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**An Insiders' View of FCC Spectrum Auctions\***

by

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## *Abstract*

After a long period of awarding spectrum licenses inefficiently, changes in the budget and budgetary process coupled with increases in the value of the spectrum for non-broadcast use led Congress to allow the Federal Communications Commission to award licenses through competitive bidding. Contrary to the perceived view of government bureaucracies as excessively cautious, the FCC used the newfound authority to adopt a novel approach to auction design -- simultaneous multiple round auctions. The innovative auction design would not have been adopted without the successful collaboration between government economists and academic economists, who helped to formulate and refine the design so that decision makers at the FCC could be convinced that the novel technique was both superior and practical. The FCC's implementation of competitive bidding was not only rapid as mandated by Congress, but also much less costly than outside alternatives and allowed the integration of spectrum policy decisions and auction design. Experience from several auctions has led to a number of open questions and refinements. The FCC is trying to replicate the success with the original auction design by facilitating dialog between the agency and outside auction experts in order to address these issues.

The lessons from the auctions process should guide policy makers as they propose and implement future programs. Development of a constituency is necessary even for efficiency enhancing programs. Once a program is in place, collaboration between government and leading academics can push these programs to further increase the public interest and withstand criticism normally leveled at government agencies. In addition, continued flexibility and willingness to re-examine a program is possible depending on the entrenched interests.

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# **An Insiders' View of FCC Spectrum Auctions**

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## **I. Introduction**

In 1994, the Federal Communications Commission ("FCC") began to award spectrum licenses via auction. The FCC auctions gained headlines as a result of the billions of dollars of bids for spectrum licenses. While less noted, the auctions also provide a variety of important lessons on the role of economics and economists in public policy. The main lesson is the value of collaboration between academic and government economists in the design and implementation of novel policies that increase economic efficiency. This paper sets forth an insiders' view of how economists inside and outside of government contributed to the design of FCC auctions. It provides a background on the path to auctions, detailed analysis of auction features, and a discussion of how the theory of bureaucracies would not have predicted such an innovative auction design. It also provides views on a number of issues that have arisen during the course of the auction process and the continuing valuable interaction with outside experts to improve the auction process.

Section two examines why auction authority was not granted until 1993 despite its greater efficiency compared to alternative assignment methods. The primary motivation for passing auction legislation was the anticipated revenues, not the greater efficiency. With a growing deficit and budget reforms that required Congress to pay for new expenditures, Congress was desperate for new sources of revenues. This ultimately overwhelmed Congress' historical protection of its control over licensees.

Section three uses the bureaucratic theory literature to frame FCC design and implementation decisions. In this light, the novel approach to auction design and implementation is quite surprising. What allowed the FCC to avoid the general risk aversion and concern with bureaucratic power in its design and implementation? A critical factor was the exceptional willingness of the new Chairman of the FCC to take risks to "do the right thing." Outside academic economists had an unusual degree of influence in the auction design, in part because responsibility for developing the auction design was given to a policy office that has a tradition of applying economics to public policy and tends to be less cautious than bureaus with heavy operational responsibilities. The cooperative interaction between government and outside economists, both those representing parties in the auction proceeding and independent outsiders, was critical to refining the simultaneous multiple round auction format and generating the confidence at the FCC needed to adopt such a novel format.

Section four provides a detailed description of the implementation process. It argues against the view that the entire auction program should have been contracted out. By

contracting out only technical and operational parts of the auction program the Commission was better able to coordinate spectrum policy and auction design decisions and at the same time save a significant amount of money.

Section five examines several issues that have arisen in implementing FCC auctions, including defaults on installment payments, bid signaling and the pace of the auction and discusses changes the FCC has made to address those issues. It also provides some background for future work to improve the auctions. Section six presents conclusions.

## II. Getting to Yes.

In 1993 Congress finally gave the FCC the right to auction spectrum licenses.<sup>1</sup> Why did it take so long and how did it happen?<sup>2</sup> The idea of auctions is not novel, nor is the idea of property rights in spectrum.<sup>3</sup> However, even in the Carter and Reagan eras where there was significant deregulation and a move to more reliance on market forces throughout the economy, Congress did not move to grant auction authority. The FCC Chairman's decision to promote auctions in the early 1980s and the eventual congressional grant of limited auction authority in 1993 provides an interesting case study in the economics and political economy of regulation.

Why did it take so long for the agency itself to support auctions? What prompted the chairman of the FCC to support auctions and propose draft legislation in 1985? Why did it take 8 more years for Congress to finally give the FCC auction authority? What caused Congress to change its mind? The rich literature on normative and positive theories of regulation provides a framework for analyzing these questions.<sup>4</sup> The first step in these frameworks is to identify the interested parties and their motivations in the process.

The major participants in the auction debates were the current licensees (both those who expect to be awarded licenses in the future and those who do not), expected future licensees who did not have licenses, the FCC, Congress, the administration, and

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<sup>1</sup> Omnibus Budget Reconciliation Act of 1993, Pub. L. No. 103-66 § 6002, 107 Stat. 312, 387-392 (OBRA 93”).

<sup>2</sup> Hazlett (1998) provides a detailed regulatory theory and background on the 67-year path to auction authority. He argues that opposition to auctions was based on a *quid pro quo* “franchise rent theory” whereby Congress and regulators create rents for broadcasters and use the threat of taking away the rents to control behavior. It was only with exemptions in the auction authority to protect broadcasters and changed circumstances for other radio services that auction legislation was able to pass. This is consistent with the analysis presented here which elaborates on the self-interested behavior of politicians, regulators and licensees.

<sup>3</sup> Ronald Coase (1959) proposed using auction to assign FCC licenses credits Leo Herzel (1951) with first suggesting the idea. See Hazlett (1998). For a detailed account of early spectrum competition and regulation, see Hazlett (1990).

<sup>4</sup> For a comprehensive survey of the literature, see Noll (1989). See also, Peltzman (1989).

economists. Overall, all but the last two groups of these participants initially felt they had more to lose than to gain from the introduction of auctions.<sup>5</sup> Following the standard economic approaches to the theory of regulation, we will attempt to explain the behavior of each of these groups in terms of their self-interest.

### *Incumbent Licensees*

Incumbent licensees were primarily broadcasters, private radio operators, and, more recently, satellite and cellular operators. Current licensees who do not expect to get future spectrum stand to gain little from auctions.<sup>6</sup> Indeed, they probably expected auctions to hurt them: pressure might develop for fees on their spectrum or additional competition might be introduced because the lure of auction revenues might induce Congress to increase the supply of available spectrum. Current licensees who expect future licenses have a more balanced tradeoff as discussed below in the section on new licensees.

Broadcasters have always been the most important source of opposition to auctioning FCC licenses. Since most valuable broadcasting licenses had already been assigned (under the analog technology available when most of the debate occurred), why would broadcasters care? It appears that they were concerned that auctions would set a precedent for charging for spectrum use that might result in the establishment of spectrum use fees levied on broadcasters for the use of their existing spectrum. Auctions would also draw attention to the substantial value of the spectrum. (The value could already be determined from private sales of stations, but these may not have received as much attention as a FCC auction in which many licenses were put up for bid in a single auction.)<sup>7</sup> Broadcasters wanted to maintain the public trustee model under which broadcasters received their spectrum for free in exchange for meeting implicit public service obligations. Since, as Hazlett (1998) has argued, this model was also in Congress's interest, broadcasters were able to block all auction legislation until 1993. And they were successful in prohibiting auctions for broadcasting licenses in the Omnibus Budget Reconciliation Act of 1993 (OBRA 93), which limited auctions to spectrum whose principle use is for subscription services. It was not until 1997 that Congress expanded authority to include commercial broadcasting licenses, and even then,

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<sup>5</sup> One example of economists' gain is the special issue of this journal.

<sup>6</sup> In some cases, current licensees who expect future competition from new licensees might favor auctions in the belief that this would impose a cost on their new competitors. Apparently the European Union agrees with this assessment and has required payments to the subsequent wireless operators who paid for their licenses in Italy and Spain. 95/489/EC: Commission Decision of 4 October 1995 concerning the conditions imposed on the second operator of GSM radiotelephony services in Italy. *Official Journal NO. L280, T3/L1/1995 P0049.*

<sup>7</sup> Levin (1980) estimates of the value of television station licenses based on the sales of stations.

broadcasters were able to obtain digital television licenses for free.<sup>8</sup>

Incumbents may oppose auctions because they may be better positioned to acquire spectrum under alternative mechanisms. If one assumes that the amount of spectrum released to the public is unaffected by the assignment method, then incumbents only stand to lose to the extent they would otherwise have preference in the award of new licenses. There is some evidence that incumbents have had better success in acquiring spectrum compared to new entrants. In 1986, the FCC awarded each of the two incumbent cellular operators an additional 10 MHz of spectrum without explicitly considering the award to a third competitor.<sup>9</sup> More recently, the FCC awarded a second terrestrial broadcast license to existing television broadcasters for use during the transition to digital television. As a result, incumbents may prefer alternative procedures to auctions because they may reasonably expect to get more of the rents.<sup>10</sup> Presumably they believed that not all rents were dissipated under the assignment mechanisms that they would face absent auctions – rule making limiting eligibility to incumbents, settlements to avoid mutually exclusive applications, first-come-first-served, comparative hearings, or lotteries. Hazlett and Michaels show that under lotteries in most cases less than half of rents were dissipated.<sup>11</sup>

Incumbents may also oppose auctions because of the possibility of increased competition. Auctions may increase the amount of spectrum the government makes available for private use because auctioning spectrum provides government revenues.<sup>12</sup> If auctions cause additional spectrum to be released, incumbents who realize scarcity rents could be harmed even if they are differentially advantaged in gaining new spectrum. On the other hand, some have suggested that the government may realize its market power in the supply of spectrum and attempt to artificially constrain the amount of spectrum released to the market to increase the net present value of auction receipts.

Most parties that expected to be seeking additional FCC licenses favored the old systems under which licenses were awarded for "free." In addition to the broadcast exemption, some of the other strongest auction opponents were able to limit the use of auctions to services with paying subscribers, thus ruling out auctions for spectrum used internally by

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<sup>8</sup> Balanced Budget Act of 1997 ("BBA 97"), Pub. L. 105-33, 111 Stat. 251 (1997), Sec.3002 requires the FCC to use auctions to assign initial licenses when there are mutually exclusive applications, with three exceptions: (1) licenses for public safety; (2) licenses for DTV service given to existing broadcast licensees; and (3) licenses for non-commercial educational or public broadcast stations.

<sup>9</sup> See Rosston (1994), Ch. 3.

<sup>10</sup> On the other side, some companies felt that although they would be allowed to acquire additional spectrum in an auction (i.e. there would not be a binding spectrum cap), they would lose in a comparative hearing in favor of new entrants. PageNet may have felt this way in the narrowband PCS proceeding.

<sup>11</sup> Hazlett and Michaels (1993).

<sup>12</sup> Note that the amount of spectrum may increase relative to prior assignment mechanisms, but still be below the socially optimal level if the government withholds spectrum to increase its price.

firms such as railroads, electric utilities and other for-profit entities.<sup>13</sup> Satellite proponents also were successful in including language that required the Commission to continue to encourage settlements to avoid mutually exclusive applications.<sup>14</sup>

### *New licensees.*

New licensees preferences for auctions depend on their view about their likelihood of receiving an initial grant for their new licenses without competitive bidding, as well as what they expect to pay for a license. For example, some PCS hopefuls did not oppose auctions because they could see that the alternatives -- comparative hearings or lotteries -- would not be to their advantage. In lotteries, they would have very small chances in the initial award and be forced to purchase their desired licenses in the secondary market, often after considerable delay and with high transactions costs.<sup>15</sup> Because of their delay and arbitrary nature, comparative hearings for PCS were also not an attractive alternative.<sup>16</sup>

Congress was particularly sensitive to arguments that small businesses, and businesses owned by women and minorities seeking new licenses would be disadvantaged by auctions and included specific language to "ensure the participation of designated entities in the provision of service." (e.g., small businesses, minorities, women).<sup>17</sup>

### *Congress and the FCC*

It was not until 1985 that an FCC Chairman asked Congress for auction authority.<sup>18</sup> In his congressional testimony he emphasized the greater efficiency of auctions, but also

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<sup>13</sup> OBRA 93 explicitly limited auctions to services with paying subscribers. The public safety exemption in BBA 97 is written so broadly that it may exempt from auctions private and commercial users such as utilities and railroads.

<sup>14</sup> When the award of a license to one party requires the denial of an award to another, the applications are termed "mutually exclusive." When there are no mutually exclusive applications, there is no need for an auction. Especially in the satellite services, there have been significant negotiations among initially mutually exclusive applicants to modify applications to avoid mutual exclusivity.

<sup>15</sup> As discussed above, Hazlett and Michaels (1993) show that not all rents were dissipated in the cellular lotteries, but the difference may be viewed as being dissipated in the transactions costs of aggregating secondary market licenses and the associated delay.

<sup>16</sup> Kwerel and Felker (1985), Rosston (1994).

<sup>17</sup> OBRA 93, Section 309(j).

<sup>18</sup> On May 1, 1985 FCC Chairman Mark Fowler sent to Congress the draft of a bill to give the FCC auction authority. "Chairman Fowler Submits Bill Proposing Auctions to Assign Initial FCC Licenses," FCC News Release, May 2, 1985. This draft legislation was not introduced in the 99<sup>th</sup> Congress.

mentioned the potential revenues.<sup>19</sup> Why was Fowler the first FCC chairman to support auctions? It may have been for three reasons. First, Fowler had a stronger pro-market ideology than previous chairmen so he was more receptive to using a market mechanism for assigning licenses. Second, he was the first chairman to have experience with lotteries, which were not authorized until 1982. Third, the FCC Office of Plans and Policy very aggressively advocated auctions, starting early in Fowler's term.<sup>20</sup>

Each year after 1985, Chairman Mark Fowler and subsequent FCC chairmen requested auction authority and were turned down. It was clear that Congressmen and Senators of both parties on the Communications Committees did not want the FCC to use auctions.<sup>21</sup> For example, in February 1987 when Chairman Fowler testified in a Senate hearing, Senator Rudman (R-NH) asserted that "Congress isn't going to go along with your auction" because it "will aid monopolies... You won't get anywhere with this, so why don't you go back to the drawing board?"<sup>22</sup> On May 19, 1987, Senator Inouye (D-HI), Chairman, Senate Subcommittee on Communications, wrote to Senator Lawton Chiles (D-FL), Chairman, Senate Budget Committee, that a proposal to collect \$600 million from a spectrum auction "undercuts the fundamental tenet in communications policy that the airwaves are a limited public resource," and "it is inappropriate to sell such a resource to the highest bidder." In 1989 Rep. John Dingell (D-MI) introduced legislation that contained the following provision:

"PROHIBITION OF SPECTRUM AUCTION--  
REASSIGNED FREQUENCIES.-- No frequency reassigned by the President under section 4 of this Act shall be allocated or assigned by the Commission by means of any system using any auction or comparable device or practice."<sup>23</sup>

Why did most politicians oppose auctions for so long? Politicians do not want to

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<sup>19</sup> "First, they would significantly reduce the amount of private and public resources consumed in preparing and processing license applications. Second, auctions would reduce the time it takes to assign a license to the party who values it most and who for that reason, has the greatest incentive to put it to good use. Finally, auctions would give the taxpayer a return for the valuable privilege conferred in the license. The revenues to be garnered could be in the billions of dollars." See "Spectrum Auctions: FCC Proposals for the Airwaves," Hearing before the Subcommittee on Telecommunications, Consumer Protection, and Finance of the Committee on Energy and Commerce, House of Representatives, Ninety-Ninth Congress, Second Session, October 1, 1986, U.S. Government Printing Office, Washington, 1987 (Serial No. 99-170), p. 12. The hearings were requested by Fowler.

<sup>20</sup> Peter Pitsch, the Chief of OPP at the time, was a strong supporter of auctions. Also an OPP working paper by Kwerel and Felker (1985) helped provide the intellectual case for auctions.

<sup>21</sup> Hazlett (1998).

<sup>22</sup> Hearing before the Senate Appropriations Subcommittee on Commerce, Justice, State, the Judiciary and Related Agencies, February 18, 1987.

<sup>23</sup> Introduced by Rep. John Dingell (D-MI), July 21, 1989.



antagonize broadcasters because they seek favorable coverage by broadcasters. Broadcasters are the primary means by which politicians are able to communicate with voters. The influence of broadcasters was apparent in the BBA 97, which gave incumbent broadcasters the free use of a second channel during a long transition to digital television service.<sup>24</sup> There were only three politicians willing to speak against this: the unlikely trio of Robert Dole, John McCain and Barney Frank. In addition, auctions tend to undermine the public interest model of broadcasting regulation, which gives politicians a limited measure of control over broadcasters.<sup>25</sup> For example, broadcasters are required to provide three hours a week of children's programming.<sup>26</sup> While not as important as broadcasters, other licensees influenced Congress to oppose auctions.<sup>27</sup>

### *The change to auction*

Eight years after Chairman Fowler first requested auction authority Congress provided it in OBRA 93. What had changed over the eight years? First, the pressure to find new revenue sources was particularly intense at this time because of the unusually large deficit and because the Budget Enforcement Act of 1990 (BEA) required that any increase in expenditures must be offset by expenditure reductions or revenue increases.<sup>28</sup> Auctions provided a new source of revenue without raising taxes. Second, it was the first time that a Democratic administration actively requested auction authority from a Democratic Congress that had traditionally opposed auctions.<sup>29</sup> In 1992, the Clinton administration vigorously sought auction authority as part of its effort to address the budget deficit.

Third, the defects of lotteries became apparent with the huge windfalls to lucky cellular lottery winners. While there have been sales of spectrum licenses since the 1920s, the visibility of the value of broadcasting licenses has been shielded by the requirement that they not be sold as bare licenses, but rather as part of an ongoing business.<sup>30</sup> However, with the introduction of cellular lotteries, entrepreneurs had strong incentives to find ways around any such requirements and sell immediately their winning lottery tickets for

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<sup>24</sup> BBA 97, Sec. 3002.

<sup>25</sup> See Hazlett (1998). In a recent speech, Commissioner Tristani expressed this clearly. "For the record, I think that broadcasting is special. I'm all for giving broadcasters special benefits in exchange for special obligations." "Broadcast Views" Speech to the Federal Communications Bar Association, May, 21, 1998.

<sup>26</sup> *Report and Order*, In the Matter of Policies and Rules Concerning Children's Television Programming, MM 93-48, FCC96-335, August 8, 1996.

<sup>27</sup> For example, Jay Kitchen, the head of a trade association representing Private Land Mobile licensees, stated in a congressional hearing "Let the industry's message be clear, we do not want auctions..." Statement of Emmett B. Kitchen, Jr., U.S. House of Representatives. (1987), p. 67.

<sup>28</sup> Davis (1997)

<sup>29</sup> Hazlett (1998)

<sup>30</sup> 47 C.F.R. 73.3535.

millions of dollars.<sup>31</sup> In addition, the beneficiaries of the lottery were diffuse and generally not connected to the parties that had influence or a continuing relationship with the Commerce committees or the FCC. Lottery winners and "application mills" stood to lose from eliminating lotteries, but the winners had low expectation of repeat winnings, and the firms preparing the applications had little political clout, especially compared with the influence of broadcasters.

In addition to the attention of the windfall gains, the value of cellular licenses was significantly larger than had been anticipated at the time of the initial licensing. At the initial licensing, estimates were that 100,000 people would subscribe to cellular telephone service by the year 2000.<sup>32</sup> As such, it was not expected to be nearly the high value service it has turned out to be. In fact, by 1993, at the time of passage of OBRA 93, there were more than 16 million cellular subscribers making cellular a \$10 billion per year industry.<sup>33</sup> Projections at that time were that wireless would continue its double-digit growth.

Different members of Congress fared differently in the move to auctions. Those on the budget committees gained revenue (as did others concerned with non-communications programs) while those on the Commerce committees with FCC oversight lost influence over the licensing process. The FCC also gained status and revenue, and may have reduced licensing costs compared to the previous methods, but lost some of its political power over licensees and some of its ability to please members of Congress.

### **III. Auction Design and Rules**

Even though Congress gave the FCC auction authority, it did so with a tight leash: the requirements for "auctionability" were relatively narrow, the auctions were approved for only a limited period of time, and the FCC had a very short time in which to adopt auction rules and begin the first auction.

In OBRA 93, Congress gave the FCC only 210 days -- until March 8, 1994 -- to develop auction rules and another 4 months to begin auctions. In addition to severe administrative pressure, it was clear that delay in the introduction of new services would hurt

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<sup>31</sup> Kwerel and Felker (1985), Rosston (1994). The rules for sales of cellular licenses (47 C.F.R. 22.139) state that one cannot acquire a license for the explicit purpose of speculation or profitable resale, but do not prohibit the sale of bare licenses and was apparently not a significant issue during the post-lottery sales.

<sup>32</sup> Huber (1992) p 4.22.

<sup>33</sup> CTIA data survey available at <http://www.wow-com.com/professional>. Currently there are more than 55 million wireless subscribers.

consumers.<sup>34</sup> As a result, the FCC had to come up with a plan to implement rules for auctions and to run auctions within a very narrow period of time.

### *Bureaucratic Theory*

The task of designing and implementing auctions was formidable. The literature on bureaucratic theory provides a background for how one might expect a government agency to react to these challenges. There is a widespread public perception supported to some degree by academic literature that government bureaucracy is ill suited to undertake a project like the implementation of competitive bidding because it is inefficient, unresponsive, and unwilling to take risks.

"The [government] programs were costing too much, interfering too much with the private sector, and were not even working. The goals were said to be Utopian, the social techniques and knowledge inadequate, and the organizations for carrying out the programs were accused of being inefficient, irrational, noninnovative, unresponsive, wasteful, oppressive, and devoted to self-service or the service of narrow pressure groups."<sup>35</sup>

And

"The reward system is heavily biased against the risks of innovation compared with that of profit-making enterprises--the bureaucratic innovator who fails is crucified, while successful innovation has little payoff."<sup>36</sup>

Additional academic writings shed light on expected policy responses to a novel mechanism such as competitive bidding. In general, the conclusion is that risk-taking and innovation are not hallmarks of government agencies. Goodsell provides a brief summary of the negative portrayal of government bureaucracies in academic writings. In discussing the economic critiques of bureaucracy, he explains how the government does not generally face competitive pressures so has limited incentives to respond to market demand. In addition, incentives for increased budgets, control and power exacerbate the problem.<sup>37</sup> He then explains that sociologists believe "bureaucracy is perceived as inherently rigid, incapable of innovation, and riddled with fighting cliques and scheming careerists."<sup>38</sup> Finally, he characterizes policy analysts as having little faith in bureaucracy

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<sup>34</sup> Jackson, Kelley and Rohlf, (1991) and Hausman (1997) estimate the lost consumer welfare from the delay in cellular service.

<sup>35</sup> Barton (1980), p-27. See also, Peters (1980), p-36.

<sup>36</sup> Barton (1980), p-28.

<sup>37</sup> Goodsell (1985). See also, Tullock (1970), Niskanen (1973), Buchanan et al (1978) Niskanen (1980).

<sup>38</sup> Goodsell (1985). p-7.

because

"Bureaucrats, used to and committed to old policies, are characterized as not liking change and hence resisting or delaying action. Also, they are said to fail to define objectives, establish performance standards, gather sufficient information, predict program effects, and avoid political interference."<sup>39</sup>

McCubbins and Schwarz present a picture of congressional oversight that responds to alarms that signal problems and political opportunities.<sup>40</sup> Kettl argues that such oversight will lead to extreme risk averse behavior on the part of agency officials.<sup>41</sup>

As a result, the literature predicts that implementation of auction authority would be "safe" or non-risk-taking, inefficient, and protect the power of the agency. The next section examines the actual implementation in light of the theory.

### *Auction Design*

The FCC issued rules and successfully implemented a novel auction technique within a year of the passage of OBRA 93. Adopting a new method that had never been used outside an experimental setting was extremely risky for the FCC and contrary to conventional bureaucratic behavior. How and why did it happen in contrast to the pessimistic predictions drawn from the literature?

Three key factors were at work to ensure that auctions were implemented efficiently. First, the Chairman of the FCC was committed to adopt pro-competitive rules, especially with the intense scrutiny of such a large decision. Second, efficient auction design and revenue maximization generally coincided. Third, the requirements of the Administrative Procedures Act required a Notice and Comment period that ensured the input of interested parties in the auction design process.

The design and implementation of the FCC spectrum license auctions was a highly successful collaboration among academia (economists both theorists and experimentalists), industry (telecommunications industry executives and lawyers) and government (policy, legal, operational). The FCC staff alone could never have designed such an efficient auction without the input of academic economists.

### *Outsiders' Views*

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<sup>39</sup> Goodsell (1985). p-7.

<sup>40</sup> McCubbins and Schwarz (1984)

<sup>41</sup> Kettl (1992). P-98.

Each interested firm was seeking to acquire certain licenses at the least cost and to minimize its regrets.<sup>42</sup> Firms were also interested in acquiring licenses quickly. When the auction legislation passed, firms generally did not know what auction design would be in their best interest, and some hired leading auction theorists to help them determine their strategy. There was substantial debate among auction experts about the most efficient auction that was feasible for the FCC to implement. Moreover, given the diverse preferences of the firms hoping to acquire licenses, not all firms believed that a totally unbiased design was necessarily in their best interest.

Some firms hoped for nationwide licenses while others hoped to complement their existing cellular franchises.<sup>43</sup> MCI and others favored an auction that would facilitate the acquisition of a nationwide license.<sup>44</sup> Others such as Pacific Bell wanted licenses in specific geographic areas where they felt they possessed superior complementary assets and would value the licenses in those areas most highly.

### *Single Round vs. Multiple Round Bidding*

Sealed (single round) bidding where the winner pays the bid price was clearly inferior to multiple round bidding on a number of grounds.<sup>45</sup> It requires bidders to guess about valuations of other bidders, which can result in inefficient assignments if they guess wrong. It deprives bidders of the information about license common values contained in the amount bid by others. This can result in lower revenue as bidders shade down their bids to avoid the “winner’s curse” – winning because they most overestimated the license value. It can result in bidder regret if the winning bid significantly exceeds the next highest bid (“leaving money on the table”). A second price (Vickrey) auction has desirable efficiency properties in certain circumstances, but in addition to efficiency concerns when licenses have strong common value components and the complexity of applying it properly to multiple licenses, the publicity risk of using such an auction could be high. The unpopular results of second price auctions held in New Zealand provided a valuable lesson: avoid large gaps between the observed willingness to pay and the actual payment. With multiple round bidding, large gaps between the winning bid and the second highest bid are unlikely.

### *Sequential vs. Simultaneous Bidding*

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<sup>42</sup> There were 222 firms who filed comments and 169 who filed reply comments in the competitive bidding proceeding. The vast majority of those comments were not related to auction design, but rather to the issue of preferences for designated entities.

<sup>43</sup> The FCC ultimately adopted rules to prevent cellular operators from acquiring 30 MHz PCS blocks in their cellular coverage area.

<sup>44</sup> MCI had billions of dollars in cash at the time and did not own any existing licenses that would limit its eligibility or desire for a nationwide PCS license.

<sup>45</sup> See McMillan (1994).

The U.S. auctions were more complicated than previous spectrum auctions because multiple units were being sold that could potentially be complements, substitutes or both. This interdependency potential was a key concern in auction design. With multiple interdependent licenses, firms with the highest valuations would have no assurance of acquiring the combinations of licenses they wanted in an inefficient initial auction and would face the prospect of extended negotiations in the secondary market that would develop subsequently. Avoiding costly delays and high transaction costs in potentially inefficient secondary markets was a concern of both the FCC and participants.

Several firms (TDS, Bell Atlantic and MCI) favored sequential (as opposed to simultaneous) auctions. TDS seemed to favor sequential auctions because they felt it would favor their strategy of acquiring smaller license surrounding the large markets such as Chicago.<sup>46</sup> They wanted to be sure who would be the licensee in the "hubs" before they bid on the "spokes." Bell Atlantic (BA) and MCI seemed to favor sequential (or a mixed system in the case of BA) auctions largely because they believed that it would be administratively less complex and therefore more likely for the FCC to be able to implement quickly. Sequential auctions would reveal prices in the most valuable markets before requiring bidding to commit on other markets if the most valuable markets were auctioned first as Bell Atlantic advocated. MCI also supported a variant of the Commission's initial proposal<sup>47</sup> to provide for sealed bids for a nationwide combination of PCS licenses, presumably because MCI thought this would facilitate their plan to acquire a nationwide spectrum block.<sup>48</sup>

Pacific Bell, National Telecommunications and Information Administration (NTIA) and AirTouch (née Pacific Telesis Corp.) proposed the use of simultaneous multiple round auctions. This novel auction design was developed by Paul Milgrom and Robert Wilson consulting for PacBell and Preston McAfee consulting for AirTouch. While similar in their basic approach, they differed in one key respect – the closing rule. Milgrom and Wilson proposed a simultaneous closing rule -- the auction would stay open for all licenses until a round passed with no bids on any license. In contrast, McAfee proposed a license-by-license closing rule – individual licenses would close when bidding ended on that particular license. He also proposed a mechanism for adjusting the pace of bidding on individual licenses to increase the likelihood that all licenses would close at approximately the same time. In addition to proposing the use of simultaneous multiple round auctions, they responded with very detailed comments about actual implementation

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<sup>46</sup> TDS also controlled US Cellular with holdings concentrated in less urban areas. TDS participated in the auction as American Portable Telecommunications (APT). For an analysis of some of their bidding strategy, see Weber (1997).

<sup>47</sup> Notice of Proposed Rule Making in PP Docket 93-253, 8 FCC Red 7635 (1993).

<sup>48</sup> Comments of MCI, PP Docket No. 93-253, November 10, 1993, p.10-14. MCI ultimately chose not to participate in the broadband PCS auctions.

to ensure that the proposal was implementable. Paul Milgrom forcefully argued that simultaneous ascending bid auctions would assign licenses with interdependent values more efficiently than sequential auctions because they (1) maximized the amount of information available to bidders, and (2) permitted bidders to pursue efficient backup strategies as more information became available during an auction. The auction design was also likely to be perceived as fair because it ensured bidders that they would not be foreclosed from winning a license as long as they were willing to bid enough and that similar licenses would sell for similar prices.

The National Telecommunications and Information Administration, whose functions include advising the White House on telecommunications policy, proposed an alternative simultaneous ascending bid auction design that provided for package bidding, *i.e.*, all or nothing bids on groups of licenses, in addition to bidding on individual licenses. Their “iterative combinatorial auction mechanism” would be conducted electronically with bidding in real time, as opposed to the discrete bidding rounds in the designs proposed by Milgrom, Wilson and McAfee. Combinatorial bidding may promote efficient aggregation of licenses that are worth more as a package than individually, and may mitigate the risk to bidders of paying too much for part of a desired package while losing the rest of the package to other bidders.<sup>49</sup> We discuss combinatorial auctions further below.

### *Inside the FCC*

A fundamental question was could the FCC implement a simultaneous auction, and if so how? If the agency was to adopt a novel auction design over traditional “tried and true” designs, such as oral outcry or sealed bids, the Chairman needed to be convinced of two things. First, it was feasible for the agency to develop and implement a new auction design within the one-year statutory deadline, and second, such an auction would significantly improve efficiency as compared to traditional auction designs. The greater potential payoff had to be large enough to offset the much greater risk of implementation failure.

The auction legislation constrained what could be auctioned -- much of the Second Report and Order addressed the question of what services are auctionable -- and to some extent how they could be auctioned. A large part of the legal analysis went into crafting the provisions for designated entities. The Commission faced the difficult task of implementing the statute without exposing itself to excessive risk of reversal or stay in court. Legal analysis was needed to ensure that the Commission had statutory authority for its rules and that proper procedures were followed in issuing the rules. The main

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<sup>49</sup> Comments of U.S. Department of Commerce, National Telecommunications and Information Administration, PP Docket No. 93-253, November 10, 1993. The details of their analysis was provided in Attachment 1, Mark Bykowsky and Robert Cull with assistance from William Maher, “Issues in Implementing a Personal Communications Services Auction,” Office of Policy Analysis and Development, Staff Paper.

procedural issue was whether affected parties had adequate notice as required under the Administrative Procedures Act. To a large extent the lawyers acted to ensure that we could find a legal way to implement good policy.

The following examples illustrate some of the legal complications in choosing an auction design:

- (1) Up-front payments are essential to ensuring sincere bidding. We justified requiring up-front payments under general auction authority to implement alternative auction designs, even though we did not have explicit statutory authority.
- (2) We could not pay interest on up-front payments because we did not have statutory authority.
- (3) At the insistence of the Office of General Council ("OGC"), we changed bid withdrawal "penalties" to bid withdrawal "payments" because of different statutory treatment of payments and penalties.
- (4) We were not able to provide minimum opening bids in the regional narrowband auction because we had not provided adequate notice. Commission lawyers also raised the issue of the legality of using a minimum opening bid because it could result in charging for a license when there may not truly be mutually exclusive applications.
- (5) OGC argued that the simple combinatorial bidding mechanism that Commission staff initially proposed violated OBRA 93. Because the Act prohibits expectation of revenue as a consideration "to assign a band of frequencies to a use," the OGC said that we could not determine whether to issue a *national license* or individual licenses based on whether the sum of the high bids for the individual licenses exceeded the high bid on a national license. However, we can award *all* the *individual* licenses on the same frequency block to a single party if that party places a single bid that exceeds the sum of the high bids placed individually on each license.

One of the unknowns at the outset was the types of aggregations bidders would desire. We originally thought that the major bidders would be firms such as AT&T and MCI with no cellular properties and that the most important aggregation would be nationwide.

We were wrong about this.<sup>50</sup> AT&T purchased McCaw and MCI decided not to enter the auction. Major bidders were firms who already held cellular properties and to whom sub-national aggregations were very important.<sup>51</sup>

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<sup>50</sup> It should be noted that predictions regarding auction participants and bidding behavior have been highly inaccurate. For example, despite claims of most SMR incumbents that no one else would bid in the SMR auctions, PageNet, a non-incumbent, was a surprise major bidder in the 900 MHz SMR auction, in part to supplement its adjacent paging frequencies.

<sup>51</sup> Nationwide coverage appears to be important with the introduction of programs like AT&T's Digital One Rate, but the need for a nationwide PCS license is not necessary with multi-mode handsets.



Throughout the auction design process we had to address the question of how good is good enough. What is the likely benefit of some additional refinement in the auction design? For example, we proposed, but ultimately did not implement, a suggested minimum bid. The idea of the proposal was to get the auction off to a fast start without running the risk that the minimum opening bid exceeded the market value of a license. Under one proposal bidders would not be required to bid above the suggested minimum bid but if they bid less and another bidder bid more, their bid would not count as activity. The programmers writing the code for the auction software strongly opposed making the programming changes to implement the suggested minimum bid, and the benefits from introducing it did not seem worth the risk of significantly delaying the software development or reducing its reliability. Since then, BBA 97 requires setting a minimum opening bid or reserve price absent a compelling reason not to.<sup>52</sup> The Commission has chosen to implement a simple minimum opening bid, not the complex suggested minimum bid where a bidder's eligibility could depend on the amount bid by others.

### *Outside Works With Inside*

There was extensive dialog between FCC staff and outside auction experts throughout the development of the FCC spectrum auctions. This dialog led to significant modifications of the auction proposals. The genesis of the Milgrom-Wilson activity rule is perhaps the best example. The initial PacBell auction proposal, developed by Paul Milgrom and Robert Wilson, provided for a simultaneous auction closing -- all markets would remain open until a round passed with no bids -- but had no mechanism to ensure active participation by bidders. FCC staff was concerned that such an auction might take an inordinate time to complete. Bidders in a simultaneous multiple round auction would have an incentive to hold back, waiting for other bidders to generate information about likely equilibrium prices. With an auction that remained open on all items until there was no bidding on any item, there was little chance that a bidder who held back at the beginning of an auction would be foreclosed from bidding on a license later in the auction. Without some mechanism to prevent the auction from dragging on for many months or years, the simultaneous auction proposal was not acceptable. This concern was clearly communicated to Paul Milgrom in an ex parte meeting arranged by PacBell to discuss their comments on the FCC's auction Notice of Proposed Rulemaking (Auction

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<sup>52</sup> BBA 97 Sec. 3002(a)(1)C(iii) requires the Commission to "...prescribe methods by which a reasonable reserve price will be required, or a minimum bid will be established, to obtain any license or permit being assigned pursuant to the competitive bidding, unless the Commission on determines that e such a reserve price or minimum bid is not in the public interest." In the recent 800 MHz SMR and LMDS auctions, the FCC used minimum opening bids. 122 licenses were unsold at the conclusion of the auction and the FCC will have to determine when to re-offer those licenses. The Commission has the discretion to lower the minimum opening bid during an auction, but it has not, so it has been virtually equivalent to a reservation price.

NPRM).<sup>53</sup> Responding to this concern, Milgrom and Wilson developed a truly novel mechanism -- the activity rule -- to help ensure a reasonable pace of the auction.

While not important in the narrowband PCS auctions, the activity rule played a vital role in ensuring the timely completion of the MTA broadband PCS auction. Because of lower than expected bidding eligibility at the start of the MTA auction, the activity rule was not binding in stage I of the auction and bidding nearly ceased after 10 rounds. Bidding activity increased dramatically when stage II, with more stringent activity requirements, began in round 12. Without the activity rule the auction might have ended shortly after round 12, with revenue at 12% of the final total. Throughout the entire auction bidders tended to bid at the minimum activity level consistent with maintaining their eligibility.<sup>54</sup> Perhaps bidders would have behaved differently early in the auction had there not been additional stages of the activity rule. But the evidence supports the view that the activity rule was essential in forcing active participation in the auction and ensuring a timely completion. By imposing a cost on holding back (permanent loss of eligibility), the activity rule steers the auction between the danger of taking too long and the danger that it end too soon in a collusive equilibrium.

In addition to the many meetings at the FCC with outside auction experts, two conferences held in January 1994 offered particularly useful opportunities for FCC staff to interact with academic game theorists and experimentalists.<sup>55</sup> Both conferences provided extensive analysis of the best feasible design for PCS auctions, with emphasis on the relative merits of sequential and simultaneous auctions. At the NTIA/Caltech conference David Porter demonstrated an electronic simultaneous ascending bid combinatorial auction using the design proposed in the NTIA comments, and Charles Plott presented experimental results comparing sequential, simultaneous, and combinatorial auction forms.

### *Policy options*

The FCC's implementation of auction authority belies the characterizations of non-innovative, risk averse and inefficient bureaucrats. The implementation process was, of necessity, rapid. But it was also innovative and risky with the stated goals of maximizing welfare and minimizing *ex post* transactions costs. The cost of FCC implementation was also significantly lower than outside offers.

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<sup>53</sup> Notice of Proposed Rule Making in PP Docket 93-253, 8 FCC Red 7635 (1993).

<sup>54</sup> Cramton (1997)

<sup>55</sup> "Spectrum Allocation: Auction Designs and Their Potential Impacts," Sponsored by the Yale School of Organization and Management, Hosted by the Annenberg Washington Program of Northwestern University, Washington, DC, January 6, 1994; and "PCS Auction Design Conference," Sponsored by the National Telecommunications and Information Administration, and California Institute of Technology, Pasadena, CA, January 27 and 28, 1994.

In implementing its newfound auction tool, the FCC had to move quickly and carefully. The FCC issued the Auction NPRM within one month of the grant of auction authority.<sup>56</sup>

There was significant concern about failure, which would provide ammunition to auction opponents. As a result, it was important to ensure that the auction design would work and was robust to "gaming" by participants. Previous auctions in Australia, New Zealand and private auctions in the United States had been subject to serious criticism for real or apparent design flaws that led to outcomes perceived as inefficient or unfair.<sup>57</sup>

In the NPRM, the FCC proposed to use sequential ascending bid auctions for the award of the PCS licenses. Such a method could have been implemented in a very "safe" manner and ensured against a large fiasco and congressional second-guessing. It also proposed accepting sealed bids on a nationwide aggregation of licenses prior to the sequential bidding, and determining winners based on whether the sum of the highest individual bids exceeded the highest sealed bid. The NPRM also asked in very general terms about the possibility of using other competitive bidding mechanisms such as simultaneous auctions and combinatorial bidding.

Options for broadband PCS ranged in complexity from a simple sealed bid auction to simultaneous multiple round auctions with full combinatorial bidding. In between, ranked in order of complexity, were oral (ascending bid) sequential auctions, Japanese sequential auctions with combined bidding on licenses in the same market, simultaneous multiple round auctions with license-by-license closing, and simultaneous multiple round auctions with simultaneous closing. Additional options with the latter auction design included the form, if any, of activity rule, whether to permit bid withdrawals, and if so, with what penalty. In running the auctions we also faced tradeoffs between complexity and other objectives. For example, should we continuously adjust the minimum bid increments based on the activity level in the previous round or generally change the bid increment only several times during the course of the auction?

The comments of outsiders (in written form and in *ex parte* meetings) were critical in changing the Commission's initial conclusion to use sequential auctions to a decision to use simultaneous multiple round auctions. It was a highly interactive process with FCC staff raising issues and outside economic experts responding with increasingly specific and refined proposals. FCC staff economists became convinced that for broadband PCS, the best option was a simultaneous multiple round auction with a simultaneous closing rule as proposed by Milgrom and Wilson that permitted bid withdrawal subject to the penalty proposed by McAfee.<sup>58</sup> These judgments were made based on insights from

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<sup>56</sup> For the FCC to adopt auction rules requires a public notice and comment period to obtain the input of outsiders.

<sup>57</sup> McMillan (1994), Milgrom (1995).

<sup>58</sup> Milgrom and Wilson (1993b) and McAfee (1993a, 1993b)

auction theory (but not proofs) and data from CalTech laboratory experiments (but not data from experiments that replicated the exact environment).

After the evaluation, the staff had to sell it to the Commissioners. Reed Hundt, who was sworn in as chairman in November 1993 was committed to meeting the congressionally mandated auction deadline, but he was willing to take the risk of using a novel auction design if it was likely to produce better results. He asked the staff not what was the safe approach, but what was the best approach.<sup>59</sup> Some senior FCC officials were (with good reason) concerned that it was too risky to conduct the first FCC auction using a technique that had never been tried. (A simplified version was tested in an experimental laboratory at Cal Tech). They did not want the FCC to be "a beta test site." On the other hand, the staff believed that simultaneous multiple round auctions were the best approach and if we didn't use them for the first auction, we might never use them. The activity rule was the hardest sell. It was difficult to understand and seemed excessively complex, but could be critical to the success of the broadband PCS auction.

According to the theory of bureaucracy outlined above, a risk-averse agency would have chosen the "tried and true" approach of sequential auctions and relied on secondary market transactions to attempt to correct for inefficient initial allocations.<sup>60</sup> However, the agency listened to outside experts and in-house advocates of the potential efficiency enhancing feature of the simultaneous multiple round auctions and chose the operationally riskier strategy that more closely met its stated goals of efficiency and welfare maximization. In addition to the outside game theorists, Chairman Hundt's desire to implement a procompetitive, efficient auction was significant. He pushed to get to the efficient answer, but wanted assurances the system would work and the future of auctions would be safe.

The theory of congressional oversight indicates that there would be significant scrutiny of problems with an auction, but very little of success. In fact, there was some congressional scrutiny of the decision to choose innovative auctions design and manage the implementation process in house. Senator Conrad Burns (R-MT), an auctioneer before his election to the U.S. Senate strongly encouraged the FCC to hand the auction process to a professional auction firm rather than to develop and implement new and untried

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<sup>59</sup> Other Commissioners and their staffs focused most of their attention on whether the band plan and system of preferences (including bidding credits and time payments) would be adequate to meet the congressional requirement of ensuring designated entity participation. This is not to say that they totally ignored questions of auction design. They were interested in seeing the auctions successfully implemented and were concerned that the design not be excessively complex, but they trusted the economists and auction team regarding auction details.

<sup>60</sup> By risk, we mean operational risk of running the auction. The chances of the systems underlying the operation of the simultaneous multiple round auction failing were much greater because of the additional complexity compared to systems required to run a sequential auction.

techniques.

Overall, the FCC belied the predictions of bureaucratic theory by adopting a risky approach to auction design. Not only was the action risky, but it required a change in approach from the method proposed initially. The comments of outside parties were critical in providing both the innovative design and the confidence that the design was feasible.

#### **IV. Implementation**

At the same time it was making auction design decisions, the FCC began to assemble the expertise to run auctions. The agency had to be sure that auction design would work in practice. The literature, however, predicts that the agency would be very inefficient in implementing the auction design.

The FCC used a combination of in-house and outside expertise in designing and implementing the competitive bidding decisions. The FCC determined that utilizing outside firms with specific skills would complement the decisions requiring FCC attention. The FCC directed the implementation process, relying on outside firms to implement specific portions such as the development of programming code, or coordination of auction publicity. The three major reasons for this approach were the complementary nature of auction design and spectrum policy, the difficulty of specifying a detailed contract with appropriate goals and monitoring, and the cost.

##### *Link between Auctions and Spectrum Policy*

The Commission chose to contract out only limited parts of the auction implementation because it wanted to closely coordinate auction policy with overall spectrum policy. The Commission needs to be able to balance auction design goals, such as simplicity and vigorous competition for licenses, with other spectrum policy objectives, such as vigorous post-auction competition for wireless services. While many analysts have argued that the FCC has historically done a poor job of promoting competition in spectrum-based services, Chairman Hundt made the promotion of competition a strong goal of the PCS allocation and auction process.<sup>61</sup> It would have been easy to design a simple and efficient auction had the FCC decided to allocate a single nationwide license for the entire 120 MHz of PCS spectrum. However, the goal of increasing competition for mobile radio services ruled out the idea of a single 120 MHz license. It also would have been less important to design an efficient initial auction if there were an efficient secondary market.

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<sup>61</sup> See Hundt (1997b) “But don’t we all agree that the market itself should set the number of competitors in a market? Governments should never do that. No one thinks the FCC should limit the number of companies in the software business, or the microprocessor industry, or the pizza delivery business, or even telephone equipment manufacturing. So why should we limit the number of companies in wireless? Yet that is what it would mean to stop or slow spectrum auctions.” See also, Hundt (1997a).

However, because of the limited amount of spectrum, diverse private valuations, and the complexity of efficient geographic aggregation of spectrum it was important to get licenses in the hands of those who valued them most highly at the initial stage.

There was also concern about how to allow cellular carriers to expand their services without preempting competition. This led to multiple geographic areas so that cellular carriers could provide PCS "out of region" to complement their cellular service. Multiple licenses and multiple geographic areas, and the fact that transactions costs are non-zero, required a more complex auction mechanism. The number of licenses auctioned at once depends on the ability of an auction mechanism to assign the licenses efficiently as well as the amount of competition desired.<sup>62</sup> Therefore, the auction design and the policy decisions for numbers and sizes of licenses are inextricably linked and it would be difficult to delegate this to outside firms.

Finally, only the Commission could make the policy tradeoffs in implementing the requirement of OBRA 93 that small businesses and businesses owned by women and minorities "are given the opportunity to participate in the provision of spectrum-based services." There was no well-established auction mechanism in the private sector for addressing this congressional concern. Given the tight congressional deadlines the commission had to decide how many resources to devote to addressing these concerns versus other auction objectives. There was no existing menu of designs from which to choose.

As auctions become more routine, contracting auction implementation becomes more feasible. With the initial auctions, both the design and implementation were novel so that the intertwining of the decisions was critical. As auction capabilities increase and policymakers become more comfortable with those capabilities, the available auction technology puts less of a constraint on spectrum policy decisions.

Even in the initial implementations, much of the work was undertaken by outside contractors. But most of these decisions were for the implementation and execution of FCC rules, rather than for the development of the auction design.

### *Contracting problems*

There are both legal and practical problems with contracting for the design and implementation. All FCC decisions must go through a "notice and comment" procedure.

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<sup>62</sup> Efficiency might have been increased if all (blocks A-F) of the broadband PCS licenses had been auctioned at once. The FCC decided against this for two reasons. First, the number of licenses would have increased the difficulty of running the auction for both bidders and the FCC. Second, the constitutionality of preferences for designated entities on the C and F blocks was in question and combining those licenses with the others could have risked court stay of the entire process.

The FCC believed that auction rules had to go through this process because they were related to the determination of the award of a license. As a result, even if an auction firm had been contracted to design the auction rules, its decisions would have been subject to the notice and comment procedure. In addition, the hiring of a firm to do the work could have taken a significant amount of time because of government procurement rules.

Aside from legal considerations, contracting could have been very difficult given the unknown scope of the work, conflicting goals and difficulty of monitoring successful performance. Congress set forth an explicit requirement that revenues not be a primary consideration in designing auctions. Efficiency could not be the Commission's only goal, because it often conflicted with the congressional goal of ensuring participation by small businesses and businesses owned by women and minorities. Moreover, even if efficiency were the only goal, writing and enforcing a contract to maximize it would be difficult.<sup>63</sup>

In addition, since the auction process was innovative and expected to be more complex than single unit auctions because of the interdependence of the items being sold, the future requirements of the contract would be difficult to determine. It is difficult to completely contract when circumstances are changing.<sup>64</sup> With a new and innovative design, it is very difficult to write complete contingent contracts, and especially to continue to maintain alignment of incentives throughout the process.

In most proceedings, the Commission writes the rules and the regulated firms must figure out how to make their businesses conform. In the case of auctions the Commission had to implement its own rules and to test the rules under realistic circumstances.

Throughout the rulemaking process the Commission could have decided not to use simultaneous multiple round auctions if they proved to be complex. One could not be sure this novel design would be used until the Public Notice announcing the nationwide narrowband PCS auction.

Finally, delegating the entire process to third party contractors might have engendered more congressional scrutiny. As discussed in the preceding section, Congress opposed auctions because of the control over the licensing process. Further ceding control to

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<sup>63</sup> Even writing a contract with incentives for revenue maximization is difficult with imperfect information. For example, it may cost more and be riskier for the contractor to design a better auction. With imperfect monitoring, the FCC would not know if the contractor were maximizing expected revenues or accounting for its own risk profile which might differ from the government's. To some extent the repeated nature of the interactions between the contractor and the government reduces the difficulty of enforcing contractor performance. Of course, the existence of moral hazard problems with contractors does not necessarily imply that government provision is superior, since running a program with government employees does not perfectly align incentives. Government managers cannot be perfectly monitored and do not necessarily act to maximize the public welfare. See Niskanen (1973).

<sup>64</sup> Williamson (1989)

outside parties might have led to additional scrutiny of any problematic decisions.

### *Cost*

Much of the bureaucracy literature is concerned with government inefficiency and unwillingness to take risks. The FCC's auction implementation provides a counter example to this general theory.

Several firms offered to provide "turnkey" solutions to the FCC for auction design and implementation. The majority of these offers were standard auctions for a percentage of the total revenue raised.<sup>65</sup> With the auction revenues, even the low end of the offers of 3% would have been significantly more than it has cost the FCC to date in auction implementation.<sup>66</sup> As of Sept. 1997 the total cost of the auction program was \$74 million which was .62% of the \$12 billion in auction revenues collected to that point.<sup>67</sup> These significantly higher offers may have been due to uncertainty over the amount of revenues, or different risk profiles of the firms.

These offers were not simply for much more money than it actually cost the government to run the auctions. They proposed very different auctions than the simultaneous multiple round format because they did not consider the spectrum policy impacts. The auction firms were concerned with running a fast, high revenue auction with no problems. Proposals ranged from a simple open outcry auction, to an electronic sequential auction. More recent proposals have been similar to the SMR format, and the FCC has out-sourced design proposals for more sophisticated auction formats including combinatorial bidding.<sup>68</sup>

### *Implementation*

- August 10, 1993  
President Clinton signs Omnibus Budget Reconciliation Act
- September 23, 1993  
FCC adopts NPRM proposing Auction rules
- November 29, 1993

<sup>65</sup> The proposed compensation typically also provided for direct reimbursement of certain well-defined expenses such as publicity. This is the typical method of compensation for auction contractors.

<sup>66</sup> The 3% figure refers to a recent offer by an outside contracting firm after significant information has been revealed about how to run the auctions and about the value of the spectrum. They proposed to use a novel combinatorial bidding system that they had employed for tradable emission rights. Initially, GSA, while not a private firm, made a proposal to the FCC to run the auctions for a fee of 15% of auction revenues. The 15% figure is typical of what traditional auction houses, such as Sotheby's and Christie's, charge.

<sup>67</sup> See FCC Report to Congress on Spectrum Auctions, September 30, 1997

<sup>68</sup> Charles River Associates and Market Design, Inc. (1997b, 1998)



Reed Hundt sworn in as chairman of the FCC

- March 8, 1994  
FCC adopts general auction rules (Second Report and Order)
- April 20, 1994  
FCC adopts auction rules for narrowband PCS (Third Report and Order)
- June 29, 1994  
FCC adopts auction rules for broadband PCS (Fifth Report and Order)
- July 25, 1994 - July 29, 1994  
FCC conducts first spectrum license auction (10 nationwide narrowband PCS) using electronic simultaneous multiple round bidding at a single auction site.
- July 28, 1994 - July 29, 1994  
FCC holds open outcry auction for 594 IVDS licenses
- October 26, 1994 - November 8, 1994  
FCC auctions 30 regional narrowband PCS licenses with remote electronic simultaneous multiple round bidding as well as on-site bidding.
- December 5, 1994 - March 13, 1995  
FCC auctions 99 MTA broadband PCS licenses with remote electronic simultaneous multiple round bidding as well as on-site bidding. Virtually all bidding is conducted remotely.

Much of the auction programming was developed by outside contractors with constant supervision and guidance by FCC personnel. Different contractors were hired to run various auctions and serve as the "auction contractor" with a very specific scope of work. In addition, the FCC hired a programming company to write (and subsequently modify) the auction software.

The FCC maintained control of the auction design with substantial outside input (see below), was able to coordinate spectrum policy decisions relating to the PCS band plan<sup>69</sup> and to get the benefit of efficient, short-term help on auction specific projects.

To provide assistance in the development and implementation of auctions the FCC hired several outside consultants -- two auction theorists (John McMillan and later Peter Cramton), a team of experimental economists from CalTech (John Ledyard, Charles Plott and David Porter) and an auctioneer (William Stevenson). McMillan provided significant advice to the FCC staff economists in evaluating the outside proposals and added credibility when making the case in favor of simultaneous multiple round auctions. Subsequently, Cramton provided both advice on modification of details of auction rules

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<sup>69</sup> *Memorandum Opinion and Order*, in GEN Docket 90-314, released June 13, 1994.

and developed a tracking tool for use by bidders during the course of the auction.<sup>70</sup>

Stevenson provided the credibility of an experienced auctioneer and practical advice in the day-to-day running of the auction. CalTech provided invaluable help to the auction contractor for the first simultaneous multiple round auction: translating the FCC auction rules into software code, testing the software used in the first and second narrowband auctions, and providing a manual back-up and real time check of all calculations during the first FCC auction.<sup>71</sup> As one senior FCC official put it, "it [the CalTech backup and checking during the first auction] is like flight insurance. If the airplane doesn't crash, you are annoyed that you wasted your money, but you get over it."

Overall, the FCC's actions contradict the theory of bureaucracy. The FCC adopted a novel and untried approach to competitive bidding that was likely to achieve more efficient license assignments than any of the feasible alternatives, implemented it rapidly, and relied on outside advice rather than attempting to maximize the size of its own staff.

In order to gain experience in the use of simultaneous multiple round auctions, the Commission first decided to use the process for the award of 10 nationwide narrowband PCS licenses.<sup>72</sup> The choice of the first licenses to auction was critical to the long-term success of the auction program. The FCC staff believed that the first simultaneous multiple round auction had to be a success if the FCC was to continue using this auction method (and possibly auctions at all). The first auction also had to be sufficiently simple that the FCC could implement it quickly with no prior experience. It had to be of sufficient value that the auction would be perceived as a success if implemented well but not of so much value that a failure would cause significant damage. With 10 nationwide licenses, if the software failed, it would have been possible to slow down the bidding process slightly and to proceed manually.

The FCC also held a traditional oral sequential auction for Interactive Video Data Service (IVDS) during the same week. In part, this provided a hedge against potential failure of the simultaneous multiple round auction. Ironically the risky novel auction method worked flawlessly and was considered a great success while the low-risk IVDS auction received some unfavorable press because of a high default rate after the auction. The high default rate was not a result of flawed implementation of the oral auction but of the low upfront payments -- to participate in the auction a payment of only \$500 per license was required. In setting the upfront payments staff thought that total auction revenue would be several million dollars when in fact bids totaled over two hundred million

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<sup>70</sup> The tool was provided in order to assist smaller auction participants in accessing information about the bidding as the auction progressed. Cramton was also part of a team from Market Design Inc. that provided a series of reports to the FCC on auction modifications beginning in October 1997.

<sup>71</sup> Plott (1997).

<sup>72</sup> See Cramton (1995) for an extensive discussion of the nationwide narrowband PCS auction.

dollars.

The second auction (regional narrowband PCS with 30 licenses) provided a test of the software and the procedures that would be used to auction the broadband PCS licenses.<sup>73</sup> Broadband PCS was believed to be of very high value so there could be a significant cost to delaying service to the public. But little would be gained if the auction software failed and service was delayed while software was debugged or if bidders contested the outcome, or if because of either software or design flaws the auction failed to award licenses to the bidders who valued them the most highly. The idea was to make the rules and the software as close as possible to what the Commission planned to do in the broadband auction.<sup>74</sup>

On December 5, 1995, the first broadband PCS auction began with one round of bidding per day to ensure that bidders had time to evaluate the other bids and to formulate their strategies between rounds. Over the course of the auction, as the overall number of bids declined, the FCC reduced the amount of time between rounds. The auction ended on March 13, 1995 after 112 rounds and \$7.7 billion in bids. Cramton (1997) discusses the results of the auction.

## **V. Auction Issues and Design Refinements**

A number of issues have arisen during the course of the auctions that have led to refinements of the auction procedures. Others have led to further study and are still ripe for refinement. Below, we discuss issues relating to defaults on installment payments, bid signaling, the pace of the auction, auction revenue and operational issues.

### *Background*

For the reader not familiar with the FCC auction process we provide a short description.<sup>75</sup> The initiated reader will probably wish to skip this section. Thirty days prior to an auction applicants must file FCC Form 175 (the “short form”) indicating the licenses on which they wish to be eligible to bid, ownership information, agreements with other parties/joint bidding arrangements, and eligibility for any preferences. Once the short

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<sup>73</sup> The software used for the nationwide narrowband PCS auction was not suitable and was completely rewritten between the July and October auctions.

<sup>74</sup> Thus, for example, a decision was made to use MHz-pops as the activity measure instead of MHz (treating each of the five regions as having the same population despite small population differences). Rounding the population in the regions would have facilitated bidders switching among regions without any significant other costs. By using MHz-pops a rounding problem was discovered in the software, which was corrected during the course of the regional auction.

<sup>75</sup> For a more detailed introduction see “Federal Communications Commission: All About Auctions,” FCC, Wireless Telecommunications Bureau, March 11, 1998, available on the FCC web site: [www.fcc.gov](http://www.fcc.gov).

form has been filed applicants for any of the same licenses are forbidden from communicating with each other about bids or bidding strategies.<sup>76</sup>

Two weeks prior to an auction, bidders must make their upfront payments, which determine their maximum eligibility to bid in any round. Each license is assigned bidding units based on the amount of spectrum available and the population within the license area.<sup>77</sup> The FCC sets a price per bidding unit for upfront payments.<sup>78</sup> The number of bidding units associated with a bidder's upfront payments determines the maximum number of bidding units on which a bidder may be active in any round of the auction. A bidder is considered active on a license in a given round if it has the standing high bid from the previous round or places a bid on the license in the current round. One week prior to the auction the FCC releases a Public Notice showing the parties qualified to bid, their bidding unit eligibility, and the licenses on which they are eligible to bid.

During the auction, the bidder's activity each round determines its eligibility in the subsequent round. To maintain eligibility, a bidder must maintain activity on a specified percentage of its eligibility.<sup>79</sup> A bidder can also maintain eligibility through the use of a limited number of activity rule waivers. The auction proceeds through stages of increasing levels of required activity. The FCC determines the high bid at the end of each round and posts minimum acceptable bids for every license in the next round. There is a chance for bidders to withdraw their high bids. The auction ends when a round has passed with no bidding on any licenses and no proactive waivers.

Five days after the close of the auction, winning bidders are required to make their down payments (5%-20% of their bids, depending on the bidder's qualifications and the rules of the auction). Bidders are then required to submit the "long form" applications, which are then subject to normal commission license award processing. At the time of license award, applicants are required to pay the remaining balance of their bids, or, if available, begin making installment payments.

#### *Defaults on Installment Payments*

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<sup>76</sup> This prohibition ends when winning bidders submit their down payments. The one exception under the FCC anti-collusion rule is for bidders that entered into a bidding agreement prior to submitting their short forms and disclosed this agreement in the short form. Such bidders are still subject to antitrust enforcement.

<sup>77</sup> The term "MHz-pops" was used in place of bidding units in the early auctions where the presence of incumbent licensees was less important. A 30 MHz license covering an area with a population of 1 million people has 30 million MHz-pops.

<sup>78</sup> In the A-B auction, the upfront payment price was \$0.02 per MHz-pop. Thus, an applicant wishing eligibility to bid on 30 million MHz-pops would submit an upfront payment of \$600,000.

<sup>79</sup> For example, with an activity rule of 2/3, a bidder would have to be active on 20 million MHz-pops to maintain 30 million MHz-pops of eligibility.

The biggest blemish on the implementation is clearly the default problems associated with the PCS “C” Block auction, which was intended to provide opportunities for small, minority and women owned businesses. The top three bidders in the auction (Nextwave, Pocket and GWI) have declared bankruptcy and the fourth largest bidder (BDPCS) failed to make the initial down payment. Their bids represented 75% of the \$10 billion in C block net bids.<sup>80</sup> The Commission was able to reacquire BDPCS’s licenses within two months of the close of the C block auction because the Commission declared BDPCS in default and never awarded it the licenses on which it had high bids.<sup>81</sup> The Commission has not been able to reacquire the licenses of the licenses of the three firms that declared bankruptcy after the award of licenses.<sup>82</sup> The final disposition of their licenses could be tied up in litigation for years.<sup>83</sup>

In this auction, the FCC created an “entrepreneurs” block and limited eligibility to entities with less than \$125 million in annual revenue.<sup>84</sup> In addition to limiting eligibility to this group, the FCC awarded bidding credits and installment payments. Initially, these preferences were tiered for a variety of different subgroups (e.g., small businesses owned by women or minorities received the most generous installment payments and bidding credits).<sup>85</sup> In response to the Supreme Court decision in *Adarand*, the Commission eliminated race and gender based preferences and substituted preferences based solely on financial size.<sup>86</sup> All bidders in the C block auction were eligible for installment financing.

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<sup>80</sup> Nextwave bid \$4.20 billion, Pocket Communications (through its subsidiary DCR) bid \$1.43 million, GWI bid \$1.06 million and BDPCS bid \$.87 million for a total of \$7.56 million.

<sup>81</sup> The net bids of \$.90 million in the reacquire exceeded BDPCS’ defaulted bid of \$.87 million.

<sup>82</sup> Most of the spectrum described by Pocket's licenses is currently available for licensing in the upcoming March 1999 auction. Over the objection of Pocket's lenders, the FCC put into effect Pocket's C Block election under the C block restructuring options. "Fourth Report and Order," FCC 98-176 (WT Docket No. 97-82), July 27, 1998. (Available on the FCC web page at [www.fcc.gov/wtb/auctions](http://www.fcc.gov/wtb/auctions).) This resulted in the cancellation of 31 of Pocket's 43 licenses and the fifty-percent reduction in the bandwidth on an additional 11 licenses. This leaves Pocket with one 30 MHz license and 11 15 MHz licenses. The Pocket lenders may continue to fight the cancellation of the licenses despite the rulings of a bankruptcy judge in November 1998, which recognized Pocket's election as a binding, unconditional election and which refused to continue a preliminary injunction that had temporarily prevented the FCC from alienating the licenses.

<sup>83</sup> When designing the installment payment plan the FCC believed that in event of default licenses would not be considered assets subject to the jurisdiction of bankruptcy court and could be revoked and quickly reacquired by the FCC. Had this analysis turned out to be correct, the delays and other costs associated with C block defaults would likely have been significantly less.

<sup>84</sup> Bidders could raise capital from non-controlling investors who exceeded these caps, but the “control group” had to meet the qualifications.

<sup>85</sup> The original C block rules provided for five different installment payment plans and three tiers of bidding credits. Small businesses were eligible for a 10% credit. Women or minority owned businesses qualified for a 15% credit, and small businesses owned by women or minorities were to be eligible for a 25% credit. *Sixth Report and Order*, PP Docket No. 93-253, FCC 95-301, July 18, 1995.

<sup>86</sup> *Sixth Report and Order*, PP Docket No. 93-253, FCC 95-301, July 18, 1995.

All “small businesses” (firms with gross annual revenues under \$40 million) were offered the most favorable installment payment plan, which was originally to be available only to small businesses owned by women or minorities. Licensees were required to pay 5% of the winning bid within 5 days of the close of the auction and an additional 5% at the time of licensing. Payment of interest only (at a rate equal to ten-year U.S. Treasury obligations) was required on the balance for the first six years. Principal and interest would be paid over the final four years. The three tiers of bidding credits that were adopted in the Commission’s original C block order<sup>87</sup> were replaced with a single 25% bidding credit for all small businesses. Virtually all bidders in the C block qualified as small businesses and received the most generous installment payment terms and the bidding credit.<sup>88</sup>

Because most parties qualified for the same preferences, one might expect them to have little effect on the net outcome of the bidding. This is true for bidding credits that simply translate the amount bid into an amount owed. However, installment payments can increase the default rate by raising bid prices. For bidders with limited assets, installment payments are like an option that can be exercised (by paying the installments) if the business turns out well and declined (by declaring bankruptcy) if it turns out badly. This option value increased bids and the probability of default since with higher bids there was a greater chance that profits would not exceed the amount paid.<sup>89</sup> Moreover, installment payments may have biased the assignment of licenses towards firms with the riskiest business plans because the option value would be greatest for such firms.<sup>90</sup>

As shown by other auctions with preferences, but without installment payments, it was the installment payments and not the auction mechanism that resulted in the problems of the C block. In the LMDS auction, there were bidding credits afforded to similar entities, but they were required to pay the balance of their bids at the time of licensing and none defaulted.

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<sup>87</sup> *Fifth Report and Order*, in PP Docket No. 93-253.

<sup>88</sup> One reason for this was that the Commission adopted a generous affiliation rule. In determining small business eligibility, the rules allowed the exclusion of revenues and assets of affiliates that qualify as entrepreneurs under the C block rules. As a result, the only cost to gaining the small business preferences was the creation of a new subsidiary. There was one C block participant that inexplicably did not do this. *Sixth Report and Order*, PP Docket No. 93-253, FCC 95-301, July 18, 1995.

<sup>89</sup> See Wilke (1997).

<sup>90</sup> The Commission faced an adverse selection problem because bidders have better information about their risks than the Commission and the bidders with the riskiest business plans were willing to pay the most for the loan that the FCC bundled with each license. This issue has been examined in the context of credit markets, see Stiglitz and Weiss (1981). Credit rationing – denying credit to high-risk applicants – is one method that has been used to address this market failure. The Commission for policy reasons chose not to perform any credit screening and offered the installment payment plan on the same terms to all license winners regardless of their risk characteristics.

## *Bid Signaling*

A second perceived problem with the auction has been the issue of bid signaling. There are two sub-issues: the use of trailing digits and the use of withdrawals. In the first set of auctions, bidders were able to bid any dollar amount to allow them to express their full willingness to pay and to help avoid tie bids. In some cases they used the final three digits of their bid in an effort to communicate with other bidders. For example, the digits might indicate the number of the market the signaler wants its rival to back off of, or the market it wants its rival to move to, or the market it will bid on in retaliation. Such signaling could potentially facilitate the coordination and enforcement of collusive arrangements to divide up licenses. Cramton and Schwarz investigate this problem in detail and conclude that in the DEF auction signaling strategies were used frequently by a small fraction of the firms and were sometimes successful.<sup>91</sup>

There is a relatively simple solution to this problem. The FCC has implemented “click-box” bidding.<sup>92</sup> Bidders are now able to raise the standing high bid by the minimum bid increment, or integer multiples of the minimum bid increment, but not to bid any other dollar amounts. So with this method bidders are unable to signal by the use of trailing digits. This constraint makes tie bids more likely, however. In cases where there are tie bids, the auction system considers the first bid entered during the round to be the high bid. Although this may be somewhat arbitrary, it should not cause significant efficiency losses because the difference in valuations between the bidders must be less than a single bid increment at that point. Moreover, tie bids rarely occur on the final bid. When a license nears its final value, there are usually two bidders contesting a market so that they will take turns in topping each other’s bid and not have tie bids.

Withdrawals were initially allowed to provide bidders a way out of a failed aggregation to reduce the risk of exposure.<sup>93</sup> The FCC realized that there was also the possibility of the strategic use of bid withdrawals.<sup>94</sup> Weber (1997) discusses the strategic use of withdrawals during the course of the AB auction.<sup>95</sup> In these cases, a bidder might bid on a license and then withdraw in the same round to signal to another bidder that the license is available, or to threaten the other licensee. The number of withdrawals increased dramatically in the DEF auction: there were 21 in AB auction, 48 in the C auction and

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<sup>91</sup> See Cramton and Schwarz (1998).

<sup>92</sup> Click box bidding was first introduced in October 1997 for auction #16 (800 MHz SMR). This is an example where the FCC should have moved more quickly to solve an apparent problem.

<sup>93</sup> Chakrovati et al (1997)

<sup>94</sup> *Second Report and Order*, PP Docket No. 93-253, FCC 94-61, April 20, 1994, paragraphs 146 -153..

<sup>95</sup> See also Cramton (1997) and Cramton and Schwartz (1998) for more in depth analysis of the strategic use of withdrawals in other auctions.

789 in the DEF auction. Since there is very little evidence that the withdrawals have been used to back out of failed aggregations, limiting the number of withdrawals would cause little harm.<sup>96</sup> As a result, the FCC has decided to limit the number of times during the course of the auction in which a bidder can submit withdrawals.<sup>97</sup>

### *Auction Speed*

Determining the optimal auction pace requires trading off the benefits of rapidly awarding licenses with the benefits of ensuring that licenses go to the parties that value them the most. In auctions with large numbers of licenses, the Commission deliberately sacrificed licensing speed when it limited the number of rounds per day in order to give bidders adequate time to process bidding information. The Commission has continued to look for additional ways of increasing the pace of the auction with minimal sacrifice in assignment efficiency.

*Larger bid increments.* The regional narrowband PCS auction would have concluded more quickly if the Commission had used larger bid increments, especially at the end of the auction. The theory was that small increments should be used toward the end to provide for more fine differences in willingness to pay.<sup>98</sup> The fear was that large bid increments could prematurely end the auction. We addressed this problem before the broadband auction by changing the rules to allow us to keep an auction open even if we received no bids in a round.<sup>99</sup> Later in the auction there is a concern about the small potential loss in efficiency and revenue if the minimum bid increments are too large. In addition, we wanted to avoid the possibility of bidders later coming to us with the claim that they were willing to pay more than the winning bidder (but not more than the minimum bid increment), but we had not given the opportunity.<sup>100</sup> Subsequently we concluded that we should raise bid increments at the end of the auction when only a few low value licenses were receiving bids. In this case the benefits from ending the auction more quickly were likely to outweigh the possible small efficiency loss on the few licenses with active bidding. The loss in benefits from delaying the close of an auction an

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<sup>96</sup> See Cramton (1997).

<sup>97</sup> For example, in the LMDS auction bidders were permitted to withdraw bids in any two rounds of their choosing. There was no limit on the number of bids that could be withdrawn in either of these rounds.

<sup>98</sup> McAfee (1993a) and Cramton (1994)

<sup>99</sup> *Memorandum Opinion and Order*, PP. Docket 93-253. FCC 94-295, November 1994. Prior to the rule change, the auction would automatically close when a single round passed in which there was no new acceptable bid on any license and no activity waiver submitted. The Commission argued in the *Order* that it needed the discretion to keep the auction open to allow the Commission to use larger bid increments without incurring the risk that the auction would close prematurely.

<sup>100</sup> Bill Stevenson of Kennedy and Wilson, who was one of the auction advisors during the nationwide narrowband auction, had told us on several occasions of the time that his auction firm was sued by a disgruntled bidder because the auctioneer had refused to accept a bid below the minimum bid increment.



additional day is likely to remain constant, but the efficiency gain from a better assignment is likely to decline over time as the number (and value) of active license declines. Moreover, the maximum efficiency loss from too large a bid increment on an individual license can be no greater than the size of the increment and the actual loss is likely to be significantly less.<sup>101</sup>

*Market specific bid increments.* The FCC implemented an “exponential smoothing” method to set minimum bid increments that depend on the number of bids a license has received in recent rounds. More bids will increase the bid increment because higher bidding activity signals that the license is below its market value relative to other licenses available.

*Better tailored activity requirements.* We discovered that the activity requirements were too lax at the beginning of the early PCS auctions and too stringent at the end. Both the regional narrowband and first broadband PCS (A & B block) auction rules required a bidder who wished to maintain its current eligibility in stage one to be active on licenses encompassing at least one-third of the MHz-pops for which it was eligible, in stage two on two-thirds, and in stage three on 100 percent.<sup>102</sup> In the first broadband PCS auction the stage one activity requirement turned out to be too low to induce aggressive bidding given the initial eligibility ratio of 1.93 (ratio of bidding eligibility to available spectrum in terms of MHz-pops). We also concluded that the stage three requirement was too stringent -- the benefits of additional flexibility to pursue backup strategies in stage three outweighed the cost of a slight reduction in auction speed. For subsequent auctions the Commission increased the activity requirements in stages one and two and reduced it for stage three. For example, in the C block broadband PCS auction the Commission adopted activity requirements of 60% for stage one, 80% for stage two and 95% for stage three.<sup>103</sup>

The activity rule was also modified to use bidding units instead of MHz-pops to account

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<sup>101</sup> An efficiency loss will occur only if the increment is greater than the difference in valuations of the two highest bidders and the sequence of bids happens to result in the bidder with lower valuation winning. Assuming a 10% bid increment and a 40% probability that the two highest valuations are within 10% the expected efficiency loss is only 1%. See Charles River Associates and Market Design, Inc. (1997a).

<sup>102</sup> A 30 MHz license covering 1 million people would require eligibility of 30 million MHz-pops. The upfront payment determines the initial eligibility level. Subsequent eligibility is determined by bidding activity. If the activity rule requires 50% activity, to maintain the current eligibility the bidder with 30 million MHz-pops of eligibility would have to have a combination of standing high bids and new bids on at least 15 million MHz-pops.

<sup>103</sup> It is not possible to efficiently set the activity rule percentages (the required activity as a percent of current eligibility necessary to maintain current eligibility) until after upfront payments have been received and we know the ratio of eligibility to available licenses. Nevertheless, the Commission has chosen to announce the activity requirements before upfront payments are received to avoid challenges that it did not provide sufficient notice of the rules.

for differences in licenses. This linked activity more closely to license value ensuring that the activity rule would promote the pace of the auction in terms of increases in total revenue. The revised metric also facilitated efficient backup strategies by treating similar licenses similarly. In the initial auctions, the presence of incumbents made some difference in the value of the licenses, but this became much more important in subsequent auctions. In the 900 MHz SMR auction, for example, some licenses for a given MTA were heavily encumbered, giving little rights to the auction winner, whereas others had no incumbents at all.

*Combine the bid submission and bid withdrawal period.* This allows the auction to proceed more rapidly with multiple rounds per day.

### ***Auction Revenue***

As discussed above, Congress' original decision to allow competitive bidding was explicit that auction revenue could not be a primary decision factor in determining the method of license award. In contrast, BBA 97 included a provision that explicitly attempts to increase revenue.

*Setting minimum opening bids.* BBA 97 requires the FCC to use a minimum opening bid or reserve price unless it finds this not to be in the public interest.<sup>104</sup> In response, the FCC now sets minimum opening bids. The FCC retained the discretion to reduce the minimum opening bids during the course of an auction, but has never done so. Thus the minimum opening bids have been equivalent to a reserve price.<sup>105</sup> In setting a reserve price, there is a tradeoff between increasing revenue when competition for a license is expected to be weak and having the government continue to hold spectrum from the market if the minimum is set higher than the market price. There were a number of licenses that did not receive bids in the LMDS auction and the Commission has yet to announce when it might again make those licenses available to the market.

### ***Operational and other issues***

*Allowing (and promoting) remote bidding.* In the first auction, all participants had to bid on-site. In the regional narrowband auction, most bidders used remote access, but had representatives locally or on site to ensure their bids. Since then, virtually all bidding has taken place remotely which allows bidders to continue with their day-to-day activities

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<sup>104</sup> Section 3002(a)(1)(C)(iii), BBA 1997.

<sup>105</sup> In an auction with an activity rule, a minimum opening bid can also act to speed up the start of an auction, even if bidders anticipate that it may eventually be lowered. With an activity rule, holding back until the minimum opening bid is reduced could result in the loss of activity waivers or eligibility.

during the course of the auction.<sup>106</sup>

*Improving bidding screens.* The auction software, and particularly the user interface, has been continually improved. The FCC has requested input from bidders, including holding debriefing sessions with large numbers of bidders after several auctions to assess their concerns and suggestions about the auction systems. One change that came before the move to click box bidding, was a warning to bidders about possibly mistaken bids. In a couple of cases when bidders entered their own bids, they added an extra zero, increasing their bid by a factor of ten. The system was modified to provide a check and warning if bids significantly above the minimum bid increment were entered.

### ***Balanced Budget Act of 1997***

BBA 97 extended the Commission's auction authority from 1998 to 2007 and expanded the set of licenses subject to auctions. Under OBRA 1993 before a license could be auctioned the Commission was required to determine the principal use is for services with paying subscribers. BBA 97 requires the Commission to use auctions to select among mutually exclusive applications with three exceptions: (1) public safety, (2) digital television licenses given to incumbent broadcasters to replace their analog television licenses, and (3) non-commercial educational or public broadcast stations.

### ***Future issues***

There are a number of issues that need to be studied to continue improving the performance of auctions and to adapt auctions to new situations. The FCC is studying some of these issues and moving forward to design and test some of the ideas. To study these issues and to begin implementation, the FCC has contracted for a series of reports and is in the process of awarding a contract for implementation design. These contracts are an attempt to follow the success the FCC had in soliciting comment on the initial auction design proposal.

*Design efficient auction when licenses exhibit strong synergies.* The auction rules used for PCS may not be appropriate when there are extreme synergies among license values and bidders have diverse preferences for license aggregations.<sup>107</sup> For example, in some bands, two alternative uses are satellite systems and terrestrial service. Satellite users seek to acquire nationwide blocks of spectrum. Although it may still be possible to provide satellite service even if licenses are not obtained for every geographic area, some seeking to provide satellite service may conclude that they do not want any licenses if

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<sup>106</sup> The DBS auction is an exception where the FCC ran two sequential auctions for DBS slots and desired to run the auctions extremely rapidly (to end in 1-2 days) so required bidders to be on-site.

<sup>107</sup> Bykowsky, Cull and Ledyard (1995) identify this problem with the current FCC auction design. For further discussion of these issues, see Charles River Associates and Market Design, Inc. (1997b, 1998).

they cannot obtain nationwide coverage. In contrast, prospective terrestrial operators generally seek to provide service in metropolitan area sized geographic areas or aggregate such areas but generally do not require nationwide licenses for a viable service.

The current auction mechanism is also not appropriate for the choice among mutually exclusive spectrum band plans or spacial allotments. At present, the FCC administratively solves the problem of choosing between mutually exclusive band plans, for example, one with all licenses containing contiguous spectrum blocks, and the other with all licenses containing pairs of separated blocks. Simply setting up an auction with each block as its own license and allowing pairing by the acquisition of two adjacent or two separated blocks without combinatorial bidding can lead to serious problems.<sup>108</sup> A more sophisticated auction design would allow bidders to choose between technologies that require inconsistent band plans in a way that is efficient. Such a design could also allow bidders to choose among mutually exclusive spacial allotments. For example, suppose that there are three potential sites for television stations: A, B and C. If a station is located at B it would interfere with stations at A and C. Thus the Commission can award licenses at A and C or at B.

Combinatorial and contingent bidding mechanisms would allow the auction to solve such problems. Combinatorial auctions provide for bidding for multiple licenses as all or nothing packages, as well as bidding on individual licenses. Contingent bids can be placed for individual licenses or packages of licenses and are contingent on winning or not winning other individual or packages of licenses. The range of packages for which bids are permitted may be defined by the FCC or bidders could be allowed to choose their own packages.

Combinatorial bidding may promote efficient aggregation of licenses that are worth more as a package than individually and simplify bidding strategy since bidders can avoid the problem of determining how to allocate the added value of a package among individual bids. Use of combinatorial bidding may mitigate the bidder's risk of paying too much for part of a desired package while losing the rest of the package to other bidders. The magnitude of this exposure depends on the specifics of the auction environment. Exposure risk is greatest when the value of a package is severely diminished by the absence of a single part. The risk of exposure is greater when bidders do not agree on how licenses should be combined. When bidders generally want the same packages of licenses, if a firm is outbid on part of a package it is likely to be outbid on the entire package, and thus not likely to be stuck holding a piece of a package that is of little value without the rest of the package.

*Continuous auctions.* The simultaneous multiple round auctions adopted by the

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<sup>108</sup> A competitive equilibrium may not exist with bidding on individual licenses with strong complementarities. Bykowsky et al. (1995) and Milgrom (1998).

Commission have discrete rounds. Bidders may place only one bid per license during a round. Other simultaneous auctions such as the AUSM (Adaptive User Selection Mechanism) mechanism provides for continuous bidding with random closing rules to provide incentives for bidders not to hold back. The revenue maximizing set of bids is calculated at the end of a discrete bidding round. A hybrid approach would be to allow for continuous bidding during the bid submission period in the FCC auctions, but still impose the activity rule on a round by round basis.<sup>109</sup> This may speed up the auction. Even though the activity rule would only apply to activity during an entire round, prices might rise more quickly than under the current rules. Under current rules the minimum acceptable bid in a round is based on the high bid from the previous round. Under a continuous auction the minimum acceptable bid in a round is based on the previous high bid, which would be greater than the high bid in last round if there were any new bids during the current round. Of course, the auction could be sped up under the current rules by increasing the number of rounds per day. However, continuous bidding gives bidders more control over the pace of the auction by permitting them to make multiple bids on the same license during a round. It should also be noted that faster is not always better. The Commission concluded that with high value interdependent licenses it was important for bidders to have sufficient time between rounds to assimilate information from the previous round and determine their next bids.

*Increase upfront payment as bids increase.* Setting upfront payments is very difficult because the value of the licenses are unknown (at least to the FCC). As a result, the FCC must make estimates of the ultimate value of the licenses. In the IVDS auction, the value estimates were significantly below the winning bids, and, as a result, the upfront payments were too small. One possible way to rectify this would to require large upfront payments. The only cost of this would be the foregone interest since the FCC cannot pay interest on the upfront payments. Another possibility is to require that during the auction bidders periodically increase their upfront payments based on the total value of their bids.

*Develop better policies to promote competition in bidding and in the provision of service post-auction.* As discussed above, the spectrum policy questions are important because of their interaction with the competitive bidding design. The FCC should try to ensure competition in both the provision of service and in the auction. Developing auction policies that result in efficient license award is one means of working towards these goals. However, there are other area that might lead to additional improvement in performance. For example, could we develop better rules for partnerships and alliances that would have resulted in more competition in the first broadband PCS auction? Should Primeco alliance have been prevented? Are there any reasonable rules that could do this without also preventing efficiency enhancing alliances (e.g., Wireless Co -- which provided synergies between cable and long distance providers). How could anti-collusion rules be clarified and refined? These types of questions are important to address both in the

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<sup>109</sup> These issues are discussed in Charles River Associates and Market Design, Inc. (1997a).

context of auctions and in spectrum policy in general.

## **VI. Conclusion**

The rocky and long delayed path to auction authority shows that economists do not always have significant influence on policy. However, the confluence of big budget deficits, visible spectrum value from the cellular lotteries and the inefficiency of the other methods of license award might not have led to auctions had economists not been advocating them for years and convinced key policy makers of their benefits.

Therefore, it was not a given that economists would wield significant influence in the auction design. However, Chairman Hundt delegated most of the auction design to the Office of Plans and Policy and just wanted to ensure the best solution, combining efficiency and practicality. The input of outside economists was critical to the process. They developed and proposed the novel simultaneous multiple round auction design and, in close collaboration with FCC staff, helped refine it into the mechanism that was ultimately used by the FCC. Because of the attitude of the Chairman, the input of outside economists, and the focus of most parties on the designated entity provisions, the agency was willing and able to follow the risky strategy of adopting an innovative approach to auctions.

The auctions have been very successful, but there are changes that have and can make them even more effective. The paper lists a number of changes that have been implemented and also addresses two of the problems that are most frequently brought up by auction opponents.

Since the input of outside economists was so important to the choice of auction design, the agency has been aggressive at continuing to solicit the input of auction experts. This advice was used in implementing the auction design and has led to contracts with outside firms for more advice, related in particular to auction refinements and to formats designed for combinatorial auctions.

Overall, the input of economists in the auction process has been significant. In addition, because of the initial participation and design by economists, economists are continuing to have significant influence on the future direction of the program. With a significant amount of spectrum to be auctioned in the future, such participation could be extremely valuable to the value of the spectrum auctioned.

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