

**REVENUES FROM A POSSIBLE SPECTRUM INCENTIVE AUCTION:
WHY THE CTIA/CEA ESTIMATE IS NOT RELIABLE**

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I. INTRODUCTION

On February 15, 2011, CTIA-The Wireless Association (CTIA) and the Consumer Electronics Association (CEA) released a “white paper” in which the two organizations estimate that an “incentive auction” of 120 MHz of broadcast spectrum would generate gross revenues of \$36 billion and net revenues of \$33-34 billion “under conservative assumptions.” In fact, the revenues that might be produced by such an auction are, at present, unknowable with any degree of precision, for two primary reasons.

First, no one has proposed a specific design for an incentive auction, nor prescribed the nature or magnitude of the “incentives” that would be offered to current spectrum licensees to cause them to “voluntarily” proffer their spectrum. Until these questions are answered, there is no meaningful way to estimate the “supply” of spectrum (that is, whether the 120 MHz of spectrum assumed by CTIA/CEA would actually be available for sale), nor to estimate the proportion (let alone the amount) of auction revenues that would be realized by the government.

Second, even if the precise design of the auction were known, and the “split” between the government and current licensees had been decided, the history of spectrum auctions teaches one primary lesson – that history is a poor guide when it comes to spectrum auctions. Thus, the hedonic price regression model employed by CTIA/CEA, which is based on data from prior auctions, is imprecise and ultimately unreliable.

Section II below discusses the many hurdles that would have to be surmounted before an incentive auction could even be contemplated, including specifically the difficulties of designing an incentive scheme that would cause current licensees to proffer the desired amount of spectrum. Section III explains the shortcomings in CTIA/CEA’s method of estimating revenues from an assumed auction of 120 MHz of broadcast spectrum. Section IV presents a brief summary, concluding that the information necessary to estimate with any reasonable level

of precision or certainty the proceeds from a prospective incentive auction is simply not available, and that the CTIA/CEA estimate, in particular, is not reliable.

II. THE CTIA/CEA ESTIMATE RELIES ON FAULTY ASSUMPTIONS ABOUT THE INCENTIVE STRUCTURE AND THE AMOUNT AND NATURE OF SPECTRUM AT AUCTION

The CTIA/CEA paper assumes that 120 MHz of spectrum will be tendered for auction, and estimates on this basis that the net proceeds of the auction (to the government) would be \$33-34 billion. This estimate depends, in turn, on the assumption that the required spectrum would be tendered by broadcasters in return for between \$1.2 and \$2.3 billion, which CTIA/CEA estimate, using two different models, to be the “enterprise value” of the broadcasters whose spectrum would be auctioned. However, the CTIA/CEA paper readily acknowledges that its models “do not attempt to estimate what additional incentives, if any, would be required to induce TV licensees to voluntarily cease operating over the air.”¹ In short, it assumes, for purposes of calculation, that broadcasters would voluntarily proffer 120 MHz of spectrum for between 3.3 percent and 6.4 percent of its market value,² while acknowledging that it has not even “attempted to estimate” the actual amount.³

¹ CTIA, CEA, *Broadcast Spectrum Incentive Auctions White Paper* (February 15, 2011) (hereafter *White Paper*) at 6. See also at 13-14 (“[B]oth of these approaches are used to derive a station’s *market value*, not a station’s *exit price* in an incentive auction. Depending upon expectations that may be created by the regulatory process or perceptions of risk, stations may not be willing to exit at their projected market value....”).

² 3.3 percent = \$1.2 billion/\$36 billion. 6.4 percent = \$2.3 billion/\$36 billion.

³ The 1996 Telecommunications Act and subsequent Federal Communications Commission regulations allow digital television broadcasters to use their licensed spectrum for “ancillary or supplementary” services (in addition to providing a required, free over-the-air video programming service). 47 U.S.C. § 336(a)(2). In part to allow broadcasters to develop additional revenue streams to help support a free programming service, and to encourage broadcasters to provide innovative new services, the Commission determined to permit broadcasters to offer these ancillary and supplementary services and to retain 95 percent of the revenues earned from any such services. Fifth Report and Order, 12 FCC Rcd 12809, ¶ 29 (1997); Report and Order, 14 FCC Rcd 3259, ¶ 20 (1998). CTIA/CEA’s assumption that significant numbers of broadcasters would or should relinquish their licenses for between 3.3-6.4 percent of their market value thus appears unrealistic. Indeed, imposing a five percent fee on broadcasters’ ancillary and supplementary services (and allowing retention of 95 percent of the gross revenues associated with such services) was designed by the Commission, as required by 47 U.S.C. § 336(e), to approximate “the revenues that would have been received had the spectrum on which these services are provided been licensed through an auction.” Report and Order, 14 FCC Rcd at 3267, ¶ 20.

In fact, the amount of spectrum that would be tendered voluntarily at auction is not known, and will depend (at a minimum) upon the nature and magnitude of the incentives offered, and on the opportunity costs broadcasters attach to the spectrum at the time the auction takes place. CTIA/CEA make no effort to estimate any of the relevant factors, relying instead on arbitrary and unrealistic assumptions. Moreover, CTIA/CEA's estimates of the value of the auctioned spectrum also depend upon decisions regarding spectrum repacking and reallocation which remain under consideration at the FCC.

A. The Amount of Spectrum Offered Depends Upon the Incentive Structure

A central theme of the CTIA/CEA paper, as well as of FCC and congressional discussions of incentive auctions, is that broadcasters and other licensees would be incentivized to offer their spectrum voluntarily in an auction, with the incentive being that the current licensees would be permitted to retain “a portion” of the auction proceeds.⁴ As Chairman Genachowski explained in a March 16, 2011 speech,

We would auction spectrum for wireless broadband services, and the spectrum in the auction would be voluntarily contributed by current licensees like TV broadcasters or mobile satellite operators, who would in return receive a portion of the proceeds of the auction.

The strength of the incentive auction proposal is that it provides an incentive-based, market-driven path to tackle the spectrum crunch, while also effectively accommodating existing businesses. It brings market forces to bear on spectrum licenses that – by virtue of their decades-old allocations – have been shielded

⁴ Several bills introduced in Congress would grant the Commission authority to conduct such voluntary incentive auctions. See H.R. 911, Spectrum Inventory and Auction Act of 2011, Sec. 3, Voluntary Incentive Auction Revenue Sharing (also providing that the FCC “may not reclaim frequencies of broadcast television licensees or any other licensees directly or indirectly on an involuntary basis” under the incentive auction authority). See also S. 28, Public Safety Spectrum and Wireless Innovation Act, Sec. 204; S. 455, Reforming Airwaves by Developing Incentives and Opportunistic Sharing Act, Sec. 9 (similarly granting incentive auction authority to FCC).

from market dynamics. It provides a mechanism where the market – a voluntary buyer and a voluntary seller – can determine the price and the use of spectrum.⁵

In utilizing a voluntary mechanism – that is, a mechanism which requires both a willing buyer and a willing seller – the Commission has two basic choices: (a) it can announce an incentive structure, and auction off as much spectrum as current licensees tender based on that structure; or, (b) it can determine in advance how much spectrum should be repurposed, and adjust the incentive structure (i.e., the “portion of the proceeds” current licensees would be permitted to retain) to achieve the desired level of reallocation. That is, either the government would set the net price, and let quantity adjust, or it would set the quantity, and let net price adjust. It cannot, so long as the transaction truly involves “a voluntary buyer and a voluntary seller,” set both the net price *and* the quantity simultaneously.⁶

The dilemma is illustrated in Figure 1 below. The horizontal axis shows the “Incentive Rate,” defined as the portion of auction revenues licensees are permitted to retain.⁷ The vertical axis shows the amount of auction revenues received by the government (net of what is retained by the licensees). If the Incentive Rate is 100 percent, licensees retain all of the auction revenues, and government revenues are zero. At the other extreme, if the Incentive Rate is zero,

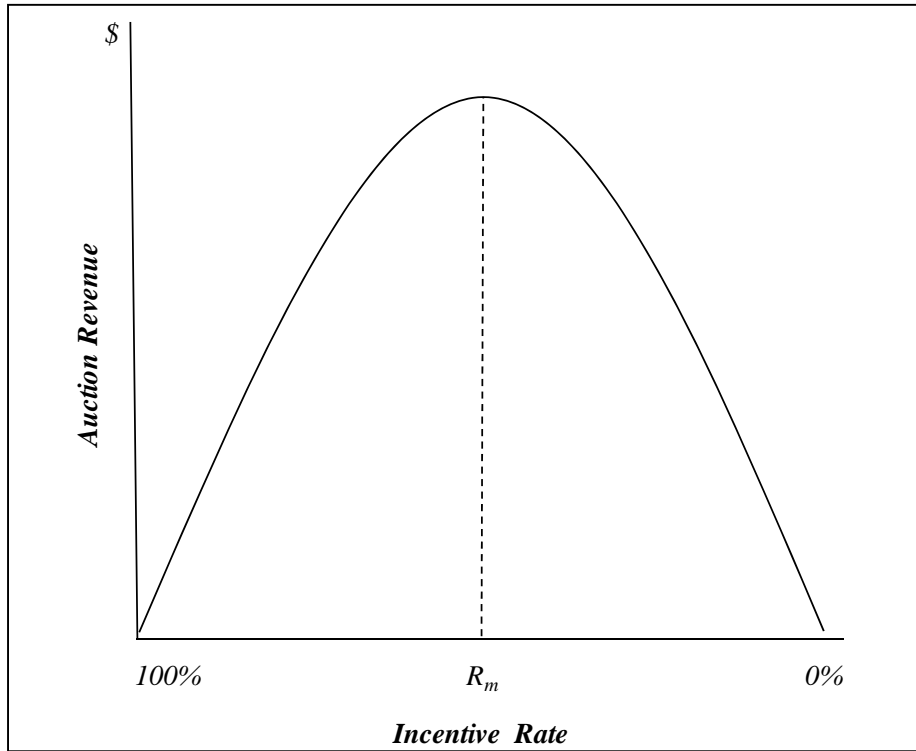
⁵ See Julius Genachowski, “The Clock is Running: Remarks on Broadband” (Washington DC, March 16, 2011) at 7 (available at http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0316/DOC-305225A1.pdf). The National Broadband Plan (NBP) straddles these issues, seeming at some points to favor allowing both prices and quantities to adjust, but at others to embrace the idea that a certain amount of spectrum must be reallocated one way or another – even if, in the end, it meant relying on administrative fiat. See Jeffrey A. Eisenach, “Spectrum Reallocation and the National Broadband Plan,” *Federal Communications Law Journal* 64 (forthcoming 2011) at 37-39 (available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1699281).

⁶ If the government had perfect information about the equilibrium price and quantity, of course, there would be no reason to rely on markets in the first place. Assuming it had perfect information and was prepared to ignore equity considerations, it could achieve economic efficiency by just reallocating the spectrum by administrative fiat, as the FCC did for many decades. However, there is a broad consensus that spectrum reallocation by administrative fiat systematically fails to achieve economically efficient allocations.

⁷ The incentive structure facing broadcasters and other licensees under an Incentive Auction could, of course, be considerably more complex than a simple “percentage of the proceeds.” At the end of the day, however, licensees’ willingness to tender spectrum will depend upon their expected net proceeds, which of course can be expressed as a percentage of the total revenues.

licensees receive no revenues, and hence proffer no spectrum; again, the government's revenues are zero.

**FIGURE 1:
RELATIONSHIP BETWEEN INCENTIVE RATE AND AUCTION REVENUES**



Somewhere in between these extremes, there is an Incentive Rate that maximizes government revenues (signified by R_M). CTIA/CEA, however, make no effort either to estimate R_M , or to assess the amount of spectrum that would be proffered, assuming the optimal rate was known. They make no effort, in other words, to assess what portion of auction revenues the government would need to share in order to elicit the targeted level of 120 MHz of spectrum, nor even to ascertain whether there is *any* Incentive Rate that would achieve the 120 MHz goal.⁸

⁸ It worth noting that R_M is *not* the socially optimal rate: Any Incentive Rate less than 100 percent implies the government is levying a *de facto* tax on spectrum transactions, which, like any tax, will reduce the quantity of spectrum that changes hands below the economically efficient amount. (For example, an incentive rate of 95 percent – meaning that current licensees receive 95 percent of auction revenues – is equivalent to a five percent excise tax on the transaction; i.e., the tax rate is $1 - R_M$.) As Hazlett and others have demonstrated, the welfare costs

B. The Amount of Spectrum Offered Depends on Opportunity Costs and on Technical Questions that Have Not Been Answered

In addition to the Incentive Rate, the amount of spectrum tendered in any incentive auction will be affected by licensees' assessments of the opportunity costs associated with both participating in the auction and with *not* participating. As noted above, CTIA/CEA acknowledge that their estimate of the enterprise value of the current licensees does not address these questions. Yet, it is simply impossible to estimate the net proceeds of a hypothetical spectrum auction without doing so.

CTIA/CEA ignore at least three significant factors that will specifically affect broadcasters' assessment of the opportunity costs associated with tendering their spectrum at auction. First, precisely what terms and conditions – beyond the Incentive Rate – will apply to broadcasters that tender their spectrum for auction? Second, what changes, if any, will the FCC (or Congress) make to the licenses of broadcasters who choose voluntarily *not* to tender their spectrum? Third, what will market conditions be at the time broadcasters have to decide whether or not to participate?

Some of the rules governing broadcasters that choose to tender spectrum in an incentive auction are under active consideration by the FCC in ET Docket No. 10-235. There, the Commission has asked for comment on whether it should make wireless services co-primary in the spectrum band currently allocated to broadcast television. It also asked how channel sharing arrangements (allowing two broadcasters to transmit over a single channel) might work from both a technical and legal perspective (e.g., how “must carry” and other rights would apply to

of taxing spectrum transactions are likely extremely high, meaning that the socially optimal tax rate is likely far below the rate that maximizes tax revenues (or, conversely, the socially optimal Incentive Rate is likely much higher than R_M). (See Thomas W. Hazlett, “Property Rights and Wireless License Values,” *Journal of Law and Economics* 51 (August 2008) 563-98.) In simple English, if the government set the *de facto* tax rate at the level that maximized its revenues from the incentive auctions, it would actually be reducing social welfare by reducing the amount of spectrum that changed hands to less than the optimal level.

broadcasters that participated in channel sharing).⁹ However, this proceeding is not addressing many other basic questions about the structure and procedures of incentive auctions; and, at the time the CTIA/CEA paper was released, initial comments had not yet been received (they were due March 18, 2011; reply comments are due April 18, 2011), even on the limited set of issues addressed. Thus, the CTIA/CEA paper estimates revenues from an auction of spectrum the FCC has not yet identified, based on terms it has not yet decided.¹⁰ Obviously, these decisions will have a profound effect on how broadcasters and other licensees assess the opportunity costs of participating in an incentive auction, and hence the price at which they would be prepared to do so.

Equally important – but not yet under formal consideration at the FCC – are the legal and technical rules that would apply to broadcasters which chose *not* to participate in the auction. How would broadcasters deciding to retain their spectrum licenses be relocated or “repacked” into a presumably smaller television band? Would such “repacking” adversely affect the service areas and interference protections afforded to remaining stations? Would they continue to have the right to provide supplemental and ancillary services, as provided for in the Communications Act? Perhaps most importantly, will licensees that do not participate in the Incentive Auction have an option, at some point in the future, to seek enhanced license flexibility comparable to the flexibility that will apply to the spectrum that is auctioned, or will their spectrum be forever bound by the current license conditions?¹¹ These questions, too, will

⁹ Federal Communications Commission, *In the Matter of Innovation in the Broadcast Television Bands: Allocations, Channel Sharing and Improvements to VHF*, Notice of Proposed Rulemaking, ET Docket No. 10-235 (November 30, 2010) (available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-10-196A1.pdf) (hereafter *Innovation NPRM*).

¹⁰ The CTIA/CEA paper “solves” this problem by referring to the “most likely FCC plan.”

¹¹ Some of these questions were put to FCC Chairman Julius Genachowski in a February 15, 2011 letter from House Telecommunications Subcommittee Chairman Greg Walden. See, e.g., Sarah Jerome, “Walden asks FCC About Fate of Broadcasters in Incentive Auctions,” *The Hill* (February 16, 2011) (available at

have a substantial bearing on broadcasters' decisions about whether, and at what prices, to voluntarily tender their spectrum for auction.

The amount of spectrum broadcasters choose to tender will also be determined by market conditions at the time an auction takes place. While there is nothing either the Commission or CTIA/CEA can do about it, the fact is that the marketplace for mobile wireless services is extremely dynamic, and market assessments of the potential value of new spectrum-based products and services are therefore extremely volatile.¹² In addition, broadcasters are now entering this market, offering mobile video potentially in competition with other wireless providers.¹³ Yet the CTIA/CEA study fails to even acknowledge these rapidly changing market conditions, implicitly assuming that today's market conditions will remain unchanged for an indefinite period.¹⁴

C. The Nature of Spectrum at Auction Depends Upon Repacking and Other Technical Factors that Are Yet to be Determined

A third factor that will affect the value of spectrum at auction is the precise nature of the spectrum blocks that are ultimately brought to market. The Commission's primary tool for (among other things) formulating a repacking plan so that spectrum relinquished by licensees can be configured into contiguous blocks for auction (called the Allocation Optimization

<http://thehill.com/blogs/hillicon-valley/technology/144661-walden-asks-fcc-about-fate-of-broadcasters-in-incentive-auctions>).

¹² Major marketplace developments potentially affecting the value of spectrum at auction in fact occur with some frequency. Recently, for example, AT&T announced its intention to acquire T-Mobile. As AT&T noted, the merger would "increase spectrum efficiency to increase capacity and output," thus "provid[ing] the spectrum and network efficiencies necessary for AT&T to address impending spectrum exhaust in key markets...." (See <http://www.mobilizeeverything.com/home.php>, visited March 21, 2011). Independent analysts noted that the deal could reduce spectrum demand and lead to lower auction revenues. See Rebecca Arbogast and David Kaut, "AT&T/T-Mo Deal Tough, But Not Unthinkable and AT&T Benefits for Even Trying," Stifel Nicolas (March 21, 2011) at 2 ("If these two companies can satisfy much of their spectrum needs by joining forces, it would reduce some of the demand for new spectrum and possibly lower auction revenue estimates.")

¹³ See, e.g., FCC Comments, Open Mobile Video Coalition, ET Docket No. 10-235 (March 18, 2011); <http://www.themcv.com>.

¹⁴ CTIA/CEA assume, obviously unrealistically, that the auction takes place in August 2011.

Model, or AOM) is not yet completed, although the Commission has said that the “fully developed model” will be available “in the near future.”¹⁵ As the Commission noted in its June 2010 *Spectrum Analysis* Technical Paper, the AOM is essential to determining “how many stations in which markets could participate voluntarily in an incentive auction in order to make progress towards freeing 120 megahertz with the minimal possible impact on service areas and consumers, or potentially develop[ing] alternative scenarios to meet the spectrum objective.”¹⁶ The fact that the Commission has not finished developing the primary tool it says it will rely on to make significant decisions about the spectrum that will be offered adds yet more uncertainty about the outcome of any future incentive auction.¹⁷

In summary, the CTIA/CEA paper relies on assumptions about the availability of spectrum which are, at this early date in the process, little more than speculation. Neither CTIA/CEA nor any other participant in the process knows what spectrum will be available at auction, or what incentives will be required in order to secure the willing participation of current licensees.

III. THE CTIA/CEA ESTIMATE RELIES UPON A FLAWED REGRESSION ANALYSIS BASED ON UNRELIABLE DATA

Even if the amount and nature of spectrum available for auction were known, the CTIA/CEA approach to estimating its value at auction would still be seriously flawed. As

¹⁵ *Innovation NPRM* at ¶10. See also Federal Communications Commission, Office of Broadband Initiatives, *Spectrum Analysis: Options for Broadcast Spectrum* (OBI Technical Paper #3, June 2010) at 12 (“The model is still in a developmental alpha version and, in its current form, can perform optimizations based on a subset of the constraints that it should ultimately be able to consider.”) (hereafter Technical Paper #3).

¹⁶ Technical Paper #3 at 5.

¹⁷ The issues discussed above are only examples of a wide range of important factors about which CTIA/CEA make important, and probably unrealistic, assumptions. For example, CTIA/CEA assume that the spectrum auctions will use the largest (and most valuable) geographic areas (“economic areas”), and that auction revenues will not be reduced by the allocation of bidding credits to certain bidders. They also assume the auction will be open to all possible bidders, without regard (for example) to their existing spectrum holdings. None of these assumptions are consistent with recent auctions.

explained below, CTIA/CEA use a hedonic regression model based on data from past spectrum auctions to predict the revenues that would result from a future incentive auction of broadcast spectrum. For the reasons explained below, the estimates from the CTIA/CEA model are inherently imprecise, and do not represent a reliable estimate of incentive auction revenues.

A. CTIA/CEA’s Hedonic Regressions Are Unreliable for Predicting Spectrum Prices

CTIA/CEA’s estimate of the possible revenues from an incentive auction is based on historic spectrum prices, which are subject to wide variation. In addition, spectrum prices are dramatically affected by the level of competition, which in turn is affected in large part by auction design. The use of prior auction data to predict future prices is made more problematic by the fact that the FCC has recently revamped its spectrum auction design. CTIA/CEA’s model fails to adequately account for these data issues, many which bias the results upwards, resulting in estimates that are both imprecise and unreliable.

1. FCC Auction Prices Do Not Necessarily Reflect Underlying Economic Values

For the pricing of spectrum in one auction to be useful in predicting the likely price in a future auction, it would ideally be the case that auction prices systematically reflect the underlying value of the spectrum.¹⁸ The FCC’s auctions generally have not achieved this objective. As the FCC itself has pointed out,¹⁹ prior to 2008, bidders were often able to game auctions – that is, to engage in signaling and other practices that distort prices.

¹⁸ Alternatively, it might be sufficient if auction prices deviated from economic values in a systematic way. For reasons discussed below, they do not.

¹⁹ See, e.g., Auction of 700 MHz Band Licenses Scheduled for January 24, 2008, AU Docket No. 07-157, October 5, 2007, at ¶145. For a recent review of various inefficiencies in FCC auctions, see Patrick Bajari and Jungwon Yeo, “Auction Design and Tacit Collusion in FCC Spectrum Auctions” (March 31, 2009) (available at http://www.mysmu.edu/faculty/jwyeyo/research/Bajari_Yeo_FCC.pdf). Bajari and Yeo find that changes in FCC auctions rules have made it more difficult for bidders to collude, i.e., that the efficiency of auctions has improved over time. To be clear, it is generally agreed that auctions have been a major improvement over previous methods of allocating spectrum, including comparative hearings and lotteries. The point here is simply that, for a variety of reasons, they have sometimes produced transaction prices that do not perfectly reflect underlying economic values.

For example, the simultaneous multi-round (SMR) auction format used by the FCC encourages “parking,” and therefore likely produces inflated prices for the most valuable spectrum in an auction. In the SMR format, blocks of spectrum are divided into geographic regions. The large-area “regional economic area grouping” (REAG) structure requires bidding on only a dozen licenses to cover the continental United States.²⁰ By contrast, cellular market area (CMA) licenses cover the United States with 734 distinct geographies.²¹ The larger licenses are often preferred by large bidders, as it is easier to cover the entire United States with only a few bids. The smaller licenses are typically preferred by the smaller regional carriers and speculators. In a SMR auction, all licenses are put up for auction at once. The auction proceeds over a series of rounds, and ends when there are no new bids.²² Each license is worth a certain number of bidding units, and bidders must purchase the bidding units before the auction with initial deposits. Because bidding units are perfectly fungible – that is, they can be moved from license to license over the course of an auction – regional bidders have found that parking eligibility is a profitable strategy. A bidder using a parking strategy bids on the licenses that it is *not* interested in early in the auction. Then, once competition has died down, it moves to the licenses of real interest. The intended result is to keep the price of the targeted spectrum relatively low.

Because large carriers are (or in any case are believed to be) relatively insensitive to the price of spectrum in major metropolitan areas, the ideal “parks” are large cities, such as

²⁰ REAG licenses are regional licenses covering groupings of Economic Areas. There are 12 REAG areas in the U.S. See Regional Economic Area Groupings, *available at*: <http://wireless.fcc.gov/auctions/data/maps/REAG.pdf>.

²¹ For a listing of the CMA geographies, see Cellular Market Areas, *available at*: <http://wireless.fcc.gov/auctions/data/maps/CMA.pdf>.

²² Here, a “bid” is defined as either a new bid or a proactive waiver, which can sometimes be used to delay the end of an auction. See, e.g., Auction of Advanced Wireless Services Licenses Scheduled for June 29, 2006, AU Docket No. 06-30, April 12, 2006, at ¶176.

Chicago, New York, or Los Angeles. It is therefore common to see smaller bidders placing bids on large licenses early in the auction and then moving those bids to a combination of smaller licenses later in the auction. This strategy tends to inflate the prices of large licenses relative to the prices of smaller regional licenses. The end result is that the underlying auction data may be skewed, which reduces its predictive value with respect to future auctions. Simply put, parking has likely exaggerated the prices of spectrum in specific auctions in which the practice was most prevalent, thereby biasing upwards any estimates based on those auctions.²³ The CTIA/CEA analysis ignores this source of bias.

2. The Use of Data from Certain Auctions in the CTIA/CEA Regression Is Inappropriate

An additional problem with the CTIA/CEA analysis is the inclusion of data from certain auctions in which the results are known to be biased, atypical, or flawed. For example, the regressions include data obtained from FCC Auction 5 – the PCS C Block auction. It has been demonstrated, however, that the unusual payment terms offered to bidders in the C-Block auction resulted in an effective discount of 40 percent from the posted prices, helping to explain why prices in this auction were dramatically higher than in the A and B Block auctions held earlier.²⁴ CTIA/CEA’s regression dataset includes price observations which are approximately 40 percent higher than those in comparable auctions, for reasons that have nothing to do with the underlying value of the spectrum, and which are not likely to be repeated in a future

²³ See, e.g., Jeffrey Banks, Mark Olsen, David Porter, Stephen Rassenti and Vernon Smith, “Theory Experiment, and the Federal Communications Spectrum Auction,” at 20, *available at*: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.19.4165&rep=rep1&type=pdf>; and Kenneth Hendricks and Robert Porter, *An Empirical Perspective on Auctions*, in HANDBOOK OF INDUSTRIAL ORGANIZATION, VOL. 3 (Mark Armstrong & Robert Porter, eds.) at 2091-92 (North Holland 2007).

²⁴ See Peter C. Cramton, “The FCC Spectrum Auctions: An Early Assessment,” *Journal of Economics and Management Strategy* 6; 3 (1997) at 22 (available at www.cramton.umd.edu/papers1995-1999/97jems-fcc-spectrum-auctions.pdf). Cramton also notes that major bidders defaulted on their bids, forcing a re-auction of much of the C-Block spectrum.

incentive auction. Thus, by including Auction 5 data, CTIA/CEA effectively inflate the estimate of incentive auction revenues.

CTIA/CEA also used data from Auction 35, the PCS C and F Block re-auction. The use of data from Auction 35 is problematic for two reasons. First, prices in this auction were affected by intense competition between Verizon and Cingular on licenses in New York City.²⁵ Ultimately, Verizon outbid Cingular on the New York licenses even when those licenses rose to extraordinary prices.²⁶ Given that Cingular (now AT&T) has a much better spectrum position in New York City than previously (and that its position would be further improved by the T-Mobile acquisition), it is unlikely that such a situation would play out again in some future auction. Thus, the Auction 35 results likely overstate the value of spectrum in New York.²⁷

A second problem with the use of Auction 35 data is that it included the controversial Nextwave spectrum. A significant portion of the spectrum in Auction 35 was tied up in litigation, and ultimately sold (by Nextwave) in the secondary market years later. Moreover, all winning bidders were permitted to opt out of their bids, and many of them did. Again, the effect of including these observations in the data set is to bias the results upward.

B. The CTIA/CEA Paper Fails to Document the Accuracy of its Revenue Estimate

The CTIA/CEA methodology employs a linear regression model that is used to *forecast* an average price for spectrum that is not in the regression sample. When making “out of

²⁵ Data on prices and individual bids in Auction 35 are available at http://wireless.fcc.gov/auctions/default.htm?job=auCTION_summary&id=35.

²⁶ The two New York City licenses on which Verizon was high bidder in Auction 35 totaled \$4.095 billion in revenues. Total net auction revenues—that is, net of bidding credits—were \$16.857 billion. There were 422 licenses in the auction. Therefore, these *two New York licenses* accounted for nearly 25 percent of the proceeds in the entire auction.

²⁷ See, e.g., Jeremy Bulow, Jonathan Levin and Paul Milgrom, *Winning Play in Spectrum Auctions*, Stanford University Working Paper, February 2009, Tables 2, 3 and Figure 2a (showing the high prices in Auction 35 and the excessive duration required to auction the New York licenses relative to the other licenses in the auction that covered metropolitan areas).

sample” forecasts, the errors of the forecast tend to be large. In particular, these errors contain the errors of *in sample* prediction, plus the additional error contained within the regression parameters themselves.²⁸ Despite these known sources of imprecision, in the table of auction revenues on page seven of the CTIA/CEA report, the low, mid-range, and high end of the auction revenue estimates are all listed as \$36.3 billion.

It is a statistical certainty that there is a confidence interval around the \$36.3 billion estimate – a range of values within which (assuming, incorrectly, that the model was otherwise correctly specified) one could be reasonably certain the true value must fall. It is a near certainty, given the nature of this particular model, that that range of values is very wide. It is also certain that CTIA/CEA either know or could easily calculate such a confidence interval, and that they did not report it, nor provide the underlying data necessary to calculate it, in the White Paper.

C. The Anecdotal Benchmarks the CTIA/CEA Paper Relies Upon Do Not Support its Estimate

Despite omitting the confidence intervals surrounding its estimates of auction revenues, the CTIA/CEA paper claims its estimates are conservative. These claims are primarily based on anecdotal data obtained from the 2008 auction of 700 MHz spectrum and recent secondary market transactions for 700 MHz spectrum.

First, CTIA/CEA claim that high prices in the B block in the 2008 700 MHz auction provide a benchmark suggesting their estimate of incentive auction revenues is conservative.²⁹ A strong argument can be made, however, that prices in the B block were *atypically* high because AT&T had a vested interest in that block due to its earlier acquisition from Aloha of the

²⁸ William H. Greene, *Econometric Analysis* (Macmillan Publishing 2d ed., 1993) at 195 (introducing the confidence interval surrounding a forecast from an ordinary least-squares regression).

²⁹ *White Paper* at 8, fn. 10.

adjacent spectrum.³⁰ Consequently, AT&T was willing to pay much more for that spectrum than for other spectrum at auction, and ultimately did. Because any spectrum let at an incentive auction would not have this characteristic, the B block prices are not a conservative benchmark for CTIA/CEA's estimates.³¹

Second, CTIA claims that a reported secondary market transaction between Qualcomm and AT&T demonstrates its estimates are reasonable. In particular, AT&T is reported to have agreed to a purchase of 12 MHz of unpaired D and E block spectrum in New York, San Francisco, Boston, Los Angeles, and Philadelphia and 6 MHz elsewhere in the country for \$1.925 billion.³² CTIA estimates the value of the transaction at over 86 cents per MHz-pop, and then adjusts that estimate upward to account for the fact that the D and E block spectrum is unpaired.

What the CTI/CEA paper fails to mention is that the price of this spectrum is distorted upward by the fact that it is disproportionately concentrated in some of the largest metropolitan areas, where AT&T needs spectrum the most. In addition, CTIA/CEA fail to mention that AT&T will use this spectrum as supplemental downlink spectrum in its LTE network.³³ That is, this acquisition represents incremental spectrum that AT&T needs to enhance service in

³⁰ See, e.g., Grant Gross, "AT&T Buys High-Speed Wireless Spectrum for \$2.5 billion," *InfoWorld* (October 9, 2007) (available at: <http://www.infoworld.com/d/networking/att-buys-high-speed-wireless-spectrum-25-billion-017>).

³¹ See, e.g., Chris Ziegler, "AT&T Says B Block and Aloha Spectrum Will Go to LTE," *Engadget* (April 3, 2008) (available at: <http://mobile.engadget.com/2008/04/03/atandt-says-b-block-and-aloha-spectrum-will-go-to-lte/>); Lynnette Luna, "AT&T's 700 MHz Purchase a Win-Win," *FierceBroadbandWireless* (October 11, 2007) (available at: <http://www.fiercebroadbandwireless.com/story/ts-700-mhz-purchase-win-win/2007-10-11>) (stating that AT&T would no longer have to bid on the large C block in the auction and instead would be more likely to focus on the A and B blocks).

³² Alan Rappeport and Paul Taylor, "AT&T to Buy Qualcomm's Spectrum for \$1.93bn," *Financial Times* (December 20, 2010) (available at: <http://www.ft.com/cms/s/0/0a76b47c-0c42-11e0-b1a3-00144feabdc0.html#axzz1HAeWrbG0>).

³³ Michelle Maistro, "AT&T Buys Spectrum from Qualcomm for Planned 4G LTE Network," *eWEEK*, December 20, 2010 (available at: <http://mobile.eweek.com/c/a/Mobile-and-Wireless/ATandT-Buys-Spectrum-from-Qualcomm-for-Planned-4G-LTE-Network-874429/>).

particular markets. Therefore, this spectrum could actually cost more *per MHz-pop* than generic spectrum covering the entire United States. Thus, the anecdotal benchmarks relied upon by CTI/CEA neither support their estimates of spectrum value nor illustrate that their revenue forecasts are conservative.

D. The CTIA/CEA Regression Suffers from Additional Econometric Problems

In addition to the other issues discussed above, the CTIA/CEA hedonic price regressions suffer from various econometric problems.

The first obvious flaw in CTIA/CEA’s analysis is the omission of relevant explanatory variables from the regression model. One relevant variable that would surely affect spectrum prices in the auctions analyzed by CTIA/CEA is the status of the spectrum as “new” spectrum, versus existing frequencies that can be used in a carrier’s existing network. For example, one of the reasons that Auction 35 prices were high in general is that the spectrum was the well-developed PCS (1.9 GHz) band, which large operators could easily incorporate into their existing networks. The omission of this and other explanatory variables from the regression model means that the results are statistically unreliable.

A second econometric problem, possibly even more severe, is that the model suffers from simultaneity bias. Specifically, the CTIA/CEA specification regresses price, in dollars per MHz-pop (the “dependent variable”), on several right hand-side variables (or “explanatory variables”), one of which is the natural log of MHz-pops of spectrum in the auction. Thus, the variable MHz-pop appears in both the denominator of the dependent variable (spectrum price in dollars per MHz-pop), and as one of the explanatory variables on the right hand side of the regression (the natural log of MHz-pop). As a result, the CTIA/CEA regression specification

suffers from what econometricians refer to as an endogenous variables problem.³⁴ The effect of this problem is that the regression parameters do not accurately represent the underlying effects of the variables in the model, leading to inaccuracies in the resulting forecasts.

The CTIA/CEA paper also fails to provide the data necessary for third parties to replicate its results. For example, CTIA/CEA include manufactured variables purported to represent differences in build-out requirements across auctions, and whether incumbent operators must be cleared from the spectrum.³⁵ Despite stating that the values of these variables are reported in the paper,³⁶ the specific observations for each auction are not listed. It is thus impossible to independently verify the paper's results.

Finally, it is worth noting that the regression estimated in the CITA/CEA paper has an R-squared of 47.6 percent.³⁷ The R-squared can be interpreted as the proportion of the variation in the dependant variable that is explained by the model,³⁸ meaning that the CTIA/CEA model explains less than half of the variation in spectrum prices used in the analysis. This fact, taken together with the paper's failure to report the confidence intervals around its auction revenue forecast, creates a strong presumption that the \$36 billion estimate is, at best, extremely imprecise.

IV. CONCLUSION

The CTIA/CEA paper attempts to place a dollar value on the proceeds of a spectrum auction to be held at an undetermined date in the future, in which the amount and nature of the spectrum to be auctioned is unclear, and the incentives that will need to be offered to the current

³⁴ See, e.g., William H. Greene, *Econometric Analysis* (Macmillan Publishing, 2d ed. 1993) at 579.

³⁵ *White Paper* at 9.

³⁶ *Id.* at fn. 12 (stating, incorrectly, that a table of values is included in the report).

³⁷ *Id.* at 19 (listing the regression results as a final page in the paper).

³⁸ See, e.g., Jeffrey M. Woolridge, *Introductory Econometrics* (Thomson South-Western 2d ed., 2003) at 40.

licensees to secure that spectrum are unknown. It resolves these uncertainties and unknowns by making assumptions, many of which are plainly implausible. Moreover, even if the spectrum to be auctioned had been identified with perfect specificity and complete finality, the methods used by CTIA/CEA to estimate its value are imprecise and, in many respects, tend to bias the results upwards – that is, to overstate revenues. As a result, the revenue estimates in the CTIA/CEA White Paper are highly speculative and ultimately unreliable.