Cell South					\$241,365 (6,8)				
Qualcomm					\$1,625,930 (27,28)	\$485,989 (23,28)			
Bluewater						\$174,128 (8,9)	\$683,894 (6,9)		
Vulcan							\$540,970 (5,7)		
Copper								\$1,906 (5,8)	
SAL								\$1,701 (39)	\$2,799 (4,8)
Triad 700								\$1,783 (40)	
Cox									\$28,701 (29,30)

bid of \$1,037,548,000 on the nationwide license was sufficient for that bid to be provisionally winning.<sup>27</sup>

As shown in Fig. 2, Google's bids on the nationwide license continued to be provisionally winning until round 30, with the exception of round 6. In round 6, Google did not raise its bid on the nationwide license and at the end of that round high bids on licenses REAGs 1, 3, 4, 6, 7, and 8 totaled \$1,962,919,000. Earlier bids on REAGs 2 and 5 were dropped in round 6. So the total of the high bids plus the minimum opening bid amounts for REAGs 2 and 5

was \$2,216,953,000, which exceeded Google's bid from round 5 of \$2,151,288,000. In the next round, Google raised its bid again and the nationwide license continued to dominate the individual licenses until round 30.<sup>28</sup>

<sup>28</sup> Harold Feld in Congressional testimony incorrectly characterizes Verizon's strategy as responding to round 26 bids that he says beat Google's package bid (see "Testimony of Harold Feld", Delivered to the Subcommittee on Telecommunications and the Internet of the Committee on Energy and Commerce, United States House of Representatives, Oversight of the Federal Communications Commission – The 700 MHz Auction, April 15, 2008, at p. 13). In fact, the package bid remained the provisionally winning bid until Verizon's bids in round 30.

<sup>27</sup> Note that \$1,036,247,000 + \$1,301,000 = \$1,037,548,000.

**Table 2**

C-block bids in the first 17 rounds by bidder (in 1,000 s of dollars). A “D” indicates the round in which a bid was dropped.

Round	Pkg 50 States	REA001		REA002	REA003			REA004		REA005		REA006			REA007		REA008
		Google	Alltel	Cricket	MetroPCS	Alltel	Cricket	King St	King St	Cell South	MetroPCS	Bluewater	Alltel	Bluewater	Vulcan	Copper	SAL
1	1,037,548	324,585	324,585	153,999	171,433		171,433	63,932	63,932	100,035			221,798	221,798	465	465	
2	1,244,993			184,799	205,720	205,720	205,720	76,719	76,719	120,042			266,158	266,158	558	558	
3	1,493,951			235,278			262,865	100,051	100,051			333,833	333,833	333,833	898	816	1,850
4	1,792,741			306,117	343,587		343,587	134,115	134,115				426,010	426,010	1,336		2,799
5	2,151,288		D		445,270	D	445,270	177,397	177,397				540,970	540,970	1,906		
6		441,570		D			591,385	241,365	241,365	D			683,894				
7	2,554,389													D			
8	2,976,465	604,624					760,487		D		174,128				D		D
9		D			D		933,360				D	D	D				D
10	3,379,984																
11																	
12	3,784,943																
13	4,294,397																
14																	
15																	
16																	
17	4,713,823																

**Table 3**

C-block bids in rounds 18 and later by bidder (in 1,000 s of dollars). A “D” indicates the round in which a bid was dropped.

Round	REA001	REA002		REA003	REA004		REA005		REA006	REA007			REA008		
	Verizon	Verizon	AT&T	Verizon	Verizon	AT&T	Qualcomm	Verizon	Qualcomm	Verizon	Verizon	SAL	Triad	Verizon	Cox
18															
19			637,183												
20			D			D									
22							578,334								
23									485,989						
24							884,144								
25							1,158,757								
26							1,405,293								8,077
27					1,625,930		1,625,930	723,228							15,010
28							D		D						21,180
29	502,774	304,358													28,701
30		424,224		1,109,715						319,798	1,668			36,138	D
39												1,701	1,701		
40													1,783		

**Table 4**

Bidding units and minimum bids for C-block licenses included in the nationwide package.

Licence	Market	Bidding units	Minimum bid
REA001	Northeast	52,530,000	\$324,585,000
REA002	Southeast	48,639,000	\$153,999,000
REA003	Great Lakes	57,568,000	\$171,433,000
REA004	Mississippi Valley	28,742,000	\$63,932,000
REA005	Central	39,958,000	\$100,035,000
REA006	West	51,966,000	\$221,798,000
REA007	Alaska	528,000	\$465,000
REA008	Hawaii	1,185,000	\$1,301,000
Total		281,116,000	\$1,037,548,000

In Fig. 2, the line for the sum of the high bids on the individual licenses increases and decreases. Increases are the result of new bids being submitted on the individual licenses, and decreases are the result of bidders choosing to drop their bids, thereby guaranteeing that they do not become provisionally winning later in the auction. Fig. 2 omits the lines for the Alaska and Hawaii licenses because the bids on those licenses were sufficiently small that they are difficult to discern on the graph.

In round 30, Verizon's bids pushed the total for the individual licenses above Google's bid on the nationwide package from round 17. After beating Google's bid, Verizon did not enter any additional bids, although SAL and Triad continued to bid on the Alaska license, with Triad ultimately winning that license.

One would expect that a motivating factor for Verizon's decision to switch its bidding activity from the A and B blocks to the C block was the growing price differential between the A and B-block licenses and the C-block licenses.

Fig. 3 shows the average prices for the A, B, and C-block licenses covering the geographic areas covered by the nationwide C-block license. (For more detail, see Table A.2 in the Appendix.) The total amount bid for the licenses in a given round is calculated using the high bids for the round or, if there is no current high bid, then the minimum opening bid. This total amount is divided by the product of the population and the bandwidth (12 MHz for the A and B block and 22 MHz for the C block). The unit of "MHz-Pop", which denotes MHz times population, is commonly used to standardize prices, although that does not capture the variety of other differences in license attributes among the blocks.

After round 26, the average \$/MHz-Pop for the A and B-block licenses (US only) was \$1.86, in contrast to the C-block prices of \$0.76. Verizon's bidding is consistent with its believing that the differences in the licenses, including the open platform restriction on the C block licenses, reduced the value of the C-block licenses by roughly \$1.10 per MHz-Pop relative to the A and B-block licenses. With these beliefs, when the gap in prices between the blocks reached that point, Verizon would have had an incentive to move its bidding activity from the A and B blocks to the C block. Alternatively, round 26 may just have been the point at which Verizon figured out a bidding strategy for the C block licenses.

## 5.2. Verizon's bidding eligibility

As described in Section 4.1, the FCC's activity rules are intended to force bidders to bid actively throughout the auction, rather than wait until late in the auction to participate. However, we see from the C-block bidding that Verizon was able to enter the C-block bidding relatively late in the auction and win most of the licenses. This begs the question how Verizon had the eligibility to do this.

Table 4 shows the bidding units associated with the licenses included in the nationwide package. Verizon had total eligibility of 590,000,000 bidding units based on its upfront payment, but in round 1 it reduced its eligibility to 306,371,250 bidding units.

Verizon entered its first C-block bids in round 27, which was the first round on Monday morning on February 4, 2008. All of Verizon's bids in the C block were in rounds 27–30, which were the four rounds held on that Monday.

Prior to round 27, Verizon actively bid on licenses in the A and B blocks. In round 26, it submitted 178 bids in the A and B blocks. After round 26, Verizon was the provisional winner on 343 licenses in the A and B blocks based on its bids in round 26 and in the previous rounds.

Going into round 27, 179,666,300 units of Verizon's eligibility were tied up in provisionally winning bids in the A and B blocks. Thus, Verizon had 126,704,950 units of eligibility remaining, which it could use to place new bids. This was not enough eligibility to place bids on all of the C-block licenses, but it was enough for Verizon to place bids on REAGs 4 and 5 in round 27.<sup>29</sup> Because those bids were not sufficient to raise the sum of high bids on the individual licenses above Google's standing high bid on the nationwide package, those bids were not provisionally winning and so did not tie up any eligibility for Verizon.

In round 28, Verizon placed no bids and used an activity rule waiver, preserving its bidding eligibility.

Going into round 29, Verizon was the provisionally winning bidder on 211 licenses in the A and B block, having been outbid on 132 licenses during rounds 27 and 28. So going into round 29, 143,958,500 units of Verizon's eligibility was tied up in provisionally winning bids in the A and B blocks. This left 162,412,750 units of eligibility that could be used to enter new bids. But this was still not enough eligibility for Verizon to bid on all of the remaining C-block licenses; however, it was enough for Verizon to bid on REAGs 1 and 2 in round 29.

But those bids were still not sufficient to raise the sum of high bids on the individual licenses above the high bid on the nationwide package. So Verizon's bids on REAGs 1, 2, 4, and 5 were not provisionally winning and so still did not tie up any of Verizon's eligibility.

Going into round 30, Verizon was the provisionally winning bidder on 204 licenses in the A and B block, tying up 142,268,500 units of eligibility. Thus, Verizon had 164,102,750 units of eligibility remaining. This was enough

<sup>29</sup> Verizon's strategy of bidding on only a few REAG licenses per round has been referred to as "strafing".

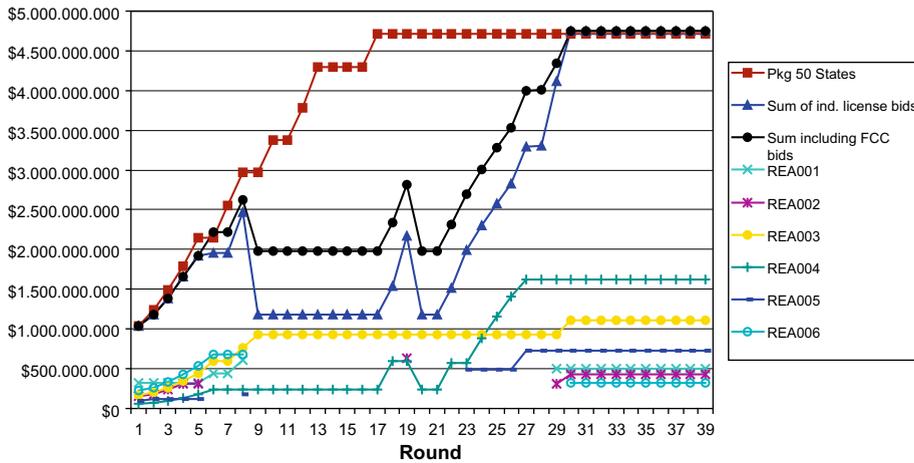


Fig. 2. High bids for the continental US licenses and for the nationwide package, as well as the sum of the high bids on all the licenses included in the nationwide package with and without the inclusion of FCC bids (minimum opening bids) on licenses for which there is no current high bid.

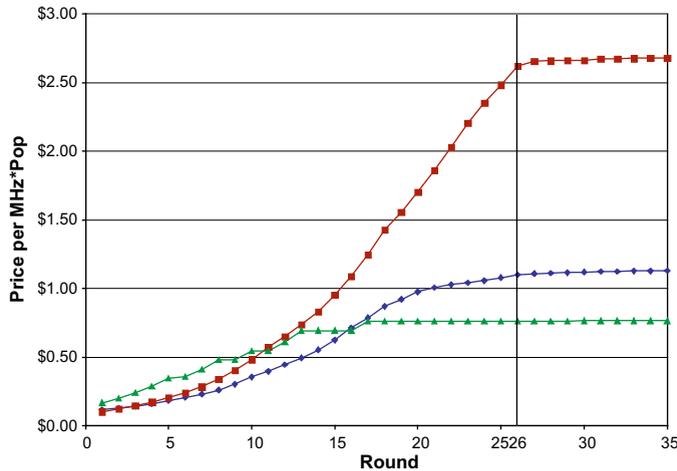


Fig. 3. Prices by block calculated using the high bid or minimum opening bid if there is no current high bid for licenses covering the 50 US states (excluding the Gulf of Mexico, Puerto Rico, Guam, American Samoa, the US Virgin Islands, and the Northern Mariana Islands).

for Verizon to raise its bid on REAG 2 and submit bids on the remaining REAGs, numbers 3, 6, 7, and 8.

As a result of Verizon's bids in round 30, all of Verizon's bids on the REAGs became provisionally winning bids.<sup>30</sup> Verizon's provisionally winning bids then had total bidding units of 421,555,500, which was more than Veri-

zon's eligibility at that time (although not more than Verizon's initial eligibility of 590,000,000 bidding units). As a result, Verizon was constrained not to submit any additional bids unless it withdrew its provisionally winning bids on a substantial number of A and B-block licenses, potentially having to pay withdrawal penalties. Even after its bid on the Alaska license was no longer provisionally winning, the bidding units on its provisionally winning bids remained above its eligibility. Thus, Verizon did not have the eligibility required to respond to the later bids by SAL and Triad on the Alaska license even if it had wanted to.

The trade press characterized Verizon's situation as follows: "If someone had placed a counter bid on Mississippi Valley or any of the other C block licenses, Verizon could not have done a thing and would have lost their nationwide footprint. ... After Verizon won the C block in Round

<sup>30</sup> In Congressional testimony, Coleman Bazelon states: "Verizon intentionally bid up the value of the Mississippi Valley license... by raising its own bid to extremely high levels – \$1.6 billion or \$2.36/MHz\*Pop – effectively blocking other bidders ability to enter the fray in the C block by starting its bidding on that license". (See "Testimony of Coleman Bazelon," delivered to the Subcommittee on Telecommunications and the Internet of the Committee on Energy and Commerce, United States House of Representatives, Oversight of the Federal Communications Commission – The 700 MHz auction, April 15, 2008, at p. 13.) In fact, Verizon did not raise its own bid on the Mississippi Valley license. As shown in Table 3, it was Qualcomm that repeatedly raised its own bid on that license.

**Table 5**

Limited information calculations on remaining eligibility.

Round	Non-nationwide bidding units	Nationwide bidding units held by non-nationwide bidder	New bid bidding units	Round activity for non-nationwide bidders	Upper bound on remaining eligibility of non-nationwide bidders
26	511,963,500	0	178,333,200	690,296,700	862,870,875
27	511,963,500	0	174,458,000	686,421,500	858,026,875
28	511,963,500	0	47,659,900	559,623,400	699,529,250
29	511,963,500	0	141,857,000	653,820,500	699,529,250
30	511,963,500	0	190,639,100	702,602,600	699,529,250
31	511,963,500	281116000	34,277,900	827,357,400	699,529,250
32	511,963,500	281116000	16,469,700	809,549,200	699,529,250
33	511,963,500	281116000	15,528,900	808,608,400	699,529,250
34	511,963,500	281116000	11,048,900	804,128,400	699,529,250
35	511,963,500	281116000	12,525,800	805,605,300	699,529,250

30, there were only two companies with enough bidding eligibility to challenge them – Google and Echostar [Dish] – and luckily for Verizon, neither was interested”.<sup>31</sup> This characterization ignores Verizon’s ability to withdraw its provisionally winning A and B-block bids to free up eligibility with which to continue bidding in the C block, but Verizon did face eligibility constraints.

After round 30, without additional eligibility Verizon also could not enter bids in the A and B blocks, where other bidders had enough eligibility to challenge it. Verizon ultimately won only 102 of the A and B licenses, down from the 343 on which it was the provisionally winning bidder when it started bidding on the C block.

Information on bidders’ eligibility levels was not released until after the auction ended, so bidders could not have known that Verizon was constrained, but Table 5 provides some calculations that would have been possible even given the limited information available during the auction. The calculations are approximate because they do not take into account the possible use of activity rule waivers by bidders nor the possibility that provisionally winning bidders might raise their own bids (something that they might have the incentive to do in order to meet the reserve price for a block). In addition, in Table 5 we approximate by assuming that by the end of round 25 every license had at least one bid (this only failed to be true for very small licenses and so the assumption does not affect our calculations much).

The bidders knew the bidding units associated with the licenses and so knew that there were 512 million bidding units associated with licenses other than the nationwide C-block licenses. Assuming that the bidder on the nationwide C-block license was not active on other licenses, one can calculate the activity of the other bidders in each round by adding the bidding units associated with new bids to the bidding units associated with the existing provisionally winning bids. If activity by non-nationwide bidders in the round were  $x$ , then the maximum eligibility for those bidders going forward would be  $x/0.8$ , unless one or more bidders used activity rule waivers.<sup>32</sup> This maximum eligibility could not increase as the auction progressed.

Starting in round 30, the round activity for non-nationwide bidders is larger than the upper bound on eligibility for those bidders. The difference is small in round 30, and so bidders might infer that the difference was a result of the approximations in the calculations. But the gap is substantial in the rounds following that, and so one would expect bidders to infer that at least one bidder had activity that exceeded its eligibility. Given that, bidders could infer that at least one bidder was constrained on its ability to enter additional bids.

Bazon states in Congressional testimony related to Auction 73 that: “A very interesting side effect of Verizon’s eligibility deficit was that it could not bid back on other licenses when it was bid off of them. Recognizing that this was likely the case, but not knowing which A and B Block licenses the new C Block PWB was winning, bidders would test the waters by bidding on a license and seeing if they were bid back. In an open auction, everyone would have known which licenses could be bid on without the existing PWB (Verizon) bidding back”.<sup>33</sup>

In summary, Verizon’s bidding strategy for the C block was not without risks and costs since it left it without sufficient eligibility to continue bidding in any of the blocks. Verizon could have entered additional bids by withdrawing some of its provisionally winning bids in the A and B blocks, but such strategy would have had its own risks and costs.

Verizon’s situation highlights the fact that the FCC’s package bidding auction design creates an additional possible motivation for bid withdrawals relative to designs without package bidding. First, irrespective of package bidding, withdrawals might be observed because a bidder decides it has won licenses than it does not want (perhaps because prices of complementary licenses were too high). Second, with package bidding, a bidder on licenses contained in a package that finds itself in the position of having exceeded its eligibility might decide to withdraw provisionally winning bids on some of its licenses in order to free eligibility to continue competing for other licenses. This incremental incentive for withdrawals is potentially of concern because withdrawals can create inefficiencies by causing licenses to go unsold when other bidders do not have sufficient eligibility remaining to bid on them.

<sup>31</sup> See Howard Buskirk, “Verizon Nearly Lost Bid for National C-Block License,” *Communications Daily*, March 25, 2008, p. 5.

<sup>32</sup> Rounds 1–35 were in “Stage 1” of the auction, where the activity requirement was 80% of eligibility.

<sup>33</sup> See the reference in Footnote 30.

### 5.3. Evaluation

The discussion above raises the questions of whether the auction rules caused the C-block prices to be below those for the A and B blocks, or whether the asymmetries were due to differences in the restrictions and other characteristics, and how one might want to restructure the eligibility rules when package bidding is allowed.

We can speculate that Verizon's bidding strategy was not to bid on the C-block licenses if no other bidder bid up to the reserve price. Verizon's bidding in the early rounds of the auction is consistent with this. Thus, we speculate that, without Google's participation in the auction, the C-block reserve price would not have been met, triggering a re-auction of that block without the restrictions. In that case, we would expect prices for the C-block licenses that were more in line with the other blocks and other recent spectrum sales. Although this line of thinking is speculative, it suggests that Google's participation may have reduced auction revenue because it triggered the sale of the restricted rather than unrestricted licenses. It also suggests that Google's participation may have been important for generating the benefit to consumers (and to Google) associated with the open access restriction.

The eligibility rules may also have depressed auction revenues. After round 30, Verizon was constrained by the eligibility rules not to enter additional bids unless it withdrew a sufficient number of its provisionally winning bids in the A and B blocks (withdrawals were not allowed in the C block). If the eligibility rules were modified so that a bidder's eligibility was increased in the event that its bids on package components became provisionally winning, then the constraint on Verizon would have been relaxed. In that case, Verizon would have been able to continue bidding on the Alaska REAG, which it ultimately lost, and it would also have been able to continue competing for the A and B licenses on which it was the provisionally winning bidder when it started bidding on the C block, but then ultimately lost without the ability to continue bidding.

This suggests that in auctions with package bidding, one might want to allow the eligibility to grow in case a non-winning REAG bid gets activated. Alternatively, one could prevent a bidder from being able to get into the position of exceeding its initial eligibility by counting high bids on the non-provisional REAG bids towards eligibility; however, in the absence of the ability to drop non-provisionally winning bids on components of a package, this could deter bidding on licenses that are components of a package. In addition, if Verizon had not been able to extend its eligibility through its incremental bidding or "strafing" strategy, the auction allocation might have been different since Google might have won the nationwide package of C-block licenses. In that case it would have been interesting to follow the activity in the resale market.

If the FCC had offered the C-block licenses with restrictions but without the contingent re-auction format, then one might have seen a different pattern of bidding altogether since then bidders like Verizon would not have had an incentive to "wait and see" by not bidding on the C-block licenses in the early rounds. Thus, we might have seen more active bidding early on in the C block. However,

it is not clear how this would have affected revenue, especially if eliminating the contingent re-auction format would have induced the FCC to lower the reserve price. Without the contingent re-auction format, Google would not have had an incentive to drive the price up to the contingent re-auction reserve price.

## 6. Conclusion

We have provided a model of bidding in a contingent re-auction in which one bidder with no private value for the licenses but with a private benefit from the imposition of usage restriction, has an incentive to force the sale of the restricted licenses in the first stage of a conditional re-auction procedure. The observed behavior in the C block in Auction 73 is consistent with this model if one views Google as benefitting from the imposition of the open access restriction proposed for licenses in that block but having no private value for the licenses.<sup>34</sup>

Google bid on the nationwide package until it reached the C-block reserve price and then entered no further bids. Google's bids were sufficient to meet the reserve price for the C block and thus triggered the open platform restriction for the C-block licenses. Later in the auction, Verizon and others outbid Google by submitting bids on the individual licenses included in the nationwide package. Our model suggests that in the absence of a bidder like Google, depending on bidders' values, bidders may have an incentive to suppress their bids in an attempt to trigger a re-auction of the licenses without the open access restrictions.

Our model makes a number of simplifying assumptions, some of which are relaxed in the more general model of Brusco et al. (2008).<sup>35</sup> The full implications of the interaction of contingent re-auction formats, package bidding in one block but not in others, procedures for withdrawing and dropping bids, and the FCC's activity rules remain largely unexplored.

Because Verizon submitted bids on individual licenses included in the nationwide package that totaled more than Google's bid, Google was not required to purchase any licenses. The primary cost to Google associated with its participation in the auction was the lost interest on its upfront payment of \$287,371,000, which was held by the FCC for the duration of the auction. Assuming the FCC held Google's upfront payment for 89 days (January 4–April 1, 2008)<sup>36</sup>, and taking Google's 2007 return on equity of 18.5% as the relevant interest rate<sup>37</sup>, one can

<sup>34</sup> Our model allows for the possibility of resale. Even if Google's private value for the licenses was low, it might have had positive surplus associated with purchasing the nationwide package at a price of \$4,713,823,000 (its final bid) if it expected to be able to resell the licenses for more than this amount.

<sup>35</sup> Mainly, we assume here that the bidders' values are common knowledge. This assumption is relaxed in Brusco et al. (2008).

<sup>36</sup> Upfront payments were due on January 4, 2008, and bidders can request the return of their upfront payment after the auction, which ended on March 18, 2008. The processing generally takes up to two weeks to complete (see the Procedures PN, p. 85).

<sup>37</sup> See Value Line's report on Google Inc. Note also that Google has no debt.

estimate the final cost to Google as approximately \$13 million.

Interestingly, Verizon was able to win 7 of the 8 licenses included in the nationwide package even though it did not have enough eligibility to do so when it started bidding on those licenses in round 27 of the auction. Verizon was able to do this by essentially reusing its eligibility. It entered bids for two of the licenses in round 27, but these bids were not sufficient for the individual licenses to beat the package. Thus, those bids were not provisionally winning and so did not tie up any of Verizon's eligibility. Verizon used an eligibility rule waiver in round 28 and entered bids for two more licenses in round 29. Again these bids were not sufficient for the individual licenses to beat the package, so Verizon was able to reuse its eligibility once again to submit bids for the remaining licenses in round 30.

If Google had chosen to bid on the individual licenses rather than on the nationwide package, Verizon would not have been able to bid as it did because then each time Verizon bid on one of the individual licenses, its bid would be provisionally winning and tie up eligibility. This might have been a worse outcome from Google's perspective if it had resulted in Google's winning some of the licenses. In the end, Verizon won 7 of the C-block licenses as well as 25 A-block licenses and 77 B-block licenses for total bids of over \$9 billion.

An alternative mechanism that would prevent bidders such as Google from being able to influence whether licenses are restricted, without actually buying the licenses, is the 'exclusive buyer mechanism' described in Brusco et al. (2008). In that mechanism, bidders would submit bids for the unrestricted licenses and then the winner for each license would decide whether it wanted the unrestricted license for a price equal to its winning bid, or the restricted license at a discounted price. In that mechanism bidders cannot determine whether a license is issued in restricted or unrestricted form without actually purchasing the license.

## Acknowledgements

The authors would like to thank Martha Stancill and Walt Strack for many helpful discussions. They are also grateful to Shane Greenstein, Bob McFarland, and an anonymous editor and referee for helpful comments.

## Appendix

Table A.1 shows the names of the C-block bidders and the abbreviations we use in the body of the paper.

Table A.2 shows the prices of the licenses in the A, B, and C block that cover the geographic areas covered by the nationwide C-block license. The total population covered by the licenses is 281,421,906. The prices are calculated using the high bids for each round or, if there is no current high bid, then using the minimum opening bid for the license.

**Table A.1**

C-block bidder names and abbreviations.

Bidder name	Abbreviated bidder name
Alltel Corporation	Alltel
AT&T Mobility Spectrum, LLC	AT&T
Bluewater Wireless, L.P.	Bluewater
Celco Partnership d/b/a Verizon Wireless	Verizon
Cellular South Licenses, Inc.	Cell South
Copper Valley Wireless, Inc.	Copper
Cox Wireless, Inc.	Cox
Cricket Licensee 2007, LLC	Cricket
Google Airwaves Inc.	Google
King Street Wireless, L.P.	King St
MetroPCS 700 MHz, LLC	MetroPCS
QUALCOMM Incorporated	Qualcomm
SAL Spectrum, LLC	SAL
Triad 700, LLC	Triad 700
Vulcan Spectrum LLC	Vulcan

**Table A.2**

High bid (or minimum opening bid) by round in dollars per MHz-Pop for US licenses covering the 50 US states (excluding the Gulf of Mexico, Puerto Rico, Guam, American Samoa, the US Virgin Islands, and the Northern Mariana Islands).

Round	Price/MHz Pop		
	A	B	C
1	\$0.12	\$0.10	\$0.17
2	\$0.13	\$0.12	\$0.20
3	\$0.14	\$0.15	\$0.24
4	\$0.16	\$0.17	\$0.29
5	\$0.18	\$0.21	\$0.35
6	\$0.21	\$0.24	\$0.36
7	\$0.23	\$0.29	\$0.41
8	\$0.26	\$0.34	\$0.48
9	\$0.30	\$0.40	\$0.48
10	\$0.36	\$0.48	\$0.55
11	\$0.40	\$0.58	\$0.55
12	\$0.45	\$0.65	\$0.61
13	\$0.50	\$0.74	\$0.69
14	\$0.55	\$0.83	\$0.69
15	\$0.63	\$0.95	\$0.69
16	\$0.71	\$1.09	\$0.69
17	\$0.79	\$1.25	\$0.76
18	\$0.87	\$1.43	\$0.76
19	\$0.92	\$1.56	\$0.76
20	\$0.98	\$1.70	\$0.76
21	\$1.01	\$1.86	\$0.76
22	\$1.03	\$2.03	\$0.76
23	\$1.04	\$2.21	\$0.76
24	\$1.06	\$2.35	\$0.76
25	\$1.08	\$2.48	\$0.76
26	\$1.10	\$2.62	\$0.76
27	\$1.11	\$2.66	\$0.76
28	\$1.11	\$2.66	\$0.76
29	\$1.12	\$2.66	\$0.76
30	\$1.12	\$2.66	\$0.77
...	...	...	...
261	\$1.17	\$2.70	\$0.77

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