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WILL BIDDER EXCLUSION RULES LEAD TO HIGHER AUCTION REVENUE? A REVIEW OF THE EVIDENCE

Abstract: As the Federal Communications Commission begins to formalize rules for the upcoming voluntary incentive auctions for broadcast spectrum, questions regarding participation limits on the largest domestic wireless carriers remain open. Proponents of bidder restrictions on AT&T and Verizon appeal to a "revenueenhancement hypothesis," under which the participation by the more successful carriers will allegedly discourage bidding by smaller firms and thus reduce total auction revenues. In this BULLETIN, we analyze data from a recent large-scale spectrum auction to shed light on the validity of the revenue-enhancement hypothesis, and our findings are significant. Among other things, we find no evidence that AT&T and Verizon reduced the number of bidders for licenses. Moreover, we find no evidence to support the claim that lower auction revenues resulted from large firm participation. As participants, the two increased overall auction revenues, both by winning licenses and by helping to reveal the valuations of other bidders. AT&T's efforts (win or not) added a 21% premium to final auction prices above and beyond the revenue effects of the typical bidder. AT&T alone accounted for nearly half of all auction proceeds, even though its winning bids were only about 10% of the total. Verizon's impact was consistent with that of the average bidder. Accordingly, our findings contradict almost every key aspect of the revenueenhancement hypothesis-not only did AT&T's and Verizon's participation not deter smaller firms from entering the auction, but their participation substantially raised total auction proceeds. Empirical evidence supporting bidder exclusions or restrictions in the forthcoming voluntary incentive spectrum auctions therefore remains weak.



I. Introduction

Pursuant to the Middle Class Tax Relief and Job Creation Act of 2012 (hereinafter the "Spectrum Act"),¹ the Federal Communications Commission ("FCC") is charged with developing and implementing a voluntary incentive auction that will (if successful) shift spectrum from television broadcasters to commercial wireless carriers who desperately need additional spectrum to release the pent-up demand for mobile data.² Given the complexity of the task, FCC Chairman Tom Wheeler announced last December that he plans to push back the auction until 2015 so that the agency can "get the incentive auction right."³ As the Commission begins to finalize its policies regarding the upcoming incentive auction, a continuing question is the degree to which the two largest mobile wireless providers (i.e., AT&T and Verizon) will be allowed to participate. While the Spectrum Act specifically prohibits the FCC from excluding otherwise eligible bidders,⁴ the Commission remains free to "adopt and enforce rules of general applicability, including rules concerning spectrum aggregation that promote competition."⁵ To this end, the agency issued a *Notice of Proposed Rulemaking* to re-evaluate, and potentially tighten, its existing "spectrum screen" – an analytical tool used by the agency to analyze spectrum holdings during its review of wireless transactions.⁶ A tightening of the screen,

³ See T. Wheeler, *The Path to a Successful Incentive Auction*, OFFICIAL FCC BLOG (December 6, 2013) (available at: http://www.fcc.gov/blog/path-successful-incentive-auction-0).

¹ Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96 (available at: <u>http://www.gpo.gov/fdsys/pkg/BILLS-112hr3630enr/pdf/BILLS-112hr3630enr.pdf</u>).

² In the Matter of Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, FCC 12-118, 27 FCC Rcd 12,357, NOTICE OF PROPOSED RULEMAKING (rel. October 2, 2012) (hereinafter "Incentive Auction NPRM").

Spectrum Act, supra n. 1, Section 6404. It should be noted that FCC Chairman Julius Genachowski was a vocal proponent of auction exclusion rules. See Remarks of FCC Chairman Julius Genachowski, 2012 Consumer Electronics Show, Las Vegas (January 11, 2012) (it would be a "mistake" to "eliminate traditional FCC tools for setting terms for participation auctions.") (available in at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-311974A1.pdf); see also B. Sasso, Former FCC Chief Rips House Spectrum Bill, THE HILL (Jan. 31, 2012) (reporting that former FCC Chairman Reed Hundt was worried that the Spectrum Act would "allow the largest wireless carriers to buy up all of the spectrum at auction, expanding their dominance of the airwaves." In addition, Hundt claimed that "the carriers might not even plan to use some of the spectrum but could buy it just to kill off competition.") (available at: http://thehill.com/blogs/hilliconvalley/technology/207655-former-fcc-chief-rips-house-spectrum-bill).

⁵ Spectrum Act, *id.* As the case law indicates, the FCC must meet a high legal burden to justify any potential bidder exclusion or restriction rule. For a full analysis, *see* L. Spiwak, *The FCC Must Satisfy a High Legal Threshold if it Wants to Impose Bidder Exclusion Rules,* @LAWANDECONOMICS (January 16, 2014) (available at: <u>http://phoenix-center.org/blog/archives/1756</u>).

⁶ In the Matter of Policies Regarding Mobile Spectrum Holdings, FCC 12-119, 27 FCC Rcd 11710, NOTICE OF PROPOSED RULEMAKING (rel. September 28, 2012) (hereinafter "Spectrum Screen NPRM") (available at: http://www.fcc.gov/document/mobile-spectrum-holdings-nprm).

especially a screen applying specifically to spectrum below 1 GHz, could serve as a de facto exclusion on the two largest mobile wireless providers for the incentive auction.⁷ Other auction rules unrelated to the spectrum screen may have a similar effect on the larger providers ability to bid.

Restricting the participation of the larger carriers appears to be an attempt to provide the two smaller nationwide mobile wireless carriers, Sprint and T-Mobile, with access to low band spectrum at prices below what they would otherwise pay if the two largest companies were allowed to bid on equal terms with them.⁸ Indeed, the Department of Justice ("DOJ") filed an ex parte in the FCC's *Spectrum Screen NPRM* in which the Obama Administration makes this goal explicit.⁹ However, because AT&T and Verizon have historically paid handsomely for spectrum, it is natural to expect that exclusions or restrictions on one or both of the carriers would, as a first-order effect, reduce auction proceeds.

Recognizing that the incentive auction must raise sufficient revenues both to incent broadcasters to relinquish spectrum as well as to fund a number of important public projects with auction proceeds, including an updated E-911 network and a nationwide public safety network (FirstNet)—not to mention satisfy Congress's intent to use auction proceeds for significant debt reduction—proponents of bidder exclusion rules have come up with an interesting hypothesis: that is, restricting the larger carriers may actually lead to *higher* auction revenues.¹⁰ At the core of this "revenue-enhancement hypothesis" is the argument that because smaller providers view it as futile to compete with the larger, "deep pocketed" carriers (since

⁷ *Id.* at ¶¶ 35-9; *see also* T. Wheeler, *Getting the Incentive Auction Right*, OFFICIAL FCC BLOG (April 18, 2014) ("A legacy of earlier spectrum assignments … is that two national carriers control the vast majority of low-band spectrum.") (available at: <u>http://www.fcc.gov/blog/getting-incentive-auction-right</u>).

⁸ The FCC reports the 2012 market shares (revenues) of the four largest mobile carriers as follows: Verizon 34.3%, AT&T 32.3%, Sprint Nextel 15.8%, and T-Mobile 9.7%. *In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services,* FCC 13-34, 28 FCC Rcd. 3700, SIXTEENTH REPORT (rel. March 21, 2013).

⁹ In the Matter of Policies Regarding Mobile Spectrum Holdings, Ex Parte Submission of the United States Department Justice, WT Docket No. 12-269 (April 22, 2013) (available of at: http://apps.fcc.gov/ecfs/document/view?id=7022269624) (hereinafter "DOJ Ex Parte"); B. Sasso, White House Backs Spectrum Caps, THE HILL (November 21, 2013) (available at: http://thehill.com/blogs/hillicon-valley/191084-whitehouse-backs-spectrum-caps); but c.f., G.S. Ford and L.J. Spiwak, Equalizing Competition Among Competitors: A Review of the DOJ's Spectrum Screen Ex Parte Filing, PHOENIX CENTER POLICY BULLETIN NO. 33 (May 2013) (available at: http://www.phoenix-center.org/PolicyBulletin/PCPB33Final.pdf).

¹⁰ See, e.g., J.B. Baker, Spectrum Auction Rules That Foster Mobile Wireless Competition (March 12, 2013) at 10-11 behalf **T-Mobile** FCC filed of in WT Docket No. 12-269 (available at: on http://apps.fcc.gov/ecfs/document/view?id=7022130299).

bidding is costly), the smaller players abandon the auction. Since, in theory, more bidders means higher auction proceeds (the "bidder effect"), the participation of the two larger firms will reduce the number of bidders, thus reducing auction proceeds by permitting the two large firms to buy spectrum cheaply. So, in turn, the argument is that by excluding or heavily restricting the participation of the largest firms in the auction, more entities will participate in the auction, thus raising overall auction revenues.¹¹ On the basis of economic theory, this revenue-enhancement hypothesis is weak; its validity is limited to some very specific and hypothetical conditions which are not supported by empirical evidence.¹²

In this BULLETIN, we evaluate the validity of the revenue-enhancement hypothesis using empirics rather than theory, analyzing the bids and bidder participation in a recent large-scale spectrum auction – the AWS-1 auction in 2006. Descriptive statistics and regression analysis of this auction cast doubt on the revenue-enhancement hypothesis. First, the auction had a very large number of bidders and winners, suggesting the fixed cost of bidding is not very large and that bidders do not view participation as fruitless. The same is true for the more recent 700 MHz auction (Auction 73), which is not the focus of our analysis. Second, large carriers won only a small share of the licenses they bid on, so there is no reason for smaller firms to view participation as an act of futility. Third, other things constant, smaller bidders were not scared off by the large firms as the revenue-enhancement hypothesis presumes. Finally, if anything, licenses for which large firms placed bids sold at higher prices. In fact, AT&T's participation added a 21% premium to auction prices above and beyond the revenue effect of the typical bidder (the "bidder effect"), though no premium is found for Verizon. AT&T is found to have a sizeable indirect effect on auction proceeds from its bidding on licenses it did not win; Verizon's indirect effect is found to be small.

II. Restricting Bidders: The Revenue-Enhancement Hypothesis

A central argument for bidder restrictions is the *revenue-enhancement hypothesis*. This hypothesis is explained by Professor Jonathan Baker, filing on behalf of T-Mobile in the *Spectrum Screen NPRM* docket:

¹¹ For details on the argument, *see, e.g.,* Baker, *id.*; G. S. Ford, *Will Bidder Exclusions Increase Auction Revenue? A Review of the Arguments,* PHOENIX CENTER POLICY PERSPECTIVE No. 13-03 (June 11, 2013) (available at: <u>http://phoenix-center.org/perspectives/Perspective13-03Final.pdf</u>); I. Ayres and P. Cramton, *Deficit Reduction Through Diversity: How Affirmative Action at the FCC Increased Auction Competition,* 48 STANFORD LAW REVIEW 761-814 (1995-6) (available at: <u>http://digitalcommons.law.yale.edu/cgi/viewcontent.cgi?article=2520&context=fss_papers</u>); P. Cramton, E. Kwerel, G. Rosston, A. Skrzypacz, *Using Spectrum Auctions to Enhance Competition in Wireless Services,* 54 JOURNAL OF LAW AND ECONOMICS S167-S188 (2011) at p. S169.

¹² See Ford, id.

Given the non-trivial fixed costs of auction participation, a firm expecting to be outbid could readily be deterred from participating in the auction in the first place. If auction participation is thin as a result of this dynamic, the large incumbent firms that are in principle willing to pay to obtain foreclosure benefits may enjoy these benefits without bidding up the auction price to a level that pays for those benefits fully, leaving the [] government with lower revenues than could be obtained.¹³

In support of the claim, Professor Baker points to a few academic articles on spectrum auctions.¹⁴ Ford (2013) reviewed those academic works and concluded that the Professor Baker was "playing fast-and-loose" with the economic theory to support the "revenue enhancement hypothesis."¹⁵ For the revenue enhancement hypothesis to work, there needs to be a monopoly incumbent mobile wireless carrier whose mere presence scares off all other potential bidders. Yet, there are many incumbents in the U.S. mobile wireless sector (including, by definition, Sprint and T-Mobile), and history has shown that many non-incumbent bidders show up even when incumbents do participate in spectrum auctions. Moreover, it is unlikely that high-value bidders will be intimidated by AT&T and Verizon, implying that even if some firms are scared off they are of the type that do not contribute much to final auction prices.

Notwithstanding this dispute, in this BULLETIN we empirically test the four key elements of the revenue-enhancement hypothesis as outlined by Dr. Baker. First, the hypothesis requires that auction participation has a "non-trivial fixed cost." If participation is not too costly, then a low probability of winning would not be sufficient to deter participation since the net gain remains positive. Second, we test whether the participation of AT&T and Verizon in an auction affects the number of bidders, causing auction participation to be "thin." Third, for "thin" participation to matter, auction prices must be affected by the number of bidders. So, we quantify the "bidder effect," testing whether spectrum auction prices rise as the number of bidders increases. Finally, we test whether AT&T and Verizon are able to buy spectrum cheaply due to lack of competitive bidding.

¹⁵ See Ford, supra n. 11; see also G.S. Ford, *The Economics of Bidder Exclusion Rules: A Response to Dr. Baker*, PHOENIX CENTER POLICY PERSPECTIVE NO. 13-04 (July 18, 2013) (available at: <u>http://www.phoenix-center.org/perspectives/Perspective13-04Final.pdf</u>); G.S. Ford, *Arguments for Bidder Exclusion Rules Remain Weak and Inconsistent*, @LAWANDECONOMICS (June 20, 2014) (available at: <u>http://phoenix-center.org/blog/archives/1408</u>).

¹³ Baker *supra* n. 10 at p. 10

¹⁴ I. Ayres and P. Cramton, Deficit Reduction Through Diversity: How Affirmative Action at the FCC Increased Auction Competition, 48 STANFORD LAW REVIEW 761-814 (1995-6) (available at: http://digitalcommons.law.yale.edu/cgi/viewcontent.cgi?article=2520&context=fss_papers); P. Cramton, E. Kwerel, G. Rosston, A. Skrzypacz, Using Spectrum Auctions to Enhance Competition in Wireless Services, 54 JOURNAL OF LAW AND ECONOMICS S167-S188 (2011) at p. S169.

III. Analysis of Auction Data

Our analysis is based primarily on the bidding activity from a large and relatively recent auction in the United States: the AWS-1 auction in 2006 (Auction 66). Proceeds from Auction 66 (AWS-1) were \$13.7 billion for 90 MHz of spectrum in the AWS Band (around 1,700 - 2,200 MHz). For this auction, bidder interests and identities were public information before the auction and after each round, so the bidding activities of AT&T and Verizon were known by all participants.¹⁶ At the time of the auction, AT&T and Verizon were two of the three largest providers of mobile wireless services, with Sprint being the third and of nearly equal size to the AT&T and Verizon.¹⁷ Sprint did not participate in the auction. Some details from the auctions are summarized in Table 1. We do not focus on the more recent 700 MHz auction held in 2008 (Auction 73). Auction 73 offered 60 MHz of spectrum in the 700 MHz band; proceeds were \$19.1 billion, the largest auction take in U.S. history.¹⁸ However, bidding activity in Auction 73 was anonymous, so the response of smaller firms to AT&T's and Verizon's participation is more difficult to directly quantify. Also, Auction 73 included a number of policies (i.e., encumbrances on the upper C Block and D Block) and interference concerns (lower A block and the E block) that limited the amount of "clean" spectrum auctioned. Indeed, we have shown how the rules greatly impacted the auction prices for the upper C Block, and other research has indicated the bidding activity in that auction did not comport well with economic theory.¹⁹ Also, the encumbrances may have tainted the bidding activity in other blocks. As such, we provide only a few descriptive statistics from that more recent auction.

¹⁶ Auction of Advanced Wireless Services Licenses; 168 Bidders Qualified to Participate in Auction No. 66; Information Disclosure Procedures Announced, Public Notice DA 06-1525 (July 28, 2006) (available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-06-1525A1.pdf).

¹⁷ In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services, FCC 08-28, 23 FCC Rcd. 2241, TWELFTH REPORT (rel. February 4, 2008) (available at: <u>http://www.fcc.gov/reports/commercial-mobile-radio-</u> <u>services-cmrs-competition-report-12th-annual</u>).

¹⁸ <u>http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=73.</u>

¹⁹ G.S. Ford, T. M. Koutsky and L.J. Spiwak, *Using Auction Results to Forecast the Impact of Wireless Carterfone Regulation on Wireless Networks*, PHOENIX CENTER POLICY BULLETIN No. 20 (Second Edition) (May 2008) (available at: <u>http://phoenix-center.org/PolicyBulletin/PCPB20Final2ndEdition.pdf</u>); J. Bulow, J. Levin, and P. Milgrom, *Winning Play in Spectrum Auctions*, National Bureau of Economic Research Working Paper No. 14765 (March 2009) (available at: <u>http://www.nber.org/papers/w14765.pdf</u>).

Table 1. Summary of Auction 66						
Auction	Band (Mhz)	Blocks	Licenses [Available] (Sold)	Qualified Bidders	Winners	Proceeds
Auction 66	1,710 - 1755	A: 20 MHz	[1,122]	168	104	\$13.7 billion
"AWS-1"	2,110-2,155	B: 20 MHz	(1,087)			
2006		C: 10 MHz				
		D: 10 MHz				
		E: 10 MHz				
		F: 20 MHz				
Top 10 Bidders		Population*	Winning Bids (Net)		Licenses	
T-Mobile		474,718,308	\$4,182,312,000		120	
Cellco Partnership (Verizon)		192,047,611	\$2,808,599,000		13	
SpectrumCo		267,387,437	\$	\$2,377,609,000		137
MetroPCS		144,544,402	\$1,391,410,000		8	
Cingular (AT&T)		198,768,198	\$	\$1,334,610,000		48
Cricket		117,802,839	\$710,214,000		99	
Denali		58,178,304	\$274,083,750		1	
Barat		41,601,174	\$127,140,000		17	
AWS Wireless		60,498,394	\$115,503,000		154	
Atlantic Wireless		35,803,110	\$75,294,000		15	
Source: <u>http://wireless.fcc.gov/auctions/default.htm?job=auctions_home</u> .						
* Population can be double counted in cases of overlapping licenses.						

The FCC provides highly detailed information on bidding activity across all the rounds of its spectrum auctions. In addition to the bidding information provided by the FCC, we have constructed variables using Census data (at the county level) to capture the economic characteristics of the license area. For each license, these variables include population (*POP*), per-capita income (*INCOME*), population density (*DENSITY*), and the Department of Agriculture's urban/rural continuum codes (nine *MET* variables).²⁰ We aggregate county-level data up to the applicable license area.²¹ Licenses in U.S. territories are excluded from the analysis, as are licenses for which population data are not available (e.g., the Gulf of Mexico, and so forth).²² The final sample size is 1,067 licenses.

²⁰ <u>http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx#.Uzrf51e9Yz0</u>. County data is assigned to each license area. Since the data is ordinal, we first compute a weighted average of the code and then round to the nearest integer. There are nine categories with lower numbers indicating more urban areas. The first category is set as the base.

²¹ For population, income and square miles, the data are summed to the license area. For the urban/rural indicator, a population-weighted average is computed for each license area and then rounded to the nearest integer.

²² FCC data is used to link the counties to the license areas (<u>http://transition.fcc.gov/oet/info/maps/areas/xref/xrefcnty1999.txt</u>).

License areas, from smallest to largest geographically, include Cellular Market Areas ("CMAs"), Economic Areas ("BEAs"), and Regional Economic Areas ("REAs"). There are 734 CMAs with an average population of about 400,000 persons; 176 BEAs with an average population of about 1,600,000 persons; and 12 REAs with an average population (of those that are populated and in the sample) of about 40,000,000 persons. Dummy variables are created to indicate each license type (*DCMA*, *DBEA*, *DREA*). A dummy variable for block size is also created (*DMHZ* = 1 for a 20 Mhz block, 0 otherwise). Using the auction history, we construct variables indicating whether or not AT&T or Verizon bid on a license (*ATTBID*, *VZBID*). Also computed using the data is the number of bidders for each license (*BIDDERS*), and the number of bidders net of AT&T and Verizon (*NETBIDDERS*).

A. The Fixed-Cost of Participation

If auction participation is costly, then some potential bidders may be excluded from the auction if the expected benefits from participation are not sufficient to offset the costs. High participation costs are an explicit component of the revenue-enhancement hypothesis. From Table 1 we see that despite the participation of AT&T and Verizon, there were 168 bidders in Auction 66. Note also that there were 214 bidders in Auction 73. Thus, there were a very large number of bidders in both auctions. With regard to Auction 66, the Commission explicitly concluded that the level of competition in the auction was sufficient to make anti-competitive outcomes difficult to sustain.²³ The large number of bidders belies the conjecture that the "fixed cost of auction participation" is high, thereby rejecting a key assumption of the revenue-enhancement hypothesis.

B. Bidder Participation

The revenue-enhancement hypothesis implies that smaller firms view participation as futile, since smaller firms assume the larger carriers will offer higher bids for spectrum licenses. Again, the evidence does not support that logic. There were 104 unique bidders winning licenses in Auction 66, and 101 unique winning bidders in Auction 73. Additionally, in Auction 66, AT&T bid on only 19.3% of the licenses available, where Verizon bid on only 2% of the licenses (but focused on the larger REA licenses). Success rates of the two large firms were actually quite small.²⁴ AT&T won only 23% of the licenses upon which it bid (spending \$1.3 billion, the fifth larger spender). For Verizon, only 62% of its bids were successful (winning

²³ *Public Notice DA 06-1525, supra* n. 16.

²⁴ Success rates are affected by both being outbid by another bidder and the inherent strategic bidding that occurs across licenses and bands.

only 1.3% of all licenses, but spending \$2.8 billion, the second largest spender).²⁵ Plainly, participation by smaller firms is not futile.

Another way to test this conjecture is to look for differences in small firm participation between licenses for which AT&T and Verizon did and did not bid. To do so, we consider the impact of the larger firm participation on the variable *NETBIDDERS*, which is defined as total bidders for each license net of AT&T and Verizon. In Auction 66, there were an average of 2.7 smaller entities bidding on licenses that AT&T or Verizon did not bid on, and 4.3 such bidders for licenses the two larger providers did bid on. This difference (1.6 bidders) is sizeable and statistically different from zero.²⁶

Not all licenses are equal, however, as this simple test presumes. Regression analysis can be employed to evaluate differences holding other factors constant. In addition to AT&T's and Verizon's participation, we view bidding interest to be motivated by the (natural log of the) population of the license market and its per-capita income, its density, the block size, and the geographic license type. The general form of the regression models *NETBIDDERS* for license *i* as

$$NETBIDDERS_{i} = \beta_{0} + \beta_{1} \ln POP_{i} + \beta_{2} \ln INCOME_{i} + \beta_{2}DENSITY_{i} + \beta_{3}ATTBID_{i} + \beta_{4}VZBID_{i} + \beta_{5}DMHZ_{i} + \beta_{6}DBEA_{i} + \beta_{7}DREA_{i} + \sum_{i=2}^{9} \theta_{m}MET_{m,i} + \varepsilon_{i}$$
(1)

where ε_i is the econometric disturbance term. If AT&T and Verizon scare off smaller bidders, then the coefficients β_3 and β_4 will be negative. If the influence of the two larger carriers is neutral, then the coefficients will be zero (or small and statistically indistinguishable from zero). The variable *NETBIDDERS* is a count (with range 0 to 10, and mean 3, variance 2.3), so we estimate the model using Poisson regression.²⁷ Detailed estimates are provided in the Appendix; tests are based on robust standard errors. The results are sensible. Bidders are more attracted to licenses in large, more densely populated markets. Bidders prefer BEAs to CMAs,

²⁵ In Auction 73 (excluding the lower C and lower D Block), AT&T bid on nearly 50% of licenses, but won only 20.3% of them for a success rate of 41%. Similarly, Verizon bid on 57% of the licenses and won only 9.6% of those, for a success rate of 17%. (Note we have excluded the lower C block from these computations.)

The t-statistic is -15.3 (Prob < 0.01).

²⁷ Given the mean and variance of of *NETBIDDERS*, over-dispersion does not appear to be a problem. Also, a goodness-of-fit test suggests the Poisson model is appropriate.

but do not prefer REAs to CMAs.²⁸ Thus, bidders prefer a larger, but not too large, geographic scope for licenses.

Turning to the larger carrier bids, the coefficient on *ATTBID* is estimated to be 0.006, which is positive but a very small coefficient (a difference in 0.02 bidders). We cannot reject the null hypothesis that the effect is zero (the robust t-statistic is 0.18). Thus, there is no support that AT&T's bidding on a license scared off other bidders. The coefficient on *VZBID* is negative (-0.089), implying its bidding reduced bidding activity by 0.25 bidders. But again, the effect is not statistically discernible from zero (the robust t-statistic is -0.87). These results suggest that the participation of AT&T and Verizon in Auction 66 had no discernible effect on the participation of small firms for licenses in which the two larger carriers expressed an interest. These results are inconsistent with a key conjecture of the revenue-enhancement hypothesis.

C. Auction Proceeds, the Bidder Effect, and a Bidder Premium

We turn now to the question of auction revenues, which permits us to quantify the bidder effect and test for differences in auction proceeds resulting from AT&T's and Verizon's participation. Auction revenues are predicted using the linear regression of the form:

$$\ln R_{i} = \alpha_{0} + \alpha_{1} \ln POP_{i} + \alpha_{2} \ln POP_{i}^{2} + \alpha_{3} \ln INCOME_{i} + \alpha_{4}DENSITY_{i} + \alpha_{5}DENSITY_{i}^{2} + \alpha_{6}DMHZ_{i} + \alpha_{7}ATTBID_{i} + \alpha_{8}VZBID_{i} + \alpha_{9} \ln BIDDERS_{i} + \alpha_{10} \ln BIDDERS_{i}^{2}$$
(2)
+ $\alpha_{11}DBEA_{i} + \alpha_{12}DREA_{i} + \sum_{m=2}^{9} \phi_{m}MET_{m,i} + v_{i}$

where $\ln R$ is the natural log of (gross) final auction proceeds for the license *i* and *v_i* is the econometric disturbance term. By using squared terms, we permit non-linear responses in population, density, and the number of bidders. Equation (2) is estimated by Ordinary Least Squares ("OLS") and tests are based on robust standard errors. Detailed estimates are provided in the Appendix. The model explains 92% of the variability in winning bids and easily passes the RESET test for specification error.²⁹ The results are sensible. Licenses sell for higher prices in larger, more densely-populated markets. Larger blocks sell for more, with about twice the revenue (plus 90%) for twice the megahertz of spectrum. Other things constant, more aggregated license areas bring lower prices.

²⁸ Since *DCMA* is excluded, CMA is the base case in the regression.

²⁹ J.B. Ramsey, Tests for Specification Errors in Classical Linear Least Squares Regression Analysis, 31 JOURNAL OF THE ROYAL STATISTICAL SOCIETY 350–371 (1969).

1. The Bidder Effect

Auction theory suggests that the more bidders there are the higher auction prices are likely to be. This bidder effect can be measured using the coefficients on the *BIDDERS* variables, and the estimates indicate that an increase in the number of bidders increases auction prices. This result is consistent with one core assumption of the revenue-enhancement hypothesis and auction theory more generally. Practically, the effects are large. The average bidder count is 3, so the average bidder increases the final price by 53%.

Table 2. The Bidder Effect				
Bidder Count	Bidder Count Increase in Price from Additional Bidder			
1		13.4%		
2	140.1%	26.1%		
3	52.8%	23.3%		
4	29.8%	16.4%		
5	19.7%	9.2%		
6	14.1%	5.4%		
7	10.7%	2.9%		
8	8.4%	1.8%		
9	6.7%	0.8%		
10	5.5%	0.2%		

As shown in Table 2, the bidder effect is subject to diminishing marginal returns. Adding a fourth bidder raises revenues by about 30%, a fifth bidder by about 20%, and the tenth bidder only by about 5.5%. From the final column of Table 2, we see that about 90% of licenses had five or fewer bidders, and two-thirds of licenses had three or fewer bidders.³⁰ So, the bidder effect is quite large, on average. For the upcoming incentive auction, the Commission has indicated a preference for BEA licenses.³¹ In Auction 66, the average number of bidders was 4.08 for the BEA licenses. Based on the figures in Table 2, removing two bidders from the incentive auction would be expected to have an enormous effect on revenues (reducing auction proceeds by about 50%), other things constant.

³⁰ A very good approximately of the effect of a marginal bidder on prices can be approximately by taking the exponential of the calculation: exp[1.59 – 1.97ln(Bidders)].

³¹ Incentive Auction NPRM, supra n. 2 at ¶ 149 ("We believe that for this spectrum, EA licensing strikes an appropriate balance between geographic granularity from a spectrum reclamation standpoint and having a manageable number of licenses from an auction design standpoint. We propose to license the 600 MHz band on an EA basis and seek comment on this approach.").

2. Proceeds and AT&T's and Verizon's Participation

AT&T and Verizon's influence on auction prices produce (at least) two effects. First, they are both bidders and thus influence prices through the bidder effect, which we quantified above. Second, given their need for spectrum to maintain service quality for their large customer bases, the two could be more aggressive bidders, thus having an effect above and beyond the bidder effect. Since the number of bidders is included as a regressor (*BIDDERS*), the coefficients on *ATTBID* and *VZBID* measure the unique effect (or premium) of AT&T's and Verizon's participation in the auction for the license *above and beyond their normal effect as a bidder*. Positive coefficients are estimated on both *ATTBID* (0.187) and *VZBID* (0.084), but only the AT&T effect is statistically different from zero (robust t-statistic is 3.26). Other things constant, *when AT&T bids (win or not), the license sells for about a 21% premium above and beyond the revenue effects of the typical bidder*.³² This increase is sizeable. While Verizon's bidding results in a point-estimate of an 8.8% premium, we cannot conclude that the premium is statistically different from zero, suggesting (statistically) that the company can be viewed as "just another bidder," its influence on prices being limited to the bidder effect (which is large).³³

We can provide a rough simulation of AT&T's and Verizon's influence on the auction by using the bidder effect and estimated premiums. For licenses bid on by AT&T, the average number of bidders is about 5.5 bidders. Adding AT&T as a bidder on a license with 4.5 bidders increases the auction price by 41% (F = 39.7, Prob < 0.001). Decomposing the individual effects we have a bidder effect of about 17% and the AT&T premium of 21%. Verizon's bids occurred for licenses with an average of 4.8 bidders. Adding the company as a bidder on a license with 3.8 bidders increases the auction price by 32% (F = 5.94, Prob < 0.05). Decomposing the individual effects we have a bidder effect of about 21% (F = 99.9, Prob < 0.001) and the Verizon premium of 8.8% (F = 0.55, Prob = 0.45), the latter of which is not statistically significant.

³² AT&T's enhanced interest in the AWS-1 band was perhaps motivated by the fact the band was internationally harmonized, and foreign carriers typically deployed the GSM-HSPA technologies also used by AT&T (and T-Mobile).

³³ Verizon's bidding was limited to only 21 licenses (mostly for the larger REA licenses), and this fact probably contributes to the larger standard error and low statistical significance.

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Table 3. Direct and Indirect Effects on Auction Proceeds					
Bidder	Direct Effect on Auction Proceeds	Indirect Effect on Auction Proceeds	Total Effect on Auction Proceeds		
AT&T	\$1.33 Billion	\$4.67 Billion	\$6 Billion		
Verizon	\$2.81 Billion	\$0.44 Billion	\$3.25 Billion		
AT&T and Verizon	4.41 Billion	\$5.1 Billion	\$9.25 Billion		

The contribution of the two firms to Auction 66's gross proceeds of \$13.7 billion is sizeable. AT&T paid \$1.33 billion and Verizon paid \$2.81 billion for licenses won at auction, for a total *direct* contribution to total auction revenue of \$4.14 billion. Together, the direct effect from winning bids of the two accounted for about 30% of total auction proceeds. The two firms did not win all the licenses they bid on, but their bidding activity contributed favorably to the final prices for those licenses through (at least) the bidder effect. For those licenses the two larger carriers bid on but did not win, the winning bidder clearly placed a higher value on the license than did either AT&T or Verizon. Since the purpose of an auction to reveal valuations that are otherwise unknown, the larger carriers played an important role in the auction even in cases where neither won the license by encouraging others to reveal their true valuation for the spectrum licenses.

By revealing valuations, AT&T's and Verizon's participation had an indirect effect on auction proceeds, which we can quantify by assuming AT&T and Verizon are average bidders and hypothetically removing a bidder from each license either of the two bid on.³⁴ As shown in Table 2, the removal of a bidder has a very large effect, on average. AT&T bid on the 206 licenses that accounted for 93% of total auction proceeds, and Verizon bid for 21 licenses (mostly at the large REA-sized licenses) accounting for 31% of total proceeds. As summarized in Table 3, our estimates indicate that the *indirect* revenue impact of AT&T was \$4.67 billion and of Verizon was \$0.44 billion, for a total of \$5.1 billion from licenses they bid on but lost. The direct and indirect effects sum to \$9.25 billion, or 67% of total auction proceeds. So while Verizon paid more for licenses in the auction, AT&T had a larger impact on auction proceeds through its indirect effect. AT&T's total effect was \$6 billion (44% of total proceeds) and Verizon's total effect was \$3.25 billion (24% of total proceeds).

D. Specification Issues

It may be sensibly argued that AT&T's and Verizon's bidding activity is non-randomly assigned across licenses. Indeed, both appear more interested in more populated markets, and

³⁴ The same analysis could be done for any bidder, though the size of the effect would be based on that specific participant's bidding activity.

Verizon focused on larger geographic licenses. One approach to addressing this concern is to use regression analysis that includes variables measuring those factors that influence participation. We did so. This approach is not effective in all cases, however. Another strategy is to estimate a selection equation and include an Inverse Mills Ratio from that equation as an additional regressor for Equations (1) and (2).³⁵ We also did so and there were no material changes to report.³⁶ As a third approach, we applied a Coarsened Exact Matching algorithm to the data, treating a bid by either AT&T or Verizon as the treatment.³⁷ Again, there were really no material changes to the results. Also, auction prices are often analyzed on a price-permegahertz-per-pop basis. Given our specification, switching to this dependent variable in Equation (2) has no sizeable impact on the results, since the regression accounts for population and block size.

Finally, our regression analysis considers only the unique contribution of AT&T and Verizon. T-Mobile was also a significant player in Auction 66. We can test for a T-Mobile effect by including a dummy variable for the firm in Equation (2). The coefficient on the variable is statistically insignificant, suggesting that T-Mobile is, like Verizon, "just another bidder," which is no small thing (see Table 2). We are unable to reject the hypothesis that the unique effect of Verizon is the same as T-Mobile (F = 0.99, Prob = 0.32), but we easily reject the hypothesis that AT&T has the same effect as T-Mobile (F = 8.62, Prob < 0.01).³⁸

E. *Caveats*

While we believe an empirical study of the revenue-enhancement hypothesis is important, there are some limitations in such an analysis. First, the revenue effects of a bidder restriction will depend on the exact form of such exclusions and restrictions, and we do not know what that form is yet. Second, we cannot evaluate the effect of outright bidder exclusions, since Auction 66 (or Auction 73) imposed no such limits. Nevertheless, we believe some information can be gleaned from analyzing actual auction data. Our "experiment" is made possible by the fact that AT&T and Verizon did not bid on all licenses. Thus, we evaluated whether or not the two large firms' bidding activity led to material differences in prices and bidder participation by comparing outcomes between licenses the two firms did and did not bid on. In doing so, we are able to provide some evidence on the potency of this revenue-enhancement argument. Nevertheless, our findings are in no sense definitive; they are only part of a broader portfolio of

³⁸ Both the *TMOBID* and *VZBID* coefficients have large standard errors that contribute to the test results.

³⁵ J. Heckman, *Sample Selection Bias as a Specification Error*, 47 ECONOMETRICA 153–61 (1979).

³⁶ The dependent variable of the selection equation indicated whether either of the two large firms bid.

³⁷ S.M. Iacus, G. King & G. Porro, *Causal Inference without Balance Checking: Coarsened Exact Matching*, 20 POLITICAL ANALYSIS 1–24 (2012).

evidence. Alternate analysis of the recent auction data is provided by Kovacs (2012) and Ford et al. (2008), just to name just a few.³⁹ An interesting theoretical analysis of bidder exclusions is provided by Mayo and Sappington (2013), a study which reaches similar conclusions to Ford and Spiwak (2013) but provides important new insights.⁴⁰

IV. Conclusion

In this BULLETIN, we shed some light on the revenue-enhancement hypothesis which claims that the participation of AT&T and Verizon in the upcoming voluntary incentive auction will reduce auction revenues by scaring off potential bidders. While it is not possible to directly assess the hypothesis, since the larger carriers have been active participants in all recent and large scale auctions held in the U.S., the evidence is suggestive. We evaluated four key elements to the revenue-enhancement hypothesis. First, given the large number of bidders in spectrum auctions, the claim that the fixed-cost of participation are high is dubious. Second, based on a regression analysis of the AWS-1 auction (Auction 66), we find that auction proceeds rise as the number of bidders for a given license increases, though this bidder effect is subject to diminishing marginal returns. That is, adding the third bidder has a larger effect than adding the fifth, and the fifth has a larger effect than the tenth (see Table 2). Third, while the bidder effect is an essential component of the revenue-enhancement hypothesis (more bidders, more revenue), we find no evidence that AT&T's or Verizon's participation reduces the number of bidders. Finally, as for auction proceeds, the participation of AT&T and Verizon can influence revenues through two effects: (a) the bidder effect, which is positive and large on average; and (b) a firm-specific premium. We find that AT&T's participation has a premium of about 21% on final auction prices. In contrast, we could not reject the hypothesis that Verizon's effect on prices was limited to the bidder effect.

Ford, Koutsky and Spiwak, supra n. 19; A. Kovacs, Neutral Spectrum Auctions: Maximizing Proceeds and Consumer Benefit, Georgetown University Center for Business & Public Policy, POLICY VIGNETTE 2012-2-13 (February 2012) (available at: www.gcbpp.org/files/EPV/EPV_Kovacs_SpectrumAuctions_21312.pdf); R.J. Shapiro, D. Holtz-Eakin & C. Bazelon, The Economic Implications of Restricting Spectrum Purchases in the Incentive Auctions, Georgetown University Center for Business & Public Policy, POLICY PAPER (April 2013) (available at: http://cbpp.georgetown.edu/2013/04/30/shapiro-spectrum-auction-design); F. Campbell, Maximizing the Success of the Incentive Auction, Working Paper (November 2012)(available at: http://cbit.org/wpcontent/uploads/2014/01/auction-whitepaper-10-31-2013-FINAL.pdf); G. Madden, E. Bohlin, P. Kraipornsak, & T. Tran, The Determinants of Prices in the FCC's 700 MHz Spectrum Auction, 46 APPLIED ECONOMICS 1953-1960 (2013) (available at: http://www.tandfonline.com/doi/abs/10.1080/00036846.2014.889807?journalCode=raec20#preview).

⁴⁰ J.W. Mayo & D.E.M. Sappington, *Employing Spectrum Auctions to Allocate Scarce Resources*, Working Paper, Georgetown Center for Business and Public Policy, (January 2014) (available a <u>http://www.gcbpp.org/files/Academic_Papers/Input_Auctions_2-17-14.pdf</u>); G.S. Ford and L.J. Spiwak, *Equalizing Competition Among Competitors: A Review of the DOJ's Spectrum Screen Ex Parte Filing*, PHOENIX CENTER POLICY BULLETIN NO. 33 (May 2013) (available at: <u>http://phoenix-center.org/PolicyBulletin/PCPB33Final.pdf</u>).

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Using the statistical model, we simulated the revenue effects of excluding either AT&T or Verizon from the auction. The reduction in revenues was substantial. In Auction 66, AT&T paid \$1.33 billion and Verizon paid \$2.81 billion for licenses, for a total *direct* contribution of \$4.14 billion, amounting to about 30% of total auction proceeds. Moreover, the two firms drove up prices for licenses they bid on but did not win. Our estimates indicate that the *indirect* revenue impact of AT&T was \$4.67 billion and of Verizon was \$0.44 billion, for a total of \$5.1 billion. The direct and indirect effects sum to \$9.25 billion, or 67% of total auction proceeds. Overall, AT&T had a larger impact on auction proceeds with a total effect of \$6 billion (44% of total proceeds) compared to Verizon's total effect of \$3.25 billion (24% of total proceeds). Both are obviously significant contributors to auction revenues, though AT&T's broader activity has a larger effect on total proceeds.

In sum, our findings contradict almost every key aspect of the revenue-enhancement hypothesis—not only did AT&T's and Verizon's participation not deter smaller firms from entering the auction, but total auction proceeds rose significantly from AT&T's and Verizon's active participation both from the licenses they acquired and by helping reveal the valuations of other bidders. Empirical evidence supporting bidder exclusions or restrictions in U.S. spectrum auctions therefore remains weak.

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			Appendix				
Summary of Regression Results, Descriptive Statistics							
	NETBIDDERS		lnI	lnR		Descriptive	
	(Mean 3.01,	S.D 1.53)	(Mean 13.52	(Mean 13.52, S.D 2.02)		Statistics	
	Coef.	t stat	Coet.	t stat	Mean	S.D.	
lnPOP	0.118**	(5.21)	0.137	0.63	12.741	1.39	
lnPOP ²			0.0358**	4.52			
lnINCOME	-0.067**	(-3.26)	-0.0376	(-1.25)	1.17	1.19	
DENSITY	0.0001*	(1.81)	0.0005**	2.65	165	270	
DENSITY ²			-8.5E-08**	(-2.26)			
DMHZ	0.0542	(-1.55)	0.643**	11.83	0.826		
ATTBID	0.0067	(0.18)	0.187**	3.26	0.193		
VZBID	-0.089	(-0.87)	0.0843	0.74	0.020		
lnBIDDERS			1.401**	18.36	1.024	0.57	
lnBIDDERS ²			-0.199**	(-3.99)			
DBEA	0.213*	(1.86)	-0.218**	(-3.40)	0.322		
DREA	-0.106	(-0.71)	-0.803**	(-5.09)	0.200		
MET 2	-0.213**	(-4.88)	0.016	0.2	0.201		
MET 3	-0.286**	(-4.98)	0.047	0.47	0.238		
MET 4	-0.390**	(-6.01)	-0.245**	(-2.16)	0.141		
MET 5	-0.335**	(-4.67)	-0.138	(-1.10)	0.124		
MET 6	-0.367**	(-4.49)	-0.185	(-1.38)	0.094		
MET 7	-0.356**	(-3.91)	-0.244	(-1.63)	0.078		
MET 8	-0.107	(-0.95)	-0.224	(-1.16)	0.035		
MET 9	-0.404**	(-4.05)	-0.266	(-1.62)	0.001		
Constant	-0.079	(-0.24)	4.29**	-2.87			
(Pseudo) R ² N Model Test RESET F	0.09 1,067 $\chi^2 = 329^{**}$		0.92 1,067 F = 570** 0.55 (p = 0.65)		1,067		
* 5%, ** 10% St	atistical Signifi	cance, Robust	t-statistics				