and lost efficiency. Nonetheless, the expected benefits of more aggressive bidding by strong bidders may outweigh this cost:

> There is a trade-off. By favoring the low-valuation type of bidders, the seller raises the probability of awarding the item to someone other than the bidder who values it the most and receiving a relatively low payment. The benefit from this policy, however, is that the favoritism forces the bidders from the high valuation class to bid higher than they otherwise would, driving up the price on average.[34]

The intuition behind this result explains why sellers in an auction sometimes set a reserve price above their actual valuations. With an inflated reserve price, the sellers are in effect subsidizing themselves as bidders. Although an inflated reservation price can induce more aggressive bidding by unsubsidized bidders, sellers also increase the risk that they will sell the item back to themselves.[35]

To see the effect of affirmative action in a specific imperfect information example, consider a seller auctioning a single good between two potential risk-neutral buyers.[36] Assume that the reservation price for the first potential buyer (Strong) is drawn from a uniform probability distribution that is equally likely to take on any value between $100 and $300 million, and that the reservation price for the second potential buyer (Weak) is drawn from a distribution that is equally likely to take on any value between $0 and $100 million. Also assume that the seller's reservation price is known to be $0.

With only these two bidders in a traditional English auction with open ascending bids, Strong will always win, paying an expected price of $50 million (the price where on average Weak would stop bidding). In this simple auction, the weak bidder offers little competition to the strong one. As suggested above, the seller can encourage more aggressive bidding by entering a bid above its own $0 valuation: Setting a reserve price of $150 million increases the seller's expected revenue from $50 million to $112.5 million.[37]

A revenue-maximizing seller can still do better. The seller can induce even more bidding competition by subsidizing both itself *and* the weak bidder. As

34. McAfee & McMillan, *supra* note 22, at 715.

35. *Id.* at 715 n.19 ("The optimal reserve-price policy . . . can . . . be seen to be a special instance of this optimal discriminatory policy, with the seller discriminating between himself, as an implicit bidder, and the actual bidders."); *see also* Robert C. Marshall, Michael J. Meurer & Jean-François Richard, *The Private Attorney General Meets Public Contract Law: Procurement Oversight By Protest*, 20 HOFSTRA L. REV. 1, 8 (1991) ("The . . . reserve . . . force[s] vendors to bid more aggressively to ensure that they exceed the reserve. When a reserve has been optimally set, the potential *ex post* inefficiency from making no award is more than offset, in an expected sense, by the higher surplus generated from more aggressive bidding.").

36. This example is adapted from one found in Bulow & Roberts, *supra* note 23, at 1061. Uniform distribution examples also can be found in Roger B. Myerson, *Optimal Auction Design*, 6 MATH. OPERATIONS RES. 58, 59 (1981).

37. Three-quarters of the time, Strong will bid $150 million; the other quarter of the time, Strong will bid between $100 and $150 million, and the seller will retain the good (($150 × 0.75) + ($0 × 0.25) = $112.5). Setting a reserve price of $100 million would increase the seller's expected revenue from $50 to $100 million, because, under our assumptions, Strong will always be willing to bid at least $100 million. But our example shows that setting a reserve price above both the seller's and Strong's minimum value can be a revenue maximizing strategy. *See* Bulow & Roberts, *supra* note 23, at 1064-69.

originally derived by Myerson,[38] the optimal English auction should take the following form:

> The seller should set a $150 million reserve price, *i.e.* the minimum acceptable bid, and give Weak a $100 million bidding credit.[39]

With the bidding credit, Weak competes more vigorously with Strong because, for example, if Weak's value was $60 million, it would be willing to bid up to $160 million. Even though it is common knowledge that Weak's valuation is lower than Strong's valuation, the seller can use Weak to extract higher bids from Strong. In this revenue-maximizing auction, the seller's expected revenue rises to $120.83 million; the bidding preference for the weak bidder raises the expected revenue by more than $8.3 million.[40]

These enhanced expected revenues come at the expense of efficiency: As before, subsidizing weaker bidders creates the possibility that lower valuing

38. *See* Myerson, *supra* note 36. Myerson employed mechanism design techniques to derive the optimal auction design. He assumes there are n bidders and a single good being sold. (The analysis applies to multiple goods, so long as their values are not interdependent.). Bidder i's valuation v_i is known only to i, but it is commonly known among bidders that each v_i is drawn independently from the distribution F_i with density f_i.

In the symmetric case, where each valuation is drawn from the same distribution ($F_i = F_j = F$), the seller optimally treats the bidders the same, and the good goes to the bidder with the highest valuation v_i. Moreover, any of the standard auction forms (with the optimal reserve) maximizes revenue for the seller. Myerson shows that the seller optimally awards the good to the bidder with the highest value of $J(v_i) = v_i - [1 - F(v_i)]/f(v_i)$ (assuming J is increasing in v_i and J is positive for the bidder with the highest valuation v_i). *See id.* at 66. The second term, $[1 - F(v_i)]/f(v_i)$, represents the information rent going to the winning bidder. This is equal to the expected difference between the highest and second highest valuation.

In the asymmetric case, ($F_i \neq F_j$), the seller optimally treats bidders differently. In this case, the seller does not always award the good to the bidder with the highest valuation v_i. Rather, the seller manipulates bidders' incentives to increase competition among the bidders at the auction. More precisely, the seller optimally awards the good to the bidder with the highest value of $J_i(v_i) = v_i - [1 - F_i(v_i)]/f_i(v_i)$.

For example, if bidder i's valuation is uniformly distributed between a_i and b_i, then $F_i(v_i) = (v_i - a_i)/(b_i - a_i)$, $f_i(v_i) = 1/(b_i - a_i)$, and $J_i(v_i) = 2v_i - b_i$. *See* Bulow & Roberts, *supra* note 23, at 1067. Suppose there are two bidders, Weak and Strong. Weak's maximum valuation, b_w, is less than Strong's maximum valuation, b_s. According to the rule above, the seller awards the good to Weak if $2v_w - b_w > 2v_s - b_s$ or $v_w > v_s - (b_s - b_w)/2$. Since $b_s > b_w$, Weak is favored in the optimal auction because Weak will sometimes win even when Strong values the good more than Weak. In an ascending-bid auction, the seller implements this preference by giving similarly situated weak bidders a bidding credit of $(b_s - b_w)/2$.

39. For explanation of this form of auction, see Bulow & Roberts, *supra* note 23 at 1069-77.

40. In equilibrium, the payoffs for Strong and Weak average $47.92 million and $4.17 million, respectively. The bidding preference, however, induces inefficiency, because the weaker bidder wins the auction 3/16th of the time (and because the reserve price prevents trade 1/8th of the time). Without the bidding preference or the reserve price, Strong always wins and produces average "gains of trade" equaling $200 million. Without the bidding preference but with the $150 million reserve price, the seller inefficiently retains the good 25% of the time—the total gains of trade therefore fall to $168.75 million ((300 + 150) / (2 × 0.75) + (0 × 0.25)). With both the $100 million bidding preference and the $150 million reserve price, the average "gains of trade" are $172.92 million (gain from optimal auction = 120.83 + 4.17 + 47.92 = $172.92)—which represents 13.54% inefficiency; the gain from an English auction would be $200 (50 + 0 + 150). *See* Bulow & Roberts, *supra* note 23, at 1064-69 (discussing construction of an optimal auction). Bidding credits improve efficiency, holding the $150 million reserve price constant, because the auction without the bidding credit completely ignores Weak and instead promotes competition by subsidizing an even weaker bidder (the seller). The bidding credit allows the seller to use Weak to induce Strong to pay more. Trade occurs 7/8th of the time with the bidding credit, rather than just 6/8th of the time with the optimal reserve price alone.

owners will purchase the good. For example, if Weak's value is $80 million and Strong's value is $170 million, then Weak would win the auction with a bid slightly above $170 million (and would pay only slightly above $70 million).

In general, the size of the bidding that will maximize revenue depends on the seller's beliefs about the strong and weak bidders' relative valuations.[41] But this example has shown that a seller cannot do as well by merely establishing minimum acceptable bids. When a seller has imperfect information about the buyers' values, subsidizing weak bidders may be necessary to maximize the seller's expected returns.

E. *Affirmative Action Can Destabilize Tacit Collusion*

Fostering additional competition by subsidizing weaker bidders may also destabilize incentives for bidders to collude tacitly. The incentives for tacit collusion are particularly acute where multiple products are being auctioned: Rational bidders consider how bidding on one product may affect the price that they will pay on other products—and might accordingly bid less.

To see how tacit collusion occurs, imagine that Sprint and AT&T are competing for two licenses: one in Philadelphia and the other in Boston. To keep things simple, assume that it is commonly known that AT&T has a reservation price of $10 million for each license and that Sprint's reservation prices for the Philadelphia and Boston licenses are $8 and $7 million respectively. Also assume that without affirmative action, no other bidder would bid more than $2 million for either license.

How much money should the government expect to make from the simultaneous auctioning of these two licenses? If both AT&T and Sprint ignore the impact of their bidding on the other license's price, then the government should earn slightly more than $15 million—as AT&T would outbid Sprint to win both licenses.

Rational bidders, however, will consider how bidding on one license may affect the other license's price. Specifically, AT&T may decide to bid only slightly above $2 million for the Boston license and to refrain from bidding for the Philadelphia license. AT&T's strategy would be an implicit offer to Sprint to divide the markets: "We'll let you buy the Philadelphia license cheaply, if you let us buy the Boston license cheaply." Coupled with this implicit invitation comes an implicit threat: If Sprint bids to increase the price of the Boston license, AT&T will retaliate by bidding up the Philadelphia license's price.[42]

41. Whenever the valuation distributions have the same shape but different means, sellers seeking to maximize expected auction revenue will subsidize bidders with the lower mean. *See* McAfee & McMillan, *supra* note 22, at 715.

42. Sprint, rather than AT&T, might just as easily have made the tacit "offer" to collude by initially refraining from bidding on the Boston license. Tacit "offers" and "acceptances" were especially easy to implement in the regional narrowband auction because the licenses for different regions were auctioned simultaneously, allowing any colluder to monitor its counterparty's compliance with the "agreement." Collusive behavior is more difficult to coordinate during sequential auctioning of individual licenses, because there is a stronger incentive for the early auction winner to breach the agreement and to bid in the subsequent auctions.

If Sprint accepts this implicit offer, AT&T and Sprint will each purchase a license for slightly more than $2 million. Both parties have an incentive to abide by this market-division agreement, because they earn higher profits by coordinating their bidding behavior rather than by competing. AT&T does better by buying one license for a low price than by buying two licenses for relatively high prices. Without the tacit market division, AT&T's expected profit would be $5 million (because it would pay $15 million for licenses that it valued at $20 million). Dividing the market, however, increases AT&T's payoff to $8 million (because it buys a $10 million license for only $2 million).[43]

Affirmative action can destabilize this collusive equilibrium. If the government gave weak bidders a 67 percent bidding credit, weak bidders (with $2 million reservation prices) would be willing to bid up to approximately $6 million. Facing subsidized competitors, AT&T would no longer want to divide the market. Tacit collusion would now allow AT&T to realize only a $4 million payoff on the Boston license, while AT&T would earn $5 million by bidding aggressively on both licenses (buying one $10 million license for $8 million and the other for $7 million).

The moral of these reductive economic fables is quite simple: Subsidizing weak bidders can enhance a seller's auction revenue by forcing strong bidders to bid more aggressively. Bidding subsidies for weak bidders—far from being "giveaways"—can *prevent* giveaways by forcing relatively strong bidders to bid closer to their reservation prices. Nonetheless, the subsidies often cause inefficiency whenever the good is actually sold to a weak bidder. But this is a cost that revenue-maximizing sellers are willing to bear. Such sellers might consider the windfall that occasionally accrues to a weak bidder as a fee for enhancing the auction competition.

II. EMPIRICISM

A. *Describing the Licenses and the Auction Rules*

The FCC offered thirty licenses for sale in the regional narrowband auction: Six narrowbands of the radio spectrum (Frequency Blocks 1 through 6) were offered in each of five regions (Northeast, South, Midwest, Central, and West). Thus, each of the thirty licenses authorized transmission on a particular frequency block in a particular region.

Each frequency block was divided so that licensee pagers could both send and receive information. Two of the six licenses in every region (Blocks 1 and 2) were allocated 50 kHz for both incoming and outgoing messages ("50/50 blocks"), while the remaining four licenses (Blocks 3, 4, 5, and 6) were allo-

43. The market division also clearly helps Sprint because it would win neither license without the tacit restraint but earns $6 million by cooperating with AT&T (as it pays $2 million for a license that it values at $8 million). Tacit collusion therefore reduces the government's revenue by $11 million (from $15 to $4 million) and creates inefficiency by allowing Sprint to win the Philadelphia license even though its valuation of that license is lower than AT&T's.

cated 50 kHz for incoming transmissions and 12.5 kHz for outgoing transmissions ("50/12 blocks").[44]

The thirty licenses were sold in a simultaneous multiple-round auction, which is similar to a traditional English auction except that, rather than selling each license in sequence, a group of licenses is auctioned simultaneously.[45] In any round a bidder may bid on any of the licenses being offered, and the auction does not close until bidding has ceased on all licenses—that is, until a round goes by in which no one raises the prevailing bid on any license.[46]

The FCC changed the rules governing designated subsidies just before the regional auction. In the July 1994 auction for nationwide licenses, the FCC had granted designated bidders 25 percent bidding credits on three of the ten narrowband licenses.[47] The 25 percent credit, however, proved to be insufficient to allow any designated bidders to win a license—and most designated bidders dropped out after the first round of bidding.[48] The FCC responded by increasing the bidding credit in the regional narrowband auction from 25 percent to 40 percent.[49] The bidding credits could be used on ten of the thirty regional licenses: the five Frequency Block 2 licenses (a 50/50 block) and the five Frequency Block 6 licenses (a 50/12 block). Although the ten licenses subject to the designated bidding credit were not de jure set aside for designated bidders, the credit was large enough to create de facto set-asides.[50] Thus, we will refer to these ten licenses on Blocks 2 and 6 as "effectively set-aside" or simply "set-aside."

The FCC also allowed any designated bidder that qualified as a small business to pay for its license over ten years at an attractive interest rate.[51] The FCC required non-designated bidders to pay 20 percent of their winning bids within five business days of the auction's close, and the remaining 80 percent within five business days of the licenses' award.[52] In contrast, the FCC required a winning small designated bidder to pay 10 percent at the auction close and only 10 percent more upon the award of the license.[53] The remaining 80 percent would be financed by the government at the ten-year treasury bill rate of 7.5 percent. The designated bidder would only owe interest for the first two years and then would make equal quarterly installments for the next eight years to pay off the remaining interest and principal.[54]

Like the bidding credit, this installment program represented a significant bidding subsidy, because designated bidders could not borrow from private lenders on such favorable terms. The size of the subsidy can be calculated by discounting the installment payments to present value using a risk-adjusted interest rate. Finance economists equate the risk-adjusted interest rate with the market rate—in this case, the rate designated bidders would have to pay private lenders. Since private lenders possibly discriminate against designated bid-

44. Licenses of the same bandwidth that cover the same region should be perfect demand substitutes, with two qualifications. First, owning licenses with adjacent bandwidths within a particular region may be particularly valuable because a small guard band that prevents interference between adjacent licenses can be used for transmission by a single owner to increase its effective capacity. Peter C. Cramton, *Money Out of Thin Air*, 4 J. ECON. & MGMT. STRAT. 267, 275 (1995). Second, owning licenses in adjacent regions on the same frequency may allow a company to reduce disruption along the geographic border of the two regions. *Id.*

45. Some core aspects of the auction form were proposed by auction experts Paul Milgrom and Robert Wilson of Stanford University and Preston McAfee at the University of Texas. John McMillan, *Selling Spectrum Rights*, J. ECON. PERSPECTIVES, Summer 1994, at 145, 154. The simultaneous, open ascending bid format allowed bidders to switch among licenses. With sequential auctions, bidders must predict future prices when determining current bids. *Id.* at 153-54. The FCC's choice of the simultaneous, open ascending bid format is an extraordinary example of reliance on economic theory in the absence of empirical data. And the FCC's willingness to innovate probably increased government revenue by millions of dollars. *See* Cramton, *supra* note 2, at 35.

46. PAUL MILGROM, AUCTION THEORY FOR PRIVATIZATION (forthcoming 1996) (manuscript at 19, on file with the *Stanford Law Review*). To ensure that the auction would end within a reasonable time, the FCC imposed several ancillary rules, including minimum bid increments and an activity rule, which reduced a bidder's eligibility to bid in later rounds if it were inactive in early rounds. For details about the auction rules, see Implementation of Section 309(j) of the Communications Act—Competitive Bidding, 9 F.C.C.R. 5532, 5541-53 (1994) (Fifth Report and Order, PP Docket No. 93-253) [hereinafter Fifth Report & Order].

47. Third Report & Order, *supra* note 20, at 2968.

48. Results of the nationwide narrowband auction are located on the Internet at http://www.fcc.gov/pub/Auctions/PCS/Narrowband/Nationwide/finalbi d.txt. Although bidder identities were supposed to be confidential, most designated bidders physically left the auction site early in the bidding. Because it was relatively easy for big, established bidders to identify each other, the FCC made bidder identities public for the second auction.

49. Implementation of Section 309(j) of the Communications Act—Competitive Bidding Narrowband PCS, 10 F.C.C.R. 175, 201 (1994) (Third Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, PP Docket No. 93-253) [hereinafter Third Memorandum & Order]. The FCC also expanded the definition of what constitutes female or minority "control." In the nationwide auction, 50.1% equity ownership by women or minorities was required, but in the regional auction, women and minorities could create control groups which owned as little as 25% of equity as long as the group owned more than half of the voting stock. Implementation of Section 309(j) of the Communications Act—Competitive Bidding, 9 F.C.C.R. 5306, 5307 (1994) (Order on Reconsideration, PP Docket No. 93-253) [hereinafter Order on Reconsideration].

50. MILGROM, *supra* note 46, at 27. A designated bidder willing to pay $100 million for a license could bid as much as $167 million.

51. The installment plan was available to all "small businesses, including small businesses owned by minorities and/or women, on all regional licenses." Order on Reconsideration, *supra* note 49. The FCC announced the small business installment plan prior to the nationwide auction. *See* Third Report & Order, *supra* note 20, at 2978-79. After the nationwide auction, the FCC allowed designated bidders that did not qualify as small businesses to pay by installments at an interest rate "equal to the rate for ten-year treasury obligations, plus 2.5 percent." Order on Reconsideration, *supra* note 49. In the regional narrowband auction, however, the only serious bidders that qualified as small businesses were also designated bidders (i.e., Benbow PCS Ventures, Constant Touch Communication, InstaCheck Systems, PCSD, and Lisa-Gaye Shearing).

52. The FCC typically awards licenses within three months of the auction's close. Cramton, *supra* note 2, at 7.

53. Third Report & Order, *supra* note 20, at 2978.

54. Order on Reconsideration, *supra* note 49, at 5307.

ders,[55] the rate they are forced to pay in the market may not represent the true risk of nonpayment.[56]

Determining the appropriate risk adjustment with any kind of precision is extremely difficult. At most, we know that the government was extending credit as a secured lender with a 20 percent equity cushion. If a designated bidder defaulted, the government could easily foreclose and resell the licenses, but their resale value would be uncertain. Therefore, the government's primary risk as lender is that the licenses may be worth less than 80 percent of the auction price and that the proceeds of subsequent resale would not repay the government's loan. Much of this risk, however, may be diversifiable and therefore does not justify a higher risk premium.[57] In order to crudely estimate the installment subsidy, we assume that the risk-adjusted market rate for designated bidders would have been 12 percent—4.5 percentage points higher than the 7.5 percent ten-year treasury rate that the government actually charged.[58] We chose 12 percent because it approximates the actual cost of secured financing for two of the narrowband bidders (as well as the cost of funds for broadly similar high technology organizations).[59]

55. When considering an installment subsidy for designated bidders, the FCC found that, in passing the Small Business Credit and Business Opportunity Enhancement Act of 1992, Pub. L. No. 102-366 (1992),

> Congress . . . recognized that these funding problems are even more severe for minority and women-owned businesses, who face discrimination in the private lending market. For example, Congress explicitly found that businesses owned by minorities and women have particular difficulties in obtaining capital and that problems encountered by minorities in this regard are "extraordinary." A number of studies also amply support the existence of widespread discrimination against minorities in lending practices.

Fifth Report & Order, *supra* note 46, at 5573.

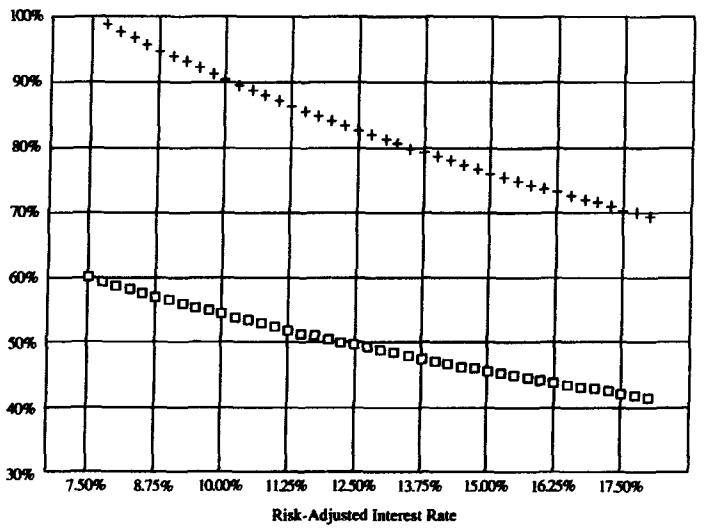
56. This suggests that the interest rate subsidy benefits the designated bidders more than it costs the government. This would be true if lenders demanded a risk premium of 8% even though true nondiversifiable risk would only justify a four-point premium.

57. The Capital Asset Pricing Model suggests that risk premia should only compensate owners for risk that they cannot avoid by diversification. RICHARD A. BREALEY & STEWART C. MYERS, PRINCIPLES OF CORPORATE FINANCE 161-66 (4th ed. 1991).

58. The 10-year treasury note rate itself overstates the risk-free rate: Treasury notes pay interest only at maturity, while the auction installment plan requires higher repayment levels in earlier years, when a lower risk-free rate would obtain.

59. PageNet, a substantial paging firm, had a bond maturing in 2002 with a yield of 11.75% at the time of the auction. Moody's Investor Service, *Corporate Bonds (U.S.)*, MOODY'S BOND RECORD, June 1995, at 81. The largest bidder's approximate cost of debt was 12%. Telephone Interview with Steve Lerner, Financial Analyst for PCSD.

FIGURE 1: PRESENT VALUE OF INSTALLMENT AND BIDDING CREDIT SUBSIDIES[60]



To illuminate the effect of this assumption on the size of affirmative action subsidies, Figure 1 represents estimates of the present value of the installment and of bidding credit subsidies for a range of possible risk-adjusted interest rates. The top line depicts how the installment subsidy alone affects the present value of designated bidders' payments, while the lower line depicts the combined effect of the installment subsidy and the 40 percent bidding credit.[61] At a 12 percent risk-adjusted rate, the present value of the installment payments equals 84.2 percent of the amount financed. This is the proportion of a winning bid that the government would receive if a designated bidder won any of the twenty regional licenses to which only the installment subsidy applied (i.e., Frequency Blocks 1, 3, 4, and 5). As for the ten set-aside licenses (Blocks 2 and 6), because of the combined effect of the installment subsidy and the 40

60. The present value of an installment subsidy for a particular risk-adjusted interest rate was calculated assuming that the government received 20% of nominal bid immediately, 7.5% of the nominal bid after both the first and second year, and 8.125% of the nominal bid in each of the remaining eight years. This cash flow was then discounted to present value for particular interest rates using the formula: present value of year n cash flow = (year n cash flow)/(1 + risk – adjusted interest rate)^n. The present value of all cash flows was then expressed as a percentage of the nominal bid. The line representing the present value of the installment subsidy and the bidding credit (expressed again as a percentage of the nominal bid) is simply 40% of the previous calculation.

61. The lower line is simply 60% of the upper line.

percent bidding credit, the government only receives 50.5 percent of the winning bids.[62]

B. *The Impact of Affirmative Action*

1. *Comparing the nationwide and regional results.*

Twenty-eight bidders participated in the regional narrowband auction; by round 12, only the twelve firms listed in Table 2 remained. Of these twelve, nine won licenses when the auction ended after 105 rounds.

TABLE 2. BIDDERS AFTER ROUND 12 IN REGIONAL NARROWBAND AUCTION

Non-Designated Bidders:	Designated Bidders:
Advanced Wireless Messaging (Advanced Wireless)	Benbow PCS Ventures, Inc. (Benbow)
AirTouch Paging (AirTouch)	Constant Touch Communications, Inc. (Constant)
Ameritech Mobile Services, Inc. (Ameritech)	Insta-Check Systems, Inc. (InstaCheck)
MobileMedia PCS, Inc. (MobileMedia)	PCS Development Corporation (PCSD)
PageMart II, Inc. (PageMart)	Lisa-Gaye Shearing (Shearing)
Radiofone Nationwide Paging Service (Radiofone)	
Westlink Licensee Corporation (Westlink)	

Two aspects of the auction outcome (Table 3) stand out: (1) four of the six frequency blocks sold as nationwide aggregates, and (2) eleven of the thirty licenses were sold to designated bidders. Not only did designated bidders win all ten of the "effectively set aside" licenses, but InstaCheck prevailed on the Block 5-South license, even though the 40 percent bidding credit did not apply.

62. As shown in Figure 1, if the appropriate risk-adjusted interest rate were 18%, the present value of the installment payments would be 69.4% and the value with both installment and bidding subsidies would be 41.6%.

TABLE 3. FINAL OUTCOME IN REGIONAL NARROWBAND AUCTION

(All values are net of applicable installment subsidies and bidding credits.)

Freq Block	Type (kHz)	Winning Bidder by Region					Present Value of Auction Revenue ($M)[63]	$ per MHz-pop	Percent Premium over Nationwide
		Northeast	South	Midwest	Central	West			
1	50/50	<-----PageMart won all regions----->					92.6	3.67	15.7
2**	50/50	<-----PCS Development* won all regions----->					76.6	3.03	-4.3
3	50/12	<-----MobileMedia won all regions----->					53.7	3.40	13.4
4	50/12	<-----Advanced Wireless won all regions----->					53.6	3.40	13.3
5	50/12	AirTouch	InstaCheck*	Ameritech	AirTouch	AirTouch	49.6	3.14	4.7
6**	50/12	Shearing*	Shearing*	Shearing*	Benbow*	Benbow*	44.8	2.84	-5.4
						Total	370.9	3.26	6.2

* Designated bidder (Woman/Minority bidder)
** Woman/Minority bidder received a 40% bidding credit on Blocks 2 and 6.

The present value of the government revenue—after taking into account both the bidding credits and installment subsidies—was approximately $371 million. Bidders paid an average of $3.26 per MHz-pop,[64] but as in the earlier nationwide auction, the 50/50 licenses were worth more per MHz-pop than the 50/12 ones.[65] Not surprisingly, after taking into account the bidding credit and

63. When non-designated bidders prevailed, the "Present Value of Auction Revenue" is simply their winning bids. When designated bidders prevailed, the figure is their winning bids multiplied by the appropriate discount factor. For all the licenses on Blocks 2 and 6, this discount factor was 50.5, which reflects the 49.5% installment subsidy and bidding credit. *See* text accompany note 62 *supra*. Estimating the present value of the auction revenue for InstaCheck's purchase of the Block 5-South license is complicated in two respects. First, because the 40% bidding credit did not apply to Frequency Block 5, only the 84.2% discount factor (reflecting the installment subsidy alone) was deducted from InstaCheck's $8 million final bid. Second, PCSD's crossover bidding on Block 1 not only induced PageMart to bid up the price of this Block 5 license, but later PCSD's decision to stop bidding on Block 1 induced PageMart to withdraw a prevailing $10.129 million bid on this Block 5 license and consequently, as required by the auction rules, to incur a $2.129 million penalty (the difference between its withdrawn bid and Instacheck's winning $8 million bid). Accordingly, the present value of the revenues generated for Block 5-South license was calculated to be: ($8 million × 0.842) + $2.129 million = $8.9 million. *See* Table 5 *infra*.

All bidding data referred to in this article are available on the Internet, either on the World Wide Web (http://www.fcc.gov) or by accessing fcc.gov by anonymous ftp. Information is organized in text or database formatted files. The data for round 12, for example, is at ftp://ftp.fcc.gov/pub/Auctions/PCS/Narrowband/ Regional/Round—012/s3—12.txt.

64. "Dollars per MHz-pop" is calculated by dividing the total revenue ($370.9 million) by both the population (252.6 million) and the number of megahertz auctioned (0.45). Population as of 4/1/90 from FEDERAL COMMUNICATIONS COMMISSION, BIDDER'S INFORMATION PACKAGE FOR THE REGIONAL NARROWBAND PCS AUCTION 3 (1994) (citing BUREAU OF THE CENSUS, U.S. DEPARTMENT OF COMMERCE, STATISTICAL ABSTRACT OF THE UNITED STATES: 1993, at 822 (113th ed. 1993)). For a given bandwidth, the "dollars per MHz-pop' measures how much a bidder is willing to pay per potential customer for a MHz license. For example, since Frequency Block 1 had a total width of 0.1 MHz (50 kHz incoming + 50 kHz outgoing = 100 kHz), a $ 3.67 price per MHz-pop suggests that PageMart was willing to pay approximately 37 cents per potential customer for 50/50 nationwide coverage.

65. In the nationwide narrowband auction, the 50/50 licenses sold for $3.17 per MHz-pop and the 50/12 licenses sold for $3.00 per MHz-pop. Nationwide auction data is located at ftp://ftp.fcc.gov/pub/Auctions/PCS/Narrowband/Nationwide/finalbid .txt.

the installment subsidy, the cost per MHz-pop of licenses purchased by designated bidders was lower than that of analogous licenses purchased by unsubsidized bidders.

The regional auction did, however, produce one surprising result: The price per MHz-pop was 6.2 percent higher than the price paid by bidders in the nationwide auction that occurred just three months earlier. This increase in the regional narrowband auction represents more than a $21 million increase in government revenue.[66] PageMart, MobileMedia, and Advanced Wireless paid significantly more for national aggregations than winners paid for identical licenses in the earlier auction. The increased prices in the regional auction are surprising because it is difficult to understand why the winners in the regional auction did not bid more when they participated in the national auction three months earlier.

Indeed, evidence from other auctions suggests that, when similar items are sold in sequence, the later items usually sell less than the earlier items.[67] This "declining price anomaly" has been observed in auctions for wine, timber, cattle, and satellite licenses.[68] Game theory provides three different reasons why we should have expected prices in the regional auction to be lower than the earlier national auction: risk-averse bidders, marketing advantages, and the difficulty of aggregating regional licenses. First, risk-averse bidders prefer the sure gains of winning today to the uncertain prospects of winning tomorrow. Such bidders, therefore, would be willing to bid more in the first auction than the expected sale price in the later auction.[69] Second, early resolution of uncertainty regarding a firm's spectrum capacity provides a tremendous marketing and development advantage. Being first to market in an unproven industry with substantial network externalities and significant switching costs has enormous value.[70] Third, because the later licenses were regional, a firm wanting to create a national paging system would probably pay a premium to avoid the

66. If the nationwide prices per MHz-pop had been realized in the regional auction, the two 50/50 frequency blocks would have each sold for $80.0 million and the four 50/12 frequency blocks would have sold for $47.3 million—generating $349.3 million, $21.6 million less than the actual regional revenues shown in Table 3 *supra*.

67. Orley Ashenfelter, *How Auctions Work for Wine and Art*, J. ECON. PERSPECTIVES, Summer 1989, at 23, 29-30 (describing the price decline anomaly at wine auctions).

68. R. Preston McAfee & Daniel Vincent, *The Declining Price Anomaly*, 60 J. ECON. THEORY 191, 192 (1993). There are exceptions to declining prices: Prices tended to increase in the sequential sale of Israeli cable television licenses. Neil Gandal, Sequential Auctions of Israeli Cable Television Licenses: An Empirical Test for Interdependent Valuations (May 25, 1995) (unpublished manuscript on file with the *Stanford Law Review*). Apparently firms were willing to pay more for later licenses because of *complementarities*. *Id.*

69. McAfee & Vincent, *supra* note 68, at 193 (noting that "[f]or a risk averse bidder . . . the randomness of utility from the final auction reduces his value and therefore increases the bid he is willing to make in the first period").

70. Fast resolution of spectrum allocation is so important that designated bidders recently petitioned the FCC to eliminate certain prospective affirmative action subsidies, which were to apply to the second broadband auction, in order to avoid litigation over the subsidies' constitutionality. *Text of "Affirmative Action Review' Report to President Clinton Released July 19, 1995*, 1995 Daily Lab. Rep. (BNA) No. 139, § 11.1.1 (July 20, 1995).

aggregation difficulties presented by buying five individual regional licenses on a single frequency block.[71]

Based on the above, we would expect prices in the regional auction to be lower than those in the nationwide auction. What, then, explains the $21 million increase in regional prices? We contend that the rise in prices was caused by the FCC's unexpected announcement after the nationwide auction that a substantial increase in the affirmative action subsidy would apply to subsequent auctions. As discussed above,[72] affirmative action can create more bidding competition by enhancing both intergroup and intragroup competition, and it can thereby increase the seller's expected revenue.[73] The increase in affirmative action is an attractive hypothesis because it alone is a key variable that changed in the interim between the nationwide and regional auctions.[74]

A simple comparison between nationwide and regional prices, however, does not provide very powerful evidence that affirmative action alone effected the price change, because other factors might have caused the regional prices to increase. For example, regional prices may have been higher not because of designated bidder competition, but rather because of the presence of non-designated bidders with regional strategies. Bidders that only sought regional licenses would not have provided direct bidding pressure in the nationwide auction, but would have been able to bid up the winning prices in the regional auction.[75] However, since three of the four non-set-aside regional frequency blocks were sold as nationwide aggregations, it is apparent that many of the non-designated firms that won in the regional auction could have purchased comparable licenses in the nationwide auction at lower prices.[76] Indeed, PageMart, MobileMedia, and Advanced Wireless did participate in the nationwide auction, but dropped out at prices well below those they were willing to pay three months later in the regional auction.[77] Thus, for regional demand

71. *See* text accompanying notes 112-116 *infra* (discussing partial aggregation risk at regional auction).

72. *See* text accompanying notes 30-33 *supra*.

73. For affirmative action to have caused the price increase, however, its existence or magnitude must have been unanticipated. If the increased demand for licenses caused by increased affirmative action in the regional narrowband auction had been anticipated, bidders who sought nationwide aggregates of regional licenses (e.g., PageMart, MobileMedia, and Advanced Wireless) would have bid more aggressively in the nationwide auction. Some auction participants might have anticipated that the FCC would enhance the affirmative action subsidies in the subsequent auction after designated bidders exited en masse following the early rounds of the nationwide auction, but we believe that, even if that were the case, they did not anticipate the *extent* of the subsidy increase.

74. After considering affirmative action's effect on revenue, we describe and critique three alternative explanations for the increased revenue—none of which proves satisfactory. *See* text accompanying notes 96-111 *infra*.

75. For an example of how regional demand can enhance bidding competition, see McMillan, *supra* note 45, at 156 n.10.

76. In the nationwide auction, 50/50 licenses sold for an average of $80 million, and 50/12 licenses cost an average of $47.3 million. In the regional auction, the non-set-aside 50/50 aggregation sold for $92.6 million, while the non-set-aside 50/12 aggregations sold for an average of $52.3 million.

77. *See* Cramton, *supra* note 44, at 296-317. Tables VIIA-D and VIIIA-G give the national auction bids of PageMart (bidder ID 9683), Advanced Wireless (alias American Portable, bidder ID 5403), and Mobile Media (bidder ID 1666). PageMart dropped out of the 50/50 bidding at $79.0 million, but paid $92.6 million in the regional auction; Advanced Wireless dropped out of the 50/12 bidding at $45.9

adequately to explain the increased regional prices, it must be that these firms did not anticipate the higher regional prices.

Another possibility is that bidders paid more in the regional auction because they were capital constrained in the nationwide auction: Since the nationwide prices exceeded government estimates, it is possible that bidders failed to bring enough capital to the nationwide auction. Under this theory, prices were higher in the regional auction simply because bidders amassed larger war chests. This capital constraint hypothesis, however, is inconsistent with the bidding behavior of some relatively liquid corporations who dropped out of the national auction, yet paid more for a national aggregation in the regional auction. In particular, AirTouch—with equity worth more than $10 billion—had substantial resources at its disposal,[78] and in all likelihood could have bid more in the nationwide auction, but chose not to.

While neither the regional demand nor the capital constraints theories adequately explain the higher prices in the regional auction, we still do not wish to base our affirmative action theory on the simple comparison between the regional and national auctions. Instead, the next section provides direct evidence from an analysis of designated and non-designated bidding behavior in the regional narrowband auction that affirmative action increased government revenue.

2. *The impact of designated crossover bidding.*

A simultaneous auction is somewhat like a game of musical chairs. The auction continues as long as there are more bidders than items to be auctioned. If three identical goods are being simultaneously auctioned, the price at which the fourth highest valuer drops out determines the price that the top three valuers will pay. For example, consider five bidders (*A*, *B*, *C*, *D*, and *E*) who have reservation prices of $50, $40, $30, $20, and $10 respectively. If we held an ascending simultaneous auction with $1 bid increments for three identical chairs, we would expect that bidders *A*, *B*, and *C* would each win a chair for $21. *D*'s willingness to bid $20 creates excess demand at prices less than $21. If *D* were not present at the auction, *E* would be the fourth highest valuer, and the three chairs would sell for only $11 each. In this example, then, *D*'s presence increases the total auction revenues by $30 (from $33 to $63). Identifying the "marginal excess demand"—i.e., the last bidder to drop out—allows us to infer how the presence of certain bidders affected price.[79]

The bidding data from the regional auction provide strong evidence that designated bidders caused the excess demand responsible for increasing government revenues by approximately $45 million. By round 12 (of the 105 rounds) when bidders had reached 70 percent of the ultimate price, all of the

million, but paid $53.6 million in the regional auction; Mobile Media dropped out of the 50/12 bidding at $44 million, but paid $53.7 in the regional auction.

78. On March 20, 1995, AirTouch's stock was worth $13.5 billion. *See* http://www.streetnet.com/airtouch.

79. Milgrom uses a similar analysis to identify the marginal bidders who determined the prices of the first broadband auction. MILGROM, *supra* note 46, at 45-46.

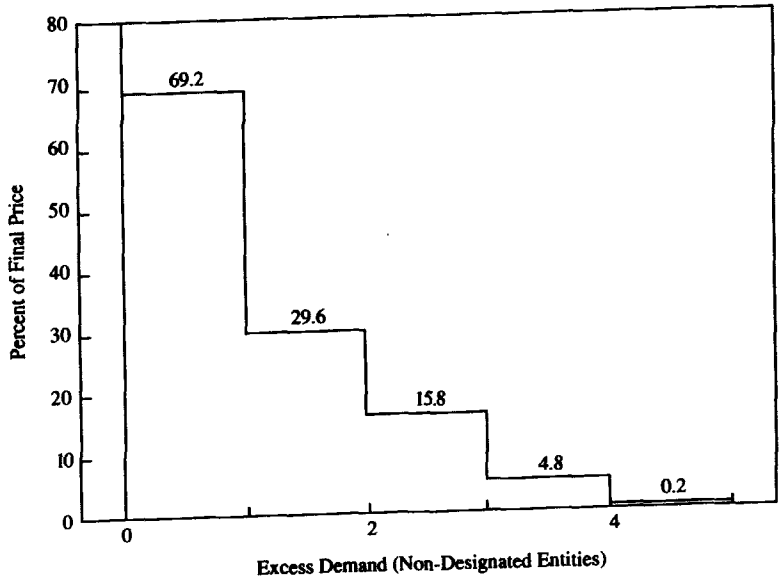
ultimate non-designated winners (PageMart, MobileMedia, Advanced Wireless, AirTouch, and Ameritech) held high bids on the licenses that they would ultimately buy,[80] and virtually all other non-designated bidders had dropped out of the auction.[81] Because the non-designated bidders that were still eligible held high bids for the licenses they desired by round 12, they had no incentive to raise prices any more.

The dramatic exit of the excess non-DE demand is illustrated in Figure 2. This figure shows the average excess demand for both 50/50 and 50/12 licenses for different auction prices (expressed as a percent of the final price). The step function shows how the excess demand by non-designated bidders was gradually extinguished as prices rose. When the auction prices had reached 20% of their final level, there were two excess non-designated bidders for each license type in each region. When the prices rose above 30% of the final price, excess demand by non-designated bidders fell from two to one for each license type (50/50 or 50/12). Most importantly, when prices rose above 70% of the final prices, there was no excess demand by non-designated bidders for any license. Figure 2, then, shows that designated bidders were responsible for the last 30% of auction revenue for the simple reason that none of the remaining non-designated bidders had an incentive to increase prices.

80. The one exception to this was AirTouch, a non-designated bidder which held prevailing bids in Frequency Block 5 in the Northeast, South, and West regions but ultimately won licenses for Frequency Block 5 in the Northeast, Central, and West regions. *See* note 63 *supra*. However, as discussed at note 87 *infra* and accompanying text, *shifting demand from the South* to the Central regional licenses would not increase the auction price.

81. The only non-designated bidders that were still active, but would not ultimately purchase a license, were Westlink, which made its last new bid in round 15, and Radiofone, which made its last new bid in round 44.

FIGURE 2: EXCESS DEMAND BY NON-DESIGNATED ENTITIES (REVENUE WEIGHTED)[82]



All of the excess demand came from designated bidding. The two frequency blocks effectively set aside for designated bidders by the 40 percent

82. Figure 2 is derived as follows. First, for each region and type of license (50/50 and 50/12), the highest bids that each non-designated bidder placed on the license(s) are identified and sorted in decreasing order. For example, consider the Northeast Block 1 license. The highest bids by the final two non-designated firms to bid on this 50/50 license were $17.5 million (PageMart) and $12.6 million (McCaw). From these bids, we conclude that at a price of $12.6 million there is excess demand for one Northeast 50/50 license by a non-designated bidder. This identifies the top step of the excess demand function.

To aggregate the excess demand curves across license type and region, we state the price dimension as the fraction of the final bid. In the case of the Block 1 Northeast 50/50 license, the top step then occurs at 12.6/17.5 = 72%. That is, when the price is above 72% of the final price, there is no excess demand by non-designated bidders. For prices below 72% of the final price, there is non-designated excess demand of at least one. These individual demand curves are then aggregated in the usual way.

Figure 2 shows the average excess demand where the licenses are weighted by revenue. When only aggregated across regions, but not across license type (50/50 or 50/12), the excess demand curves are nearly identical to the curve in Figure 2. Excess demand by non-designated bidders falls to zero (on average) when prices are greater than 70% of the final price. Hence, by this measure, 30% ($70 million) of the revenue collected in the auction comes from bidding by designated bidders. This number is bigger than the $45 million number we determine in Table 4, because here the assumption is that by placing a highest bid of $12.6 million, McCaw is expressing a willingness to pay $12.6 million, but no more. In Table 4, the alternative assumption applies—that McCaw is willing to bid all the way up to the response to the $12.6 million that caused McCaw to drop out. In fact, since bids increase in a discontinuous fashion, it is impossible to know how high McCaw would be willing to go. The only known fact is that McCaw dropped out after placing a final bid of $12.6 million. The actual increase in revenue caused by the designated firm bidding is probably between the overly conservative figure of $45 million and the overly optimistic figure of $70 million.

bidding credit (Blocks 2 and 6) were insufficient to satisfy the demands of the five designated bidders still in the auction: PCS Development, Shearing, Benbow, InstaCheck, and Constant. These designated bidders upped the price of the ten set-aside licenses to the point where it became attractive for them to cross over and bid on the licenses for which only the installment subsidy was available. Specifically, in round 18 (after Benbow and PCSD had bid up the prices on Frequency Block 2), PCSD crossed over and bid against PageMart for Frequency Block 1 licenses.[83] PCSD raised the price on the Block 1 licenses thirteen times before dropping out. PageMart ultimately won all the Block 1 licenses, but PCSD's bidding raised the price on Block 1 licenses by $16.4 million, as shown in Table 4. PCSD could afford to push the bidding on Block 1—even without the 40 percent bidding credit—because it still would receive the installment subsidy, permitting payment of only 84 percent of a winning bid. Moreover, the 40 percent bidding credits, which effectively set aside the Block 2 licenses, allowed PCSD to cross over and bid against PageMart without fear that PageMart would retaliate by bidding up the price of Block 2 licenses.[84] Our inference that designated crossover bidding caused the price increase is particularly strong because designated bidders were the only firms to bid against PageMart for Block 1 licenses after round 12.[85]

Although Instacheck also bid for Block 1 licenses, we attributed the price increase to PCSD's crossover because InstaCheck did not ultimately drop out of the bidding for the non-set-aside licenses. Instead, at various times in the auction, InstaCheck merely shifted its constant demand for a single license by bidding on a variety of licenses one at a time.[86] Accordingly, InstaCheck's crossover bidding did not represent *excess* demand but merely *shifted* demand: Instacheck never reduced its demand for a non-set-aside license as it ultimately purchased a South license for Frequency Block 5. However, PCSD's crossover demand for non-set-aside licenses was excess in the sense that PCSD reduced its demand (to zero) before the auction's end. As in our earlier example of musical chairs, it is only excess demand that drives up auction prices.[87] PCSD's crossover bidding was therefore crucial in driving up the ultimate sale

83. *Compare* ftp://ftp.fcc.gov/pubs/Auctions/PCS/Narrowband/Regional/Round—01 8/s3—18.txt *with* Round—017/s3—17.txt. The competition between Benbow and PCSD had increased the combined price of Frequency Block 2 Northeast and South licenses to $49.94 million by round 17, which, even after deducting the 40% bidding credit, was still more than PCSD's $29.64 million bid on the same two regional Frequency Block 1 licenses in round 18 (29.64 < (49.94 × 0.6) = 29.97).

84. MILGROM, *supra* note 46, at 33.

85. PCSD raised PageMart 13 times, and Instacheck raised PageMart three times.

86. InstaCheck was active in crossover bidding raises in each of the non-set-aside frequency blocks: three times in Block 1, four times in Block 3, three times in Block 4, and 10 times in Block 5.

87. In the earlier example, *see text accompanying note 79 supra*, even though the fourth highest valuer (*D*) controlled the auction price, we would expect to observe "shifted" demand from the ultimate winners (*A*, *B*, and *C*). For example, if in the middle of the auction *A*, *B*, and *C* each held a high bid of $15 on one of the chairs, *D* might raise the price of Chair 1 to $16, displacing *A*'s previous high bid. Instead of bidding $17 on Chair 1, *A* might temporarily shift its demand and bid $16 on Chair 2, thereby displacing *B*'s previous high bid. Likewise *B* might shift its demand and bid $16 on Chair 3, displacing *C*. *C* might in turn raise the price of any one of the chairs to $17. Shifting demand would continue until *D* finally dropped out of the market after bidding its reservation price of $20.

TABLE 4. EFFECT OF DESIGNATED BIDDER CROSSOVER BIDDING IN RAISING REVENUES ON NON-DESIGNATED BIDDER BLOCKS

Non-Designated Bidder block	Maximum region bid by Non-Designated Bidder who ultimately dropped out ($M)	Number of subsequent crossover raises by Designated Bidders who ultimately dropped out	Number of subsequent raises by Non-Designated Bidders who ultimately dropped out	Number of subsequent raises by PageMart on 50/12s after Designated Bidder crossover bidding	Final bid ($M)	Increase in revenue caused by crossover bidding ($M)
1	76.2	16	0		92.6	16.4
3	42.8	1	0	26	53.7	10.9
4	42.8	1	0	25	53.6	10.8
5	42.8	0	0	10	49.6	6.8
Total	204.6	18	0	61	249.5	44.9

price of Block 1 licenses because it was the last bidder to reduce its demand for the non-set-aside licenses.

PCSD's crossover bidding on Frequency Block 1 also predictably led to price increases for the other non-set-aside frequencies (Blocks 3, 4, and 5). PageMart, facing unexpected competition from PCSD on Block 1 licenses (and unable to retaliate by bidding up prices of Frequency Blocks 2 or 6), responded by repeatedly shifting its demand to Blocks 3, 4, and 5. As shown in Table 4, PageMart shifted its demand from the Frequency Block 1 50/50 licenses to the 50/12 licenses in Frequency Blocks 3, 4, and 5, raising the bid on these latter licenses 61 times and increasing their final price by $28.5 million.[88] PageMart's shifted demand was the only bidding that raised the prices of the 50/12 licenses in the last 60 rounds of the auction (all other firms bidding on 50/12 licenses during the last 60 rounds ultimately purchased 50/12 licenses),[89] and PageMart only shifted its demand to the 50/12 licenses because of PCSD's crossover bidding on the Frequency Block 1 50/50 licenses.

Table 4 shows that the only excess demand for the last $44.9 million of the auction increases came from designated bidders. As shown in the column labeled "Number of subsequent raises by non-designated bidders who ultimately dropped out," none of the bidding that gave rise to the last $45 million in revenue came from non-designated bidders who ultimately dropped out. Had affirmative action not created excess designated bidder demand, the ultimate winners would not have needed to bid above the levels listed in the "Maximum region bids by non-designated bidders who ultimately dropped out" column.

InstaCheck's purchase of a non-set-aside license is also strong evidence that designated bidding determined the final price of the non-set-aside licenses.[90] Once excess demand for the set-aside licenses drove up their prices to the point where crossover bidding became attractive, the excess designated demand started setting the prices for both set-aside and non-set-aside licenses. Our theory that excess designated demand determined non-set-aside license pricing is confirmed by the similarity of the prices paid for the set-aside licenses (net of the 40 percent bidding credit) and the non-set-aside licenses.[91]

88. From Table 4, 10.9 + 10.8 + 6.8 = $28.5 million. The "Maximum region bids by Non-Designated Bidders who ultimately dropped out" was calculated by identifying the ultimate winner's response to the highest bid from a non-designated bidder who ultimately dropped out or reduced the number of licenses that it demanded. A license by license breakdown of Table 4 appears in Table 5 *infra*.

89. As shown in Table 4, designated bidders on two occasions raised the price of non-set-aside 50/12 frequency blocks: Constant once raised the bidding on a Block 3 licenses (in round 17), and PCSD once raised the bidding on a Block 4 license (in round 28). This crossover bidding by designated bidders who ultimately reduced their demand shows even more directly how affirmative action raised prices.

90. *See* Table 3 *supra*; *see also* MILGROM, *supra* note 46, at 30 ("The fact that a minority-owned bidder was able to acquire a license for which no discount was offered indicates that there was excess demand for the reserved licenses."). If excess non-designated demand had been determinative in pricing the non-set-aside licenses, designated bidders would have been able to buy set-aside licenses more cheaply than non-set-aside licenses.

91. The prices of the set-aside bands net of the 40% bidding credit were 1.7% higher than those of the non-designated bands and represented the minimum bid increment by which the non-designated bidders needed to exceed the designated bidders. Net revenue for the designated band/MHz = (90.9 + 53.2) / (0.1 + 0.0625) = $887/MHz. Net revenue for the non-designated band/MHz = (92.6 + 53.7 +

The crossover bidding effect on the regional auction can be summarized as follows:

(1) Excess demand by designated bidders for the set-aside frequency blocks (2 and 6) drove PCSD to cross over and bid up the price of Frequency Block 1.
(2) Crossover bidding by PCSD on Frequency Block 1 caused PageMart to bid up the price of Frequency Blocks 3, 4, and 5.
(3) The auction ended when the bidding on Frequency Block 2 finally extinguished excess designated demand—allowing PCSD to create a national aggregation of regional licenses on Frequency Block 2 so that it no longer needed to cross over and bid on Frequency Block 1.

By round 104, the bids were high enough to squelch the excess designated demand and, therefore, the impetus for crossover bidding—but only after this crossover bidding had increased the government's revenues by approximately $45 million—or 12 percent of the government's total auction revenue. In short, PCSD's crossover bidding, and the shifted bidding it inspired, made the government a substantial sum of money.

3. *The impact of the set-aside licenses.*

The prior section demonstrated how crossover designated bidding on Frequency Blocks 1, 3, 4, and 5 increased auction revenue, but it did not discuss how affirmative action affected the price on the frequency blocks that were effectively set aside by the 40 percent bidding credit. To analyze these de facto set-asides, we need to estimate not only the effect of the set-asides on the prices designated bidders ultimately paid for Frequency Blocks 2 and 6, but also how the reduced supply affected the prices non-designated bidders ultimately paid for the non-set-aside frequencies.

One might initially suspect that affirmative action would have decreased the auction revenues for the set-aside licenses because the 40 percent bidding credits effectively precluded non-designated bidder competition. But, in the absence of affirmative action, allowing the excluded non-designated bidders to compete for the set-aside licenses would not have increased the winning bids for these licenses. Table 4 shows that the final excess demand by non-designated firms was extinguished when the bidding for the 50/50 block went above $76.2 million and the bidding for the 50/12 blocks went beyond $42.8 million. Allowing these excluded non-designated bidders to compete for the set-aside licenses would not have raised the price of set-aside licenses for the simple reason that—even after deducting the bidding credit and installment subsidy—the set-aside frequency blocks sold for more (Block 2 for $76.6 million and Block 6 for $44.8 million) than the excluded non-designated bidders were willing to pay. On these facts, it does not appear that setting aside Frequency Blocks 2 and 6 reduced their equilibrium price.

53.6 + 50.8) / (0.1 + (3 × 0.0625)) = $872/MHz. Comparing the designated and non-designated bands: ($887 − $872) /$872 = 1.7%. The price setting effect of the excess designated demand does not mean that designated bidders were not weaker bidders. Indeed, the installment subsidy by itself was substantial, reducing the present value of the designated bidders' payments to 84% of these net bid.

The 40 percent bidding credit acted as a safety net to insure a minimum amount of designated entity participation, but in the end this safety net was not needed. The designated demand was sufficient to compete away virtually all of this bidding credit—as the nominal prices on Blocks 2 and 6 were approximately 40 percent higher than on their non-set-aside counterparts. Indeed, the final auction bids superficially suggest that the installment subsidy did all the work—meaning that if only the installment credit had been granted, designated bidders would have still been strong enough to win eleven licenses and would have still pushed the bidding of the non-designated firms to the same level.

Yet this superficial analysis ignores how the "safety net insurance" of the 40 percent bidding credit may have induced designated entities (and their passive non-designated partners) to form and prepare for the auction. Knowing that there were at least 10 licenses effectively set aside may have induced many designated firms to undertake the fixed costs to organize, investigate, and finance auction participation. Having incurred these fixed costs, the designated firms created enough demand that they bid away virtually all of the 40 percent bidding credit, but the bidding credit may have played an important role in encouraging the firms to incur these costs.[92]

There is an important lesson here. The government can offer very substantial bidding credits to insure minimal minority and/or female participation often without increasing the cost of the subsidy.[93] Guaranteeing a minimum amount of participation may induce stronger designated firms to form so that in the end the government need not pay off on the guarantee.[94]

In sum, the bidding data suggest that the 40 percent bidding credit did not reduce the price of the effectively set-aside licenses and, if anything, this large credit, by providing a type of insurance, may have induced stronger designated demand to form. The designated demand was so strong that even after taking account of both the bidding credit and the installment subsidy, the designated firms paid more for the set-aside blocks than the non-designated firms were willing to bid. Since affirmative action did not reduce the government's revenue on the set-aside licenses, the evidence that crossover DE bidding raised the price of the other licenses by $45 million therefore constitutes our combined estimate of the revenue-enhancing impact of affirmative action.[95]

92. We consider whether the 40% bidding credit deterred non-designated firms from bidding at text accompanying notes 110-111 *infra*.

93. This analysis is extended in Ian Ayres, Narrow Tailoring (March 16, 1995) (unpublished manuscript, on file with the *Stanford Law Review*).

94. If the designated entities had not formed, the final bids on the non-set-aside block would almost surely have been lower. Although Table 4 estimated that without crossover bidding the 20 non-set-aside licenses would have sold for $204.6 million—the price where excess non-designated demand stopped pushing up the bidding—if 50% more licenses were offered to non-designated firms, then the prices on all the non-set-aside licenses would undoubtedly have been lower. Rather than the 21st highest valuer's determining license prices, the 31st highest valuer would have determined the final price.

95. One may be tempted to reduce the revenue increase by the effect the higher revenue has on tax receipts. For example the Congressional Budget Office routinely applies an offset of 25%, which is the average marginal corporate tax rate. *See* CONGRESSIONAL BUDGET OFFICE, BUDGET ESTIMATES: CURRENT PRACTICES AND ALTERNATIVE APPROACHES 8-9 (1995). (The 25% offset is specifically mentioned in Emil M. Sunley & Randall D. Weiss, *The Revenue Estimating Process*, TAX NOTES, June 10, 1991, at 1302.) This would be the right thing to do if the larger amounts paid by firms reduced corporate taxes

C. *Alternative Hypotheses*

Before accepting our $45 million estimate, however, we consider three alternative hypotheses that might explain the auction's outcome. Our estimate is based on a crucial assumption that, in the absence of affirmative action, no bidder would have bid above the final price where the excess non-designated bidders dropped out of the auction. This assumption, however, might fail for three reasons:

(1) Non-Designated Bidders Hid in the Grass: The reservation prices of the non-designated bidders that dropped out may have been higher than their observed highest bids—so that in the absence of affirmative action, these non-designated bidders may have forced up the bidding;

(2) Designated Bidders Would Have Bid Anyway: In the absence of affirmative action, the winning designated bidders may have still bid more than the prices at which the non-designated bidders dropped out; and

(3) Affirmative Action Chilled Non-Designated Bidder Participation: In the absence of affirmative action, the reservation prices of the non-designated bidders that did not participate may have been increased.

If any of these explanations are true, then our estimate of revenue enhancement would be inflated because our benchmark of what the winning prices would be in the absence of affirmative action would be too low.

Before considering each of these alternative hypotheses, however, it is important to emphasize that our $45 million estimate does not depend on the earlier comparison with the nationwide auction. As suggested above, even though unexpected regional demand or capital constraints might explain why the regional prices were higher than the nationwide prices, these theories do not refute the evidence that all the excess demand responsible for the last $45 million of bidding came from designated bidders. Our benchmark—the price at which non-designated bidders dropped out of the auction—already takes into account the possibility that these bidders had unexpected regional demand[96] or were less capital constrained.[97] We now, however, consider three reasons why

by 25% of the extra revenue. However, according to David P. Gamble, Vice President of PageNet, "The amount paid to the government does not change our tax position at all." Telephone Interview with David P. Gamble, Vice President of PageNet (February 9, 1996). Because of the enormous outlays in building a paging network, the paging companies rarely, if ever, show a profit that would be taxed. PageNet, the largest and most established paging company in the U.S. has never paid corporate income tax. Hence, in the paging business the appropriate offset for lost corporate taxes should be much less than 25%.

96. Only four non-designated firms, AirTouch, Ameritech, Radiofone, and Westlink, showed any regional demand. Our $45 million estimate already takes into account the pressure that Radiofone and Westlink exerted on the bidding by setting the pre-crossover designated bidding benchmark at the prevailing prices when these firms dropped out of the bidding. And because the demand of AirTouch and Ameritech was ultimately satisfied, the regional demand of these bidders was not the excess demand that caused the last $45 million in bidding.

97. Even if limited capital constrained prices in the nationwide auction, bidders in the regional auction would not have used their increased liquidity unless necessary. Our previous analysis of regional bidding indicates that prices were not increased by competition among large, liquid non-designated bidders in the last rounds of the auction; instead, PCSD's subsidized crossover bidding drove prices up.

our excess demand benchmark may have understated the prices that would have prevailed in the absence of affirmative action.

1. *Hiding in the grass.*

Recall that PCSD crossed over to bid on non-set-aside licenses when the set-asides proved insufficient to satisfy its demand. If PCSD had not provided the excess demand, it is possible that a non-designated bidder would have stepped in at the lower prices and created excess demand by bidding on more licenses. If this were true, the excess demand of non-designated bidders would have been greater than we observed in the auction bidding; one or more of the non-designated bidders would have been "hiding in the grass"—bidding on fewer licenses than it actually preferred to buy at a given price. If non-designated bidders were hiding in the grass, then our inference that crossover designated bidding caused the $45 million increase would be incorrect. In the absence of affirmative action, some of the non-designated bidders may have bid on a greater number of licenses and driven the prices at least part of the way toward those achieved through crossover bidding.

Hiding in the grass strategies usually assume that rivals have limited capital budgets: Hiding in the grass in early rounds may let a bidder buy a license more cheaply if its rivals commit too much of their limited budgets to other licenses and thereby lose the ability to bid as much against the hidden demand when the "snake" surfaces by bidding in later rounds.[98] For example, consider an auction in which a forthright bidder has a limited budget of $100 million and early in the auction holds high bids for three licenses at $20 million per license. Under these assumptions, a snake bidder might delay revealing its interest in one of these licenses—even if its reservation price is $30 million. By hiding in the grass for a number of rounds, the snake may induce the forthright bidder to commit more than $70 million in bids on the other two licenses; the snake can then enter the bidding knowing that it can outbid the incumbent. Hiding in the grass is a rational strategy when a rival faces a firm budget constraint, and higher bids on one license by the rival necessarily reduce its ability to bid on other licenses.

The FCC designed the auction eligibility rules to discourage hiding in the grass. To maintain eligibility in the first stage of the auction (which the FCC ended in round 20), each bidder needed to remain "active," by holding or raising the prevailing bid, on at least one-third of the bandwidth it ultimately sought to buy.[99] In the second stage (which the FCC ended in round 73), each bidder needed to remain active on two-thirds of the bandwidth it ultimately sought to buy.[100] By round 12, nearly all of the excess non-designated bidder eligibility came from ultimate license winners.[101] These eligible non-desig-

98. There is some evidence that GTE employed this strategy in the initial rounds of the broadband auction. *See* MILGROM, *supra* note 46, at 47.

99. *See* note 46 *supra*.

100. *Id.*

101. The only other bidders who remained eligible were Constant, Radiofone, and Westlink. *See* Table 2 *supra*.

nated bidders represent the only potential sources of unobserved excess demand.

The observed bidding behavior of these eligible non-designated bidders, however, was not consistent with a hiding in the grass strategy. A snake holds back in early rounds, intending to increase demand in later rounds. But no bidder increased its demand for licenses after round 12.[102] To the contrary, as prices rose, bidders reduced demand.[103] For example, MobileMedia began by demanding three nationwide aggregations, and PageMart demanded two. After round 1, MobileMedia reduced its demand to two nationwide aggregations, and after round 6, further reduced it to one band. By round 7, PageMart had also cut its demand to a single nationwide aggregation.[104]

That individual nationwide bidders controlled three of the four non-set-aside frequency blocks by round 12 makes us particularly confident that hiding in the grass would not have been a rational strategy. As discussed below,[105] bidders that hold the prevailing bid for a national aggregation are willing to pay a premium in order to retain the aggregation. Breaking up a bidder's national aggregation can expose the bidder to significant losses if it must buy a subset of the regional licenses; thus, any snake that waited until later rounds to show its demand would confront an opponent whose fear of suffering significant losses would bolster its willingness to compete. Hiding in the grass appears irrational as it creates more hardened national rivals that need to defend their aggregations.[106]

Not only would it be unprofitable to hide in the grass in hopes of outbidding an entrenched nationwide bidder, but the strategy would also unlikely provide an advantage against a rival bidding on only a single license. The strategic rationale for hiding in the grass, that the competitor may commit too much of its budget to another license, does not apply to single license bidders. Excluding nationwide and single license bidders as potential targets of a hiding in the grass strategy eliminates virtually all non-designated bidders. While it is impossible to prove that in the absence of crossover bidding additional non-designated demand would not have surfaced, the observed bidding behavior, as well

102. The only exception is PageMart's bidding for multiple 50/12 licenses, as in rounds 72 and 74. This behavior, however, was not hiding in the grass: Before round 73, PageMart tested multiple bidders in a single round, which was consistent with its behavior in the nationwide auction. After round 73, Stage 3's heightened activity rules required multiple license bidding—PageMart needed to bid on two 50/12 licenses to retain the option of later bidding on a single 50/50 license.

103. The early rounds of the auction were characterized by aggressive, jump bidding to stake out large claims. *See* MILGROM, *supra* note 46, at 32.

104. These reductions in demand are consistent with the behavior of these firms in the nationwide auction, where no bidder increased demand after the first few rounds of bidding. Even if the crossover designated bidding ultimately outstripped the amounts that possible snake bidders were willing to pay, snake bidders should have emerged before the bids went above their reservation price, hoping to bid just as the designated bidders were dropping out. However, these interim increases in non-designated demand never materialized.

105. *See notes* 112-116 *infra* and accompanying text.

106. Likewise, national aggregate bidders become more vulnerable to retaliation as the amounts at stake increase, and they therefore are much more likely to test the waters by revealing their increased demand before they commit to defending their aggregations. The high cost of partial aggregation suggests that the national aggregate bidders would not have chosen to hide in the grass and risk retaliation.

as partial aggregation risk, strongly discounts this hypothesis as a plausible reason to question our excess demand benchmark.

2. *The designated bidders would have bid anyway.*

Our excess demand benchmark might also fail if designated bidders (or their passive non-designated partners) still would have raised prices without affirmative action. Our $45 million estimate implicitly assumes that, without affirmative action, no bidder would have increased the price beyond the point at which the excess non-designated bidders dropped out. But if the designated bidders or their passive non-designated partners would have bid up the price even without affirmative action, then all price increases could not be attributed to the presence of affirmative action.

We think it unlikely that either the designated bidders or their passive partners would have enhanced competition in the absence of affirmative action. None of the designated bidders or their partners appears to have had the resources to bid successfully without affirmative action—indeed, none of these firms was a serious contender in the earlier nationwide auction. The installment payment subsidy was especially important in inducing the designated bids. Without government financing, designated bidders would have needed five times as much liquid capital to pay for the licenses.

Even if designated bidders would have been willing to pay the same present value in the absence of affirmative action, the government revenue would still have been much less—because of the interest rate subsidy increasing the nominal designated bids and forcing non-designated firms to pay 16 percent more. Table 3 estimated that in present value terms designated entities paid $76.7 and $44.8 million respectively for the set-aside 50/50 and 50/12 blocks.[107] Even if we made an assumption more unfavorable to our thesis—that in the absence of affirmative action, there would be sufficient designated demand to buy all six blocks at these prices—we still find that affirmative action would have increased the auction price by more than $38 million.[108] But given our strong belief that designated bidders would not have been willing to bid as much (or at all) in the absence of the 80 percent government financing,[109] we are also confident in rejecting this criticism of our excess demand benchmark.

3. *Affirmative action might have chilled non-designated bidder participation.*

Finally, it is possible that affirmative action deterred some non-designated bidders from participating in the regional auction. Given the effective set-aside of Blocks 2 and 6, some non-designated bidders may have calculated that it was not worth the fixed costs of preparing for an auction—including the substantial

107. *See* Table 3 *supra*.

108. If, in the absence of affirmative action, designated demand pushed up the price that the designated winners were willing to pay with affirmative action, then the six blocks would have sold for $332.4 million ((76.6 × 2) + (44.8 × 4)) which is $38.5 million less than the auction with affirmative action produced.

109. *See* text accompanying notes 59-61.

expense of amassing a war chest to pay quickly for any purchased licenses. This theory would undercut our excess demand benchmark, because, in the absence of affirmative action, these additional non-designated bidders may have driven up the prices beyond the amounts at which the participating non-designated bidders dropped out.

This theory seriously qualifies our reliance on the excess demand methodology. However, we note that there were no conspicuous "no shows' at the regional auction. All of the nationwide bidders that could legally purchase additional licenses made substantial up front payments and then actively bid in the regional auction.[110] This is not surprising: The nationwide auction bidders would have incurred most of the fixed costs necessary to participate in the regional auction. Thus, while we cannot guarantee that without affirmative action other non-designated bidders would not have entered to provide additional competition, no direct evidence of deterred participation exists.[111]

D. *Strategic Perversities: Bidding Above Atomistic Reservation Prices*

The preceding analysis assumed that bidders' reservation prices for particular licenses were independent of who won other licenses. In this section, we show how simultaneously auctioning multiple licenses might lead bidders to pay more for a license than they would pay if the license were offered in isolation.

1. *Risk of partial aggregation.*

In an auction for regional licenses, a bidder that values a national aggregation more than its constituent parts risks winning a subset of regional licenses. Because the cost of an incomplete aggregation may be greater than its synergistic reservation price, an auction participant may be willing to place a total bid that exceeds its reservation price for the aggregation.

This perverse overbidding is analogous to the bidding behavior observed in simple classroom demonstrations of a "both pay" auction in which the professor offers to auction a prize of $10 to two students. The prize goes to the student who bids the most, but the game also requires each bidder to pay the

110. Pagenet could not purchase additional licenses because the FCC prohibits firms from owning more than three licenses.

111. While the text has focused primarily on the possibility that affirmative action might have deterred non-designated bidders from incurring fixed costs of participation, it is also possible that affirmative action might have deterred non-designated bidders from incurring nonfixed costs, such as investigating the value of licenses (as much as they would have in the absence of affirmative action). Spending less on such investigations might then exacerbate the "winner's curse' (to the extent that the auction had a common value element, see note 24 *supra*) and consequently reduce the reservation prices of even those non-designated bidders that participated in the auction. *See* Cramton, *supra* note 44, at 279-82. While reducing the quantity of licenses available would seem to induce less investigation on the margin, the strategic interaction of bidders is not so straightforward. Game-theorists have shown that reducing the quantity of items being auctioned may, for a variety of subtle reasons, induce greater bidder investigation. *See* Cramton, *supra* note 44, at 24. Because it is difficult to even "sign" the effect of affirmative action on how much bidders will investigate and because many of the investigations would have already been incurred in preparation for the nationwide auction, we believe this possibility is of secondary importance.

amount of her last bid. Requiring both the winner and the loser to pay often induces each of the students to bid more than $10—because a bidder about to lose the auction with a $9 bid would prefer to win with an $11 bid (and thereby lose $1 instead of $9).[112] The crucial feature of this game is that making the loser pay can induce both bidders to bid above their reservation prices—this is the core aspect of all "war of attrition" or "escalation" games.[113]

To see how the risk of partial aggregation induces similar overbidding as a "both pay" game, consider an "incumbent" bidder that values owning a national aggregation of five licenses at $100 ($20 per license) but values owning four of the five at only $40 ($10 per license). If it held high bids of $15 on all five ($75 total) and then an "attacker" bid up the price of individual licenses, a rational incumbent would worry that if it were to lose one license, it would be stuck paying $60 (at $15 per license) for the other four licenses that it valued at only $40. To avoid losing the fifth license, the incumbent would be willing to spend up to $120 to win all five licenses.[114] This might mean, for example, that if the bidder thought it could win all five for $23 each, it would prefer bidding above its reservation price rather than winning four for $15 each.[115]

The risk of partial aggregation may induce a firm to bid more than its reservation price, including the synergistic value, for a national aggregation of licenses. As in the "both pay" auction, the prospect of a negative payoff leads to higher bidding. The cost of defending their national aggregations may explain why PageMart, MobileMedia, and Advanced Wireless were willing to pay so much more after PCSD began its crossover bidding: The PCSD crossover might have surprised them and disrupted PageMart's national aggregation.[116] Yet the possibility that partial aggregation exposure induced higher bidding does not undermine our positive thesis. The bidding pattern shows clearly that PCSD's crossover bidding started the chain of events that disrupted PageMart, Multimedia, and Advanced Wireless' national aggregations. Thus, even under this theory, affirmative action was a but-for cause of these higher prices (indeed partial aggregation risks enhanced the effect of designated bidder crossovers).

112. Barry O'Neill, *International Escalation and the Dollar Auction*, 30 J. CONFLICT RESOLUTION 33 (1986); Martin Shubik, *The Dollar Auction Game: A Paradox in Noncooperative Behavior and Escalation*, 15 J. CONFLICT RESOLUTION 109 (1971).

113. *See, e.g.*, John G. Riley, *Strong Evolutionary Equilibrium and the War of Attrition*, 82 J. THEORETICAL BIOLOGY 383, 383-85 (1979).

114. If the attacker were bidding only on a particular license, the incumbent might bid up to $60 to retain the license—meaning that it would pay $60 for four licenses and $60 for the attacked license. However, an attacker will often switch its bidding among the five licenses, increasing the price of each.

115. If the incumbent miscalculates and later finds that $23 per license is not sufficient to win all five, her predicament deepens. Having high bids of $23 on four licenses means that the incumbent now stands to lose $52 ($40 - $92), which means she should now be willing to bid up to a total of $152 to win all five, or more than $30 per license. Just as in the simple "both pay" auction and other "war of attrition games," a bidder's belief that she can win at an intermediate value determines her willingness to continue.

116. See notes 119-121 *infra* and accompanying text for a discussion of PageMart's motivation for bidding against MobileMedia and Advanced Wireless when Frequency Block 5 (50/12) licenses were cheaper.

2. *Raising rivals' costs and predatory strategies.*

Not only does the risk of partial aggregation affect incumbents' bidding behavior, it may also have secondary effects on other auction participants. Anticipating that aggregate bidders will pay inflated prices to avoid being stuck with partial aggregations, firms may strategically choose to bid up the price of a rival's individual license in order to weaken their rivals' market positions (e.g., requiring the rival to charge higher use-fees to cover its interest payments).

While such behavior is theoretically possible, it is probably not rational for a firm to engage in this strategy because the risk of actually buying one of the rival's regional licenses, should the rival drop out of the bidding, likely outweighs any advantage. Additionally, money spent on licenses is sunk and therefore should not affect a rival's subsequent pricing decisions.[117] Finally, engaging in this strategy may induce the rival to retaliate, especially if the initial bidder is itself trying to form a national aggregation.

As an alternative, a bidder may engage in an even more extreme "predatory" strategy. Whereas the goal of raising rivals' costs is just to make them pay more for their licenses, predation seeks to stop the rival from forming a national aggregation. Breaking up a rival's national aggregation might increase the marginal cost of providing certain nationwide paging services (and thus satisfy Salop's marginality requirement). But given bidders' aforementioned willingness to defend their national aggregation "turf,' we doubt that reducing the number of national competitors from nine to eight would be worth the amount of money needed to outbid an entrenched firm.[118]

Nonetheless, there is some evidence that, in shifting its demand from 50/50 licenses to the 50/12 licenses after PCSD's crossover, PageMart targeted MobileMedia and Advanced Wireless' national aggregations even though AirTouch's licenses were then cheaper.[119] While it is possible to interpret these episodes as evidence of either a "raising rivals' costs" or a "predatory" strategy, we think it more likely that PageMart was engaged in a "temporizing" strategy in which PageMart attempted to retain eligibility by remaining active on the 50/12 licenses so that it could later return to bid against PCSD for the Block 1 national aggregation.[120] Thus, PageMart bid against the national aggregators despite the higher prevailing bids in these markets, because PageMart had greater confidence that these bidders would defend their national aggregation and ultimately outbid PageMart. This provides a nonpredatory explanation

117. *See, e.g.*, Thomas G. Krattenmaker & Steven C. Salop, *Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power over Price*, 96 YALE L.J. 209 (1986) (emphasizing that only strategies that raise a rival's *marginal* costs are likely to weaken its ability to compete).

118. The nationwide auction produced 10 nationwide competitors and the regional auction added four more. *See* Table 3 *supra*; note 65 *supra*. The number of nationwide competitors may increase further when the FCC auctions subsequent narrowband blocks.

119. AirTouch also bid against MobileMedia and Advanced Wireless but only when the prevailing bids on Blocks 3 and 4 were cheaper than AirTouch's Block 5 bid. Rather than engaging in predation, AirTouch was arbitraging a price difference.

120. This term and this interpretation of PageMart's strategy were developed by Milgrom. *See* MILGROM, *supra* note 46, at 31-34 (describing the Lidding strategy of PageMart).

for why PageMart might have been willing to bid on Blocks 3 and 4 when AirTouch's comparable Block 5 licenses were cheaper.[121]

Regardless of PageMart's motivation, it is clear that PageMart's 50/12 bidding was caused by PCSD's crossover. PageMart showed no interest in the 50/12 licenses until PCSD repeatedly bid up the price of the Block 1 (50/50) licenses. Moreover, PCSD's disruption of the Block 1 licenses both gave PageMart an excuse for bidding on the 50/12 licenses and made PageMart less susceptible to retaliation from Advanced Wireless and MobileMedia.[122]

3. *Reduced retail competition.*

Because firms were bidding for the right to provide paging services in competition with other license winners, auction rules that affected the identity of the ultimate retail competitors, such as affirmative action, also might have affected how much a firm was willing to bid. Specifically, if affirmative action reduced the expected competitiveness in the paging services market, then non-designated bidders might have been willing to pay more to enter the market.[123] If non-designated bidders perceived that their designated competitors would have higher marginal costs or limited capacity, they might be willing to bid more for a license because they would expect to earn higher oligopolistic profits in the paging market.

We do not, however, believe that this hypothesis provides a plausible explanation for the narrowband bidding. In most regions, designated bidders hold only two of seventeen narrowband licenses (and there are thirteen nationwide non-designated bidder aggregations). Even if the designated bidders were less effective competitors,[124] the reduction from seventeen to fifteen strong competitors should not substantially affect pricing.

121. Indeed, there is some evidence that at times PageMart might have been trying to win one or more of the 50/12 licenses. For example, in round 72, PageMart entered jump bids of $14 million in the West region on all three 50/12 frequency blocks (Blocks 3, 4, and 5). PageMart's message appeared to be that it preferred a 50/12 in the West at $14 million to a 50/50 at nearly $21 million. PageMart was challenging each of the non-designated 50/12 bidders in the West to top $14 million or leave it to PageMart. *See* ftp://ftp.fcc.gov/pub/Auctions/PCS/Narrowband/Regional/Round—072 /s3—72.txt.

122. Retaliation would be harder to accomplish because PageMart was no longer defending a national aggregation of the 50/50 licenses. PageMart's bidding on Blocks 3 and 4, when Block 5 licenses were cheaper, led to final bids on Blocks 3 and 4 that were $4.1 million higher than the final Block 5 bids. Even if PageMart were not a predator, MobileMedia and Advanced Wireless would have had to pay at least what Block 5 winners paid because the Block 5 winners (AirTouch, InstaCheck, and Ameritech) switched whenever there was an arbitrage opportunity. Final bids for Blocks 3 and 4 each totaled approximately $53.6 million, and the final bid for Block 5 was $49.6, which included the $2.1 million PageMart penalty. *See* note 63 *supra* and accompanying text. Thus, even if the instances of PageMart's bidding on the more expensive 50/12 licenses were not caused by affirmative action, "predation" would only reduce our $45 million estimate for the aggregate effect of affirmative action by a few million.

123. At the extreme, if firms expected that without affirmative action, non-designated bidders would win all of the licenses and compete the price of paging services down to its marginal cost, then firms would only have been willing to bid very little.

124. We are skeptical that designated bidders will prove to be less efficient. First, the "build out" costs of exploiting a narrowband license are small (approximately $2.5 million) compared with the cost of the licenses. Third Report & Order, *supra* note 20, at 2969 n.40. Second, the designated bidders, together with their partners, have sufficient capital and expertise to bring PCS paging services to market.

Reduced competition also does not explain why designated bidders and their passive non-designated partners were willing to pay such substantial sums for licenses, if they expected difficulty succeeding in the subsequent marketplace.[125] We have nonetheless highlighted this possibility to underscore the point that producing more government revenue is not the same as allocating licenses to the most efficient users.[126]

This section has shown how affirmative action in the FCC's regional narrowband auction increased government revenues. While game-theorists have long understood as a matter of theory that subsidizing weaker bidders can enhance a seller's expected payoff, we have presented the first empirical demonstration that subsidies can increase revenue.[127] We do not claim that the FCC intended this effect. Nor do we claim that affirmative action increased revenues in other FCC auctions where designated bidder subsidies were smaller, less comprehensively designed, or nonexistent. Indeed, designated subsidies might have stimulated bidding competition in other FCC auctions. For example, in the initial broadband auction, which did not include any designated preferences,[128] competition for several licenses was relatively weak. While a few

125. If there were fewer licenses for sale, however, it would be possible to construct an example in which a designated bidder would be willing to pay a substantial sum for a license: For example, if the FCC sold only two licenses, setting one aside for a designated bidder, then a designated bidder that could commit to limiting its capacity might expect to earn supracompetitive profits. The non-designated bidder would then find it profitable to charge a supracompetitive price and might not find it worthwhile to drive the less efficient designated bidder from the market. *See* Judith R. Gelman & Steven C. Salop, *Judo Economics: Capacity Limitation and Coupon Competition*, 14 BELL J. ECON. 315 (1983) (outlining strategies for smaller firms to effectively compete with larger firms).

126. Game-theorists analyzing the "success" of the FCC auctions may tend to equate the highest willingness to pay with the most efficient user. Regulators, however, may worry that the firms that can most easily collude would be willing to bid the most. Also, large bidders have a strong incentive to reduce demand to keep auction prices low. *See* Lawrence M. Asubel & Peter C. Cramton, *Demand Reduction and Inefficiency in Multi-Unit Auctions*, (Univ. of Md. Working Paper, 1995). Hence, small bidders (like InstaCheck) may inefficiently win licenses when the large bidders (like AirTouch) have higher valuations.

127. Controlled experiments have shown similar results. Andrew Schotter & Keith Weigelt, *Asymmetric Tournaments, Equal Opportunity Laws, and Affirmative Action: Some Experimental Results*, 107 Q.J. ECON. 511 (1992) (finding that affirmative action may lead to increased employee effort and employer revenue); *see also* Allan Corns & Andrew Schotter, *Can Affirmative Action be Cost Effective? An Experimental Examination of Price-Preferences*, (N.Y. Univ. Working Paper, 1996).

128. Because of a concern that auctions with set-asides might be delayed by suits challenging the constitutionality of race- and gender-based preferences, the FCC limited designated preferences to a fixed set of licenses and conducted separate auctions for broadband licenses with and without designated preferences. Separating the auctions (and thereby "quarantining" the designated licenses), allowed the non-designated auctions to take place without delay.

As feared, the first broadband auction with designated preferences was stalled in the courts. On March 15, 1995, the U.S. Court of Appeals for the District of Columbia stayed the auction until it could hear the case brought by Telephone Electronics Corporation ("TEC"), a rural telephone company. TEC claimed that it was unfairly excluded from the auction and questioned the constitutionality of bidder preferences for women and minorities. *See* Edmund L. Andrews, *Court Stalls FCC Program for Women and Minorities*, N.Y.TIMES, Mar. 16, 1995, at A22. On April 18, TEC unexpectedly withdrew its lawsuit in a settlement with the FCC. *See* Gautan Naik, *Firm Plans End to Challenge of PCS Auction*, WALL ST. J., Apr. 19, 1995, at A3. The auction, which was scheduled to begin in June 1995, was postponed until early August, and then again when the June 12 Supreme Court decision in Adarand Constr. v. Pena, 115 S. Ct. 2097 (1995) made it likely that the race and sex preferences would not survive constitutional challenge. The FCC modified the rules to give all small businesses, regardless of the race or sex of its owners, the same 25% price preference and attractive payment terms previously

small bidders helped drive up prices, subsidized designated bidding might have further increased competition and auction revenues.[129]

III. APPLICATIONS TO GOVERNMENT PROCUREMENT AND PRIVATE EMPLOYMENT

FCC auctions are not the only arena in which affirmative action subsidies might enhance competition. This Part illustrates how an analogous effect could reduce government procurement costs or increase private employer profits. As we emphasized in our discussion of affirmative action's effect on auction revenue,[130] affirmative action is likely to increase competition only if:

(1) absent affirmative action, there would be insufficient bidding competition; and

(2) the decisionmaker is able to estimate the expected difference between the reservation prices of preferred and nonpreferred bidders.

While these conditions would not apply to most employment and procurement settings, the strength of the FCC data suggests that affirmative action could enhance competition in a limited set of circumstances.

A. *Government Procurement*

While our finding that affirmative action enhanced bidding competition in the FCC's sale of telecommunication licenses is itself significant, affirmative action may also enhance bidding competition when the government is a buyer. Inducing bidders to sell goods and services to the government at lower prices could affect a significant portion of the economy: Procurement by federal, state, and local governments accounts for "about 10 percent of the GNP or approximately $450 billion per year."[131]

There is ample evidence that the current procurement process is not always sufficient to guarantee the government a good price. Even beyond the hype of anecdotal $450 dollar hammers,[132] relatively few firms bid for major contracts. For example, Steven Kelman's detailed case studies of computer procurement

available only to women- or minority-controlled firms. The auction was rescheduled for August 29. However, it was postponed yet again when the D.C. Circuit stayed the auction in response to a suit filed by Omnipoint, a New York provider that claimed the new rules would allow large companies to dominate the auction by making it too easy for small companies to serve as fronts for large ones. *See* Edmund L. Andrews, *FCC is Ordered to Delay an Auction for Wireless Licenses*, N.Y. TIMES, July 28, 1995, at D4. The D.C. Circuit again lifted the stay, and the auction was rescheduled for December 11. The Sixth Circuit then granted another stay, but the Supreme Court lifted that stay on October 30. FCC v. Radiofone, Inc., 116 S. Ct. 373 (1995); FCC v. Radiofone, Inc., 116 S. Ct. 283 (Stevens, Circuit Justice 1995). The auction finally began on December 18, 1995.

129. The bidders McCaw and American Portable were especially important. *See* Cramton, *supra* note 2, at 15-24 (describing the bidding in the broadband auction). Although 62 bidders applied to bid, only 30 followed through with the required upfront payment. *Id.* at 17. Clearly, a number of potential bidders were unable to participate because of a lack of capital.

130. *See* notes 19-25, 34-41 *supra* and accompanying texts.

131. Marshall, Meurer & Richard, *supra* note 35, at 3 n.1 (citing STEVEN KELMAN, PROCUREMENT AND PUBLIC MANAGEMENT 2 (1990)).

132. Jerry Mashaw, *The Fear of Discretion in Government Procurement*, 8 YALE J. ON REG. 511, 511 (1991) (discussing media distortions in coverage of government procurements).

found an average of only 4.2 bidders per contract.[133] Furthermore, procurement officers "often demonstrate a preference for a familiar product or an incumbent firm. This kind of firm-specific favoritism is well known in procurement circles and has led to such expressions as, "No one was ever fired for buying from IBM."[134] Favoritism for incumbent firms reduces bidding competition by entrenching the market power of either one or a small number of firms.

Affirmative action can enhance bidding competition and reduce the government's cost of procurement in the same ways that it increased the government's revenue from selling narrowband licenses. The nonpreferred private firms competing to sell the government goods and services are likely to bid more aggressively (i.e., offer *lower* prices) both because they might have to compete against subsidized bidders and because they might have to compete for fewer contracts.

While our earlier examples demonstrated the revenue-enhancing effect of affirmative action in multiple-round, open-bid auctions, affirmative action in single-round, sealed-bid auctions, commonly used in government procurement, can produce the same results.[135] A private bidder who knows it must compete with a large number of subsidized bidders may reduce the markup in its sealed bid to increase its chances of winning the contract. Giving traditionally disadvantaged groups bidding subsidies may be especially effective in destabilizing tacit collusion for the very reason that bidders from different social networks may have more difficulty coordinating behavior.

Set-asides may also create lower overall procurement costs because the reduced quantity of contracts available to nonpreferred firms can induce them to bid more aggressively. For example, if four incumbent construction firms were bidding to build four different playgrounds, they might be able to coordinate their bidding (either tacitly or explicitly) to divide the contracts among themselves. Setting aside one of the bidding contracts for traditionally disadvantaged, nonincumbent firms may enhance intragroup competition, as the four incumbents must now compete for just three contracts. Any incumbent that believes it may end up empty-handed is likely to reduce the markup in its sealed bid. While the government may pay more on contracts set aside for traditionally disadvantaged bidders, reduced costs for non-set-aside contracts can lower overall procurement costs.

Failing to recognize how affirmative action can be used to enhance procurement competition grossly overstates the cost of affirmative action subsidies. For example, nonpartisan state legislative analysts estimate the California Department of General Services spent an additional $9.9 million last year by rejecting low bids from firms that failed to comply with affirmative action

133. *See* Marshall, Meurer & Richard, *supra* note 35, at 8 n.23 (citing KELMAN, *supra* note 131, at 109-83).

134. *Id.* at 14 n.49; *see also* Jean-Jacques Laffont & Jean Tirole, *Auction Design and Favoritism*, 9 INT'L J. INDUS. ORG. 9 (1991) (discussing effects of auction favoritism on seller's ability to maximize profits).

135. *See generally* Kelman, *supra* note 131 (describing common procurement methods).

requirements. Unfortunately, these estimates ignore how affirmative action may have driven down the low bids that were used as the benchmark.[136] Without the enhanced bidding competition created by affirmative action, these low bids and the low bids on other bidding contracts may have been substantially higher. While we do not have access to sufficient data to reliably claim that affirmative action reduced California's procurement costs, the procompetitive effects of subsidizing weak bidders (and the evidence from the FCC's regional narrowband auction itself) suggest that affirmative action is much less costly than appears from simply comparing the low bids to the winning bids of traditionally disadvantaged firms.

There is even a sense in which affirmative action promotes the "full and open competition" mandated by the Competition in Contracting Act of 1984.[137] The government procurement process seeks to balance three competing goals of "equity (fair access to competing bidders), integrity (reduction in opportunities for corruption) and economy, (obtaining goods or services required at the lowest possible price)."[138] Although the main thrust of our argument has concerned economy, affirmative action may also increase fairness and integrity. When affirmative action increases auction competition, it inevitably diminishes firms' opportunities to bilk the government. The privilege of participating in a noncompetitive auction could be recharacterized as unfair access to the public fisc. And affirmative action may promote fairness by redressing past and present instances of either private or governmental discrimination. To the extent well-organized incumbents are more likely to capture or corrupt the purchasing process,[139] affirmative action subsidies counteract both possibilities by forcing favored incumbents to bid closer to their reservation prices.

Moreover, the enhanced bidding competition induced by affirmative action need not reduce efficiency in government procurement. While selling to higher cost producers decreases *productive* efficiency (as in the FCC auctions), creating lower overall prices may increase *allocative* efficiency by inducing the government to make more efficient choices about the quantity and mix of its purchases. Absent the bidding competition affirmative action fosters, the government may face inflated procurement prices which distort its choice of inputs. In efficiency terms, the increase in allocative efficiency may outweigh or at least mitigate the decrease in productive efficiency caused by selling to disadvantaged firms with higher production costs.[140]

136. Indeed, a strategic bidder who knows that it is not in compliance with state affirmative action requirements might have an incentive to purposefully enter a low-ball bid to exacerbate the perceived cost of affirmative action.

137. 10 U.S.C. § 2304 (1994). The Competition in Contracting Act of 1984 attempted to discourage sole-source procurement partly by raising the status of procurement by competitive proposals. Mashaw, *supra* note 132, at 513.

138. Mashaw, *supra* note 132, at 512.

139. *See generally* IAN AYRES & JOHN BRAITHWAITE, RESPONSIVE REGULATION: TRANSCENDING THE DEREGULATION DEBATE 54-100 (1992) (discussing factors conducive to regulatory capture).

140. This enhancement in allocative efficiency would not apply to the government's sale of FCC licenses unless the government's choice of what or how much to sell were influenced by artificially deflated revenues.

Although the preceding analysis suggests that the procurement context satisfies the first precondition (the revenue-enhancement effect), the government still faces a substantial information problem in calculating the size of the affirmative action subsidy. Even if the government is confident that disadvantaged contractors are likely to be weaker bidders, the government would still need to estimate the expected *difference* in reservation prices to know how much of a subsidy or set-aside would lower costs. This is not a straightforward calculation, but the government does makes just this kind of calculation when it subsidizes small businesses. For example, the Department of Defense sometimes reimburses small bidders for certain bidding costs if it anticipates greater competition will lower the government's price.[141] Even if the government does not have the requisite data to ensure that affirmative action actually decreases procurement costs, the government may have sufficient information (e.g., data concerning the effects of past bidding) to be confident that affirmative action is less costly than the direct cost of the subsidy.

B. *Private Employment*

To explore the limits of our analysis, this section considers whether affirmative action could induce workers to "bid" more aggressively for their jobs. Although employees do not literally bid for their jobs, their decisions over how hard to work or what level of pay to accept might be analogized to an auction bid. Workers may commit to work harder or for less money if they face subsidized competition from preferred job applicants or have to compete for fewer jobs because some are set aside for a preferred class.

While our goal for the moment is to assess whether as a positive matter private employers would have a profit motive for engaging in this type of affirmative action, we emphasize that the translation of our theory from firm-based preferences to individual-based preferences raises two troubling normative problems. First, the premise that women or minority workers have lower expected productivity is a more invidious stereotype than the FCC's assumption concerning designated bidders' ability to compete. Even if the choice to subsidize disenfranchised groups were based on the disadvantages to which the individuals had been subjected, this profit motive for affirmative action lacks the moral coherence of standard diversity theory, which presumes not that traditionally disadvantaged workers are less productive, but that they bring different life experiences to their jobs, which synergistically enhance corporate decisionmaking.[142] Second, the goal of extracting additional surplus from white and/or male workers is more problematic than extracting additional surplus from non-designated firms.[143] Non-designated bidders have no right to make supracompetitive profits from our nation's finite radio spectrum, but workers have a normative claim to some of the surplus from their employment. The problem is that employers would use affirmative action to extract additional surplus from nonpreferred workers.

We return to these normative issues in the final section, but even at a positive level, we believe that, in the labor markets, the two preconditions for affirmative action to enhance competition rarely both obtain. Employers do not need to resort to affirmative action to extract surplus from white or male employees because competition among these employees is sufficient to drive the wage to the marginal product. Due to the persistent unemployment in the United States, the number of job applicants usually far exceeds the number of openings. Under such conditions, voluntary affirmative action would not be necessary for employers to gain bargaining power: Affirmative action is most likely to be able to spur additional competition only if there are relatively few bidders compared to the number of items being auctioned.

Nonetheless, we see a small possibility that employers could benefit from using affirmative action to enhance their bargaining power when, because of private information and/or contracting costs, employers are unable to extract all of the gains from trade.[144] A recent article by Andrew Schotter and Keith Weigelt experimentally tested whether affirmative action subsidies could spur employees to work harder.[145] These authors found that overall effort of their subjects increased when weak "employees" were favored. While there is only

The importance of allocative efficiency is at the core of Henry Manne's justification for legalizing insider trading: If insider trading drives stock prices more quickly toward their true value, better investment and consumptive choices might follow legalizing its exchange. HENRY G. MANNE, INSIDER TRADING AND THE STOCK MARKET (1966).

141. Jerome S. Gabig & Richard C. Bean, *A Primer on Federal Information Systems Acquisitions: Part Two of a Two-Part Article*, 17 PUB. CONT. L.J. 553, 580-81 (1987) (discussing Department of Defense proposals to subsidize benchmarking costs for small information systems firms).

142. *See, e.g.*, Taylor Cox, Jr., *The Multicultural Organization*, 5 ACAD. MGMT. EXEC. 34 (1991) (contending the diversity enhances decisionmaking, creativity, and marketing to foreign communities); *Duncan Kennedy, A Cultural Pluralist Case for Affirmative Action in Legal Academia*, 1990 DUKE L.J. 705 (arguing that affirmative action would improve the quality and social value of legal scholarship).

143. In a sense the employer would be using affirmative action to induce a "rat race." *See* George Akerlof, *The Economics of Caste and of the Rat Race and Other Woeful Tales*, 90 Q.J. ECON. 599, 603-05 (1976). The rat race effect results from workers' increasing their efforts to distinguish themselves from other coworkers without considering that their extra efforts would inspire others to work harder. The rat race effect might intensify where workers with higher expected productivity had to work even harder to exceed the subsidized output of workers with lower expected productivity.

The rat race effect underscores how affirmative action's possible profit motive will usually reduce social efficiency. While reducing workers' market power may lead to more efficient use of labor, *see note* 140 *supra* and accompanying text, it is just as likely that employees' disutility of work will exceed employers' enhanced profitability.

144. Most importantly, employers often receive only a noisy signal about the expected productivity of a particular applicant. The heterogeneity in expected productivity reduces the competitive pressure that employees with the strongest resumes face from other applicants with less scintillating resumes. Because applicants may know more about their prospective productivity than employers, employers cannot simply extract the surplus by tailoring the contractual terms of employment to each employee's actual abilities. For example, consider an employer that wishes to promote a small proportion of its entry-level employees based on the employees' observed productivity during a long probationary period: If the employees exhibit different expected productivities, then the strongest workers might be able to shirk without fear that they will be passed over for promotion. Because the employees' exact capabilities are unknown to the employer, simply requiring employee-specific minimum output would not allow the employer to extract all of the expected gains from trade. Instead, the employer might be able to do better by subsidizing some of the weaker applicants in this competition. Faced with this subsidized competition, the employees with the highest expected productivity may work harder.

145. Schotter & Weigelt, *supra* note 127. For groups with a severe disadvantage, affirmative action significantly increased effort and firm profits. Without the affirmative action, the disadvantaged parties tended to supply no effort, since their chance of promotion was so small. *Id.*

indirect empirical evidence that affirmative action enhances productivity,[146] our enhanced-competition theory may provide a causal explanation for two of the most important changes during the last decade in entry level hiring for law teaching—(1) an increase in the perceived amount of affirmative action and (2) an increase in the number of publications candidates must write before application.

We remain skeptical, however, that employers would subsidize disadvantaged applicants solely to maximize profits. Even if affirmative action subsidies or set-asides could profitably enhance employers' bargaining power, few employers have sufficient information to risk subsidizing workers with lower expected productivity when profit-maximization is their sole motivation.[147] However, when employers are motivated by other factors to offer affirmative action subsidies, our overarching conclusion still pertains: Private employment subsidies may not be nearly as costly as commonly assumed if they enhance the employer's terms of trade with nonpreferred employees.

IV. Legal Implications

The central thesis of this article has been positive rather than normative: Affirmative action can (and in the FCC auction did) increase government revenues by enhancing bidding competition. But at some level this fact is insignificant unless it informs normative legal issues. Accordingly, this section addresses the normative relevance of the revenue-enhancing effect.

A. *Public Affirmative Action*

An expected increase in government revenue or decrease in government procurement costs is an inadequate constitutional rationale for race- or gender-conscious subsidies. But, in cases where there are independent constitutional justifications, the simple fact that affirmative action subsidies may not be as costly as is commonly thought may help demonstrate that affirmative action is cost-justified.

1. *Revenue enhancement is constitutionally insufficient.*

After *Croson*[148] and *Adarand*,[149] to withstand an equal protection attack, a racial subsidy must be "narrowly tailored" to further a "compelling government

146. One intriguing study of stock market "events" shows that when the Labor Department announced awards for companies that had exemplary affirmative action programs, the companies' stock prices increased. Peter Wright, Stephen P. Ferris, Janine S. Hiller & Mark Kroll, *Competitiveness Through Management of Diversity: Effects on Stock Price Valuation*, 38 Acad. Mgmt. J. 272 (1995).

147. We can think of few examples where private employers explicitly subsidize weaker applicants to spur competition, but "second-sourcing'—where a firm profitably subsidizes a higher cost second-source to enhance its bargaining power with the primary input supplier—may be analogous. *See* Ayres & Braithwaite, *supra* note 139, at 134.

148. City of Richmond v. J.A. Croson Co., 109 S. Ct. 706 (1989) (requiring that city affirmative action plan satisfy a compelling governmental interest and be narrowly tailored to remedy the past effects of discrimination).

149. Adarand Constr. v. Pena, 115 S. Ct. 2097 (1995) (holding that all governmental racial classifications must withstand strict judicial scrutiny).

interest."[150] Reducing the federal government's budget deficit is unlikely to qualify as a "compelling government purpose" for disparate racial treatment.[151] Even if increasing government revenue were a constitutionally permissible goal, the means of achieving this goal would not be "narrowly tailored," because there is a strong possibility the government could find a racially neutral means of substantially achieving the same goal. Specifically, if the FCC had simply subsidized small firms,[152] similar revenue-enhancing effects might have been achieved.

Whether a small-firm subsidy would create more or less revenue than a race/gender subsidy depends in part on the government's ability to identify a stable, nonracial class of "weak" bidders. While many critics of affirmative action have complained that sham corporations have falsely qualified for minority status,[153] the problem of "sham" corporations might be even more intractable if preferred status were determined simply by a corporation's revenue or financial structure. Strong bidders might be able to redefine their corporate structure to qualify for small business subsidies. Thus, while it is possible that racial and/or gender classifications are the best means to enhance bidding competition, we think it clear that the current Supreme Court would not accept revenue enhancement by itself as a sufficient justification for affirmative action set-asides.

2. *Did the FCC's rules enhance minority or female control of the airwaves?*

To underscore our agnosticism about whether the FCC's affirmative action was consistent with the Constitution's equal protection requirement, we digress for a moment to consider whether the FCC's designated bidder regulations enhanced minority or female control of the airwaves. The FCC designed the designated bidder regulations to avoid two problems: (1) unjust enrichment and (2) sham designated bidders. The unjust enrichment problem was created by bad publicity generated when previous lottery winners quickly resold their

150. *Id.* at 2117. Gender-based subsidies may be more likely to pass constitutional muster because they need not satisfy strict scrutiny. Mississippi Univ. for Women v. Hogan, 458 U.S. 718, 724 (1982) (subjecting gender-based discrimination to intermediate scrutiny). Even under the relevant "heightened scrutiny," however, it may be difficult for the government to justify revenue enhancement as a substantial government purpose.

151. The Court would likely require the government to show that there was no equally effective race-neutral means to achieve the same result. *See Adarand*, 115 S. Ct. at 2118. In *Adarand*, two justices even wrote that there could be no compelling government purpose for race-based subsidies. *Id.* at 2118-19 (Scalia, J. and Thomas, J., concurring separately).

152. Although in the regional narrowband auction the FCC subsidized firms with annual gross revenues of less than $40 million in the last two years, the subsidies were not as significant as those given to designated bidders. Small firms received no bidding credit, but they were able to pay in installments at the 10-year treasury note rate. The installment payments applied to all licenses. *See* Order on Reconsideration, *supra* note 49, at 5306-07.

153. *See, e.g.*, Mark I. Pinsky, *FCC Takes Trinity TV Station: Religious Broadcaster Illegally Used Minority Status, U.S. Says*, Sun-Sentinel, Nov. 16, 1995, at 1D, *available in* LEXIS, News Library, Curnws File (" "[T]he findings establish that TBN and Crouch created a sham corporation to take advantage of the minority preference' policies of the FCC.").

licenses for huge profits.[154] The FCC responded by promulgating detailed unjust enrichment rules aimed at stopping unjust minority enrichment. These rules restricted designated bidders' ability to resell or lease licenses in the short term to non-designated bidders, and required repayment both of the 40 percent bidding credit and the installment subsidy if the license were resold in the long term.[155] These rules should stop unscrupulous designated bidders from capitalizing on the affirmative action subsidies. Indeed, because the 40 percent bidding credit did not mean that designated bidders actually paid 40 percent less than non-designated bidders for comparable licenses, the pay back rules may discourage even legitimate resale.[156]

The FCC also attempted to deter corporations from trying to get designated status by using minority or female entrepreneurs as fronts, without allowing them any actual control over the corporation. The FCC therefore required that women or minorities own a majority of the voting stock and at least 25 percent of the total (voting and nonvoting) equity.[157]

The greatest weakness of the FCC's approach was its failure to limit the amount or terms of designated bidder leverage. While nonvoting stock could represent no more than 75 percent of total equity, designated bidders were allowed to borrow unlimited amounts from their passive equity holders. In fact, female or minority entrepreneurs did not have to pay in any capital in return for their majority control; some designated bidders financed 100 percent of their auction payments with debt and capital contributions from nonvoting shareholders. Moreover, while designated bidders were required to file a "long-form" application to qualify for designated status, they never had to disclose the amount or terms of debt financing.

The lack of leverage regulation created a strong likelihood of extreme separation of ownership from control. The FCC did not limit the amount of free cash flow passive financiers could take from the corporation. The FCC's regulations thus permitted a leaky bucket—where many of the benefits of affirmative action ultimately flowed to people who were not members of the

154. *See, e.g.*, Edmund L. Andrews, *Airwave Auction Bill Advances*, N.Y. TIMES, May 12, 1993, at D1, D13; Edmund L. Andrews, *Senate Plan to Sell Radio Frequencies*, N.Y. TIMES, May 28, 1992, at D1, D9.

155. Implementation of Section 309(j) of the Communications Act—Competitive Bidding, 9 F.C.C.R. 2348, 2394-95 (1994) (Second Report and Order, PP Docket No. 93-253) [hereinafter Second Report & Order].

156. The extensive crossover bidding and the designated bidder purchase of a non-set-aside license suggest that the effective bidding credit was 0% (not including the installment benefit). Thus, making the designated bidders pay back the full 40% actually penalizes resellers. Although designated bidders presumably take this illiquidity into account when valuing designated licenses, requiring overpayment of the bidding credit will tend to increase the inefficient holding of designated licenses.

157. Third Memorandum & Order, *supra* note 49, at 212. In addition, if the designated bidder control group owned less than half of the total equity, then no single non-designated investor could own more than 25% of the total equity or more than 15% of the voting stock. *Id.*

The FCC's rules, however, did not prohibit designated bidders from adopting supermajority voting requirements that might undermine the effective control of the control group. For example, while a woman owned 85% of Benbow P.C.S. Ventures, Inc., her dominant ownership share was insufficient to make many major corporate decisions, because any such decision required approval from 86% of the voting shares. Long Form Application of Benbow P.C.S. Ventures, Inc., FCC Form 401, Exh. VI at 1 (Nov. 23, 1994).

disadvantaged group. FCC apologists might respond that capital markets are sufficiently competitive to protect designated entrepreneurs and that the goal of the program is to let designated entrepreneurs control part of the telecommunications spectrum. However, the complete lack of leverage regulation threatens to undermine the more limited goal of giving women and minority entrepreneurs effective control of the designated firms.

Passive financiers in these ventures must have been sorely tempted to control the bidding strategies when millions of dollars of their own money were at stake. The FCC regulations failed to specify the amount of control that passive debtholders and nonvoting stockholders were allowed to exert. Quite possibly, these so-called passive financiers might have made round-by-round bidding decisions, with the ultimate threat of withholding financing should the controlling shareholders act otherwise. In other instances, exerting this type of influence has exposed passive debtholders to various types of control liability.[158]

While we cannot assess who controlled the bidding strategies of the prevailing designated bidders in the regional auction, an analysis of their long-form applications for designated status indicates extreme forms of leverage. For example, Lisa-Gaye Shearing disclosed that its passive partner financed 100 percent of the more than $3 million spent for auction prepayments.[159] Moreover, some of the designated bidders seemed to cede control of the bidding process to their white male financiers.[160] For example, the female controlling shareholder of Benbow seemed detached during important parts of the bidding, and one of us observed her reading a novel for several rounds while her white male team decided how to bid.[161]

Because the entrepreneurs who own the designated firms did not face the same threats of ouster by proxy contest or merger as those who run typical corporations, it strains the imagination to think that nonvoting shareholders and debtholders would extend virtually all of the firm's working capital without retaining substantial influence over its most important decisions. Race- and gender-conscious subsidies must do more than merely enhance government

158. *See, e.g.*, A. Gay Jenson Farms Co. v. Cargill, Inc., 309 N.W.2d 285, 294 (Minn. 1981) (holding lender vicariously liable to other creditors because its financial and managerial control over the principal created an agency relationship); *see also* RESTATEMENT (SECOND) OF AGENCY § 14(o) cmt. a (1957) (security holder may be considered principal of debtor where security holder takes over management of debtor); Daniel R. Fischel, *The Economics of Lender Liability*, 99 YALE L.J. 131 (1989).

159. Long Form Application of Page Call, Inc., FCC Form 401 Exh. IV at 5, 7 (Nov. 23, 1994) (on file with the *Stanford Law Review*). Benbow similarly disclosed: "Westlink has advanced funds to Benbow to make the necessary down payments to the Commission." Long Form Application of Benbow, P.C.S. Ventures, Inc., *supra* note 157, at 2.

160. Shearing's long form states that she "had an oral agreement [with her passive partner, Adelphia] that they would consult with each other on bidding strategies during the auction and, to the extent Lisa-Gaye Shearing chose not to be present at the auction, she would direct what bids to place in what markets and an Adelphia employee would act as her agent in placing those bids." Long Form Application of Page Call, *supra* note 159, at 5.

161. While controlling shareholders might rationally delegate many corporate decisions, it seems odd that the controlling shareholder would delegate how the corporation invests the vast majority of its capital. Benbow's observed behavior is all the more disheartening if one of the goals of affirmative action is to create role models for future disadvantaged entrepreneurs.

revenues to pass constitutional muster, and we remain agnostic about whether the FCC subsidies achieved these additional requirements.

3. *Affirmative action costs the government less than is commonly assumed.*

Notwithstanding the fact that a revenue-enhancing effect is not constitutionally sufficient to justify affirmative action, our finding that affirmative action can enhance government revenue has normative relevance. The cost of affirmative action is significant to determining its wisdom as a matter of public policy. Affirmative action may appear more attractive if it costs the government very little to redress past discrimination. Even if race- and gender-based subsidies further a compelling government purpose, the amount of affirmative action must turn, at least in part, on the cost of the subsidy.[162]

From this perspective, it is not crucial that the FCC's affirmative action subsidy actually increased government revenue—it is only important that the subsidy cost the government less than is commonly assumed. The government cost of affirmative action is exaggerated if one considers only the shortfall on contracts that go to minorities. A more accurate view takes account of the ways in which subsidized minority bidders drive traditional players to surrender more of the gains of trade on the contracts they win. The naive analysis wrongly assumes as a benchmark that unsubsidized bidders would have bid as aggressively in the absence of competition from preferred bidders. The naive benchmark also wrongly assumes that minority bidders only compete with unsubsidized bidders—therefore that competition among minority bidders does not compete away any of the subsidy. But in the narrowband auction, designated competition was sufficient to do just this—competing away virtually all of the 40 percent bidding credit. What naively seems like a huge giveaway ended up costing the government nothing. As our examination of the FCC auction reveals, subsidizing discrete classes of bidders can increase both inter- and intragroup competition, invalidating both of the naive assumptions.

While we have shown that the affirmative action subsidies increased revenues in comparison to an auction without any bidder subsidies, some critics might argue that we have not chosen the appropriate benchmark and in particular that we should use for comparison an auction with the most effective race- and gender-neutral subsidies. We emphasized above that small business subsidies might have been able to generate more government revenue than the affirmative action subsidies did.[163] Yet even if giving small business subsidies could have extracted higher bids from the dominant bidders, our central finding would still hold: Affirmative action subsidies cost much less than we would have estimated if we merely multiplied the eleven licenses that designated bidders acquired by the effective 50 percent (or in one case 16 percent) subsidy.[164]

162. Assessing the cost of affirmative action will also turn on a variety of other factors, including the cost of excluding white males and the amount of social inefficiency.

163. *See* note 152 *supra* and accompanying text.

164. *See* text accompanying note 62 *supra*.

This naive method would estimate that affirmative action cost the government $125.6 million. A small business subsidy may have succeeded in extracting even more from the established bidders, and in comparison with this benchmark, affirmative action may still have cost the government some revenue. But this shortfall in revenue would only be a fraction of the naive cost estimate.

Even if the race and gender subsidies had not increased government revenues, the take-home lesson of this article is that the fiscal cost of affirmative action may be much less than the facial expense of a 50-cents-on-the-dollar subsidy. In a sense, the legal significance of our finding is captured by the simple idea that "demand curves slope downward"—meaning the discovery that affirmative action has a lower price should, on the margin, induce society to demand more of it.

B. *Private Affirmative Action May Deserve Higher Scrutiny*

Our discovery that affirmative action subsidies can enhance bidding competition does not unambiguously militate for an increase in all types of affirmative action. The theoretical possibility that employers may adopt race-conscious hiring or promotion standards solely to make money suggests that private affirmative action may deserve higher scrutiny than currently given in Title VII litigation.

A bed-rock principle of Title VII is that there is no profitability defense for disparate treatment on the basis of race or gender.[165] Particularly with regard to disparate racial treatment, the statute explicitly excludes racial classifications as a possible "bona fide occupational qualification."[166] Unlike equal protection jurisprudence, which requires the symmetrical treatment of laws favoring and disfavoring racial minorities,[167] Title VII distinguishes between race-conscious employment standards that favor minorities and those that disfavor them. Thus, even though "there is no BFOQ for race' when disfavoring minorities, the Supreme Court has said that race-conscious disparate treatment (in the form of an employer's voluntary affirmative action program that favors minorities) does not violate Title VII if it is intended to "eliminate a manifest racial imbalance" and does not unduly burden or absolutely bar the advancement of white employees.[168]

Our enhanced-competition theory suggests, however, that employers might engage in affirmative action *solely* to extract more surplus from their white and/or male employees. While the Supreme Court has not yet treated race-conscious employment practices that favor and disfavor minorities symmetrically, we suspect that the Court would require symmetric application if it thought that a private employer adopted a voluntary affirmative action program solely to

165. *See* City of L.A. Dep't of Water & Power v. Manhart, 435 U.S. 702, 716-17 (1978) (noting that "Title VII [does not] contain . . . a cost-justification defense comparable to the affirmative defense available in a price discrimination suit.").

166. 42 U.S.C. § 2000e-2(e)(1) (1994).

167. *See, e.g.*, 42 U.S.C. § 1981 (1994).

168. Johnson v. Transportation Agency, Santa Clara County, 480 U.S. 616, 630 (1987) (citing United Steelworkers of America v. Weber, 443 U.S. 193, 208 (1979)).

increase profits. The Supreme Court may therefore require employers to prove more than a statistical imbalance—that is, to make some showing that they are motivated by more compelling factors than making money.[169]

Yet the need for heightened scrutiny turns in large part on how often private employers would likely implement voluntary affirmative action solely to make money. In our previous analysis, we sketched how racial and gender preference might enhance a firm's profits, but concluded that in practice employers would seldom have the information necessary to calculate the appropriate subsidy with any confidence.[170] Accordingly, heightening the employer's standard of justification because of the possibility of enhanced employee competition seems unwarranted.[171]

CONCLUSION

In undertaking this study, we set out to estimate how much the bidding subsidies cost our government. Our first intuition was that allowing firms controlled by women and/or minorities to pay just 50 percent of their winning bids would lower the government's auction revenue. Only after analyzing the bidding data through the lens of game theory did it become clear that the FCC's affirmative action increased narrowband prices by forcing nonpreferred firms to bid more aggressively. In a simultaneous auction, the last bidders to drop out determine final prices—and in the regional narrowband auction the subsidized designated bidders dropped out last, but only after they drove up final prices by 12 percent or $45 million.

Our results demonstrate how law-and-economics can illuminate otherwise counterintuitive behavior. The game-theoretic explanation does not come naturally to those unschooled in strategic thinking. Civil rights advocates have implicitly conceded that affirmative action subsidies burden the public fisc—they

169. Our interim conclusion that Title VII should prohibit affirmative action programs adopted solely to increase an employer's profits, however, has broader application: Namely, the more conventional "diversity" justification for affirmative action—improving decisionmaking by increasing the diversity of decisionmakers—would also violate Title VII unless the employer could offer a sufficient nonprofit based motive.

170. *See* text accompanying notes 143-147 *supra*.

171. While this article has focused on the impact of affirmative action at the regional narrowband auction, installment payments and bidding credits for designated bidders have had large effects in other FCC spectrum auctions. For example, in the C-block broadband PCS auction for designated bidders, prices as of February 25, 1996, were nearly double the prices in the early MTA broadband PCS auction, where two bands (A and B) were sold to non-designated bidders. The average final price in the early broadband auction was $15.54 per pop; whereas the average net price in the C-block auction was $27.70 per pop for an identical 30MHz license. *See* http://www.fcc.gov. Competition in the first auction was weak compared to that of the set-aside auction, in which small businesses were given a 25% bidding credit and installment payments similar to those in the regional narrowband auction. The evidence is strong that the earlier auction ended at prices well below full value because of the lack of competition in many markets. *See* Cramton, *supra* note 2, at 31. Judging from the intense competition in the C-block auction, the FCC may have raised substantially more revenues in the broadband auctions if the auctions for the A, B, and C blocks were combined into one auction and C-block bidders were given installment payments in the A and B blocks. In any event, it is clear that the bidding credits and installment payments did not cost the taxpayers a penny. The broadband results illustrate an important disadvantage of using set-asides. Namely, set-asides do not permit the crossover bidding between designated and non-designated licenses. As a result revenues may suffer in one market or the other.

argue instead that the social benefits of remedying past discrimination or of promoting diversity justify the cost of the government subsidies. Showing that the subsidies cost much less than previously thought—or indeed that the subsidies may reduce the federal deficit—makes it easier for affirmative action programs to pass cost-benefit analysis.

Opponents of affirmative action might contend that the effect on the public fisc should not be dispositive. But for those who believe that there is an appropriate role for affirmative action in remedying past discrimination or in furthering diversity, then the results of this article will help illuminate the size of the public subsidy.

The United States has a long history of giving away the radio spectrum:[172] From 1927 until 1982, radio spectrum licenses were assigned by a process known as "comparative hearings" in which the FCC evaluated competing requests for broadcast licenses. The licenses were simply given away—once applicants had paid their lawyers significant sums to construct arguments explaining why they would best serve the nebulous "public interest." By 1982, the volume of new cellular telephone licenses began to overwhelm the FCC's ability to conduct comparative hearings, so Congress authorized the agency to assign the licenses by lotteries, again without charge. Hundreds of thousands of firms applied for the giveaway—many only with the desire to resell their lottery winnings for a profit.[173]

Congress' decision to auction licenses went a long way toward ending these blatant giveaways—but even in an auction, entitlements can be sold on the cheap if there are not enough bidders. The recent FCC auctions created just this risk. Had large telecommunications companies reaped windfalls by purchasing licenses at prices substantially below their valuations, the auctions would have continued the trend of giving away the spectrum. Though requiring disadvantaged firms to pay just 50 percent of their winning bids struck many commentators as an unjustifiable giveaway,[174] we have shown that besides promoting diverse ownership of the broadcast spectrum, the FCC's affirmative action actually prevented an even larger corporate gratuity.

172. This history is detailed in MILGROM, *supra* note 46, at 2, 12-13.

173. Milgrom gives the example of a sham telephone company, i.e, one formed solely for the purpose of filing lottery applications, that won the right to supply cellular services to Cape Cod and promptly resold its license to Southwestern Bell Telephone Company for $41 million. MILGROM, *supra* note 46, at 13.

174. *See, e.g.*, Rauch, *supra* note 8, at 9, 12 (discussing "discriminating for the sake of discriminating" in interactive video and paging licenses).

APPENDIX

Table 5 shows on a license-by-license basis how we calculated the information in Table 4. The full names of the relevant bidders appear in Table 2, with the exception of the non-designated bidder, KDM Messaging Co. (McCaw), which is a wholly owned subsidiary of McCaw Cellular, now owned by AT&T. The information contained under the heading "Last Non-Designated Bidder Excess Demand" reports the last time an unsuccessful non-designated bidder entered a bid on a particular license. For example, for the Midwest Region/Block 1 license, McCaw placed the last unsuccessful non-designated bid of $12.6 million in round 6. The next column, "Response to Final Bids By Non-Designated Bidders Who Ultimately Dropped Out," simply reports how the ultimate winners responded to this excess non-designated demand. For example, in response to McCaw's Midwest/Block 1 bid, PageMart bid $16 million. We assume that, without the crossover designated bidding, prices for the licenses would have risen to this level, because there was demonstrated excess non-designated demand at lower prices. While it would be tempting to use this response as the benchmark estimate as the price for which each license would sell, this method ignores the fact that 50/12 licenses within the same region are close to perfect substitutes (for any bidder not seeking a national aggregation). To calculate a more conservative estimate of the effect of crossover bidding, we assumed a bidder expressing demand of $12 million on a Block 3 regional license would have been willing to bid as much for the similar regional license on Blocks 4 and 5. Accordingly, we calculated, for each region, the maximum response on three 50/12 licenses (to the final bids by non-designated bidders that ultimately dropped out). We used this higher figure as our benchmark for expected revenue in the absence of affirmative action. For example, we assume that Westlink would have been willing to replicate its bid of $8.941 million on the West Block 5 license on *all* of the West 50/12 licenses, and used the response of $9.4 million as the relevant benchmark for each of the three licenses. The bottom of the table aggregates the increase in revenue by block—the overall increase of $44.9 million.

TABLE 5: ANALYSIS OF DESIGNATED BIDDER CROSSOVER BIDDING ON INDIVIDUAL LICENSE BASIS

		Last Non-Designated Bidder Excess Demand			Response to Final Bids By Non-Designated Bidders Who Ultimately Dropped Out ($M)	Maximum response within region ($M)	Final Bid ($M)	Increase In Revenue Caused By Crossover Bidding ($M)
Freq Block	Region	Final Non-Designated Bidder Who Ultimately Dropped Out	Last Non-Designated Bidder's Bid	Round Placed				
1	NE	McCaw	12.6	7	13.2	13.2	17.5	4.3
1	South	Advanced Wireless	10.0	4	5.0	15.0	18.4	3.4
1	Mid	McCaw	12.6	6	16.0	16.0	16.8	0.8
1	Cent	Westlink	15.0	8	16.0	16.0	17.3	1.3
1	West	Westlink	15.0	6	16.0	16.0	22.5	6.5
3	NE	Mobile Media	7.5	4	8.3	.3	9.5	1.2
3	South	Mobile Media	7.5	4	8.3	8.3	11.8	3.5
3	Mid	Mobile Media	7.5	4	8.3	.5	9.3	0.8
3	Cent	Mobile Media	7.5	4	8.3	.3	8.3	-0.1
3	West	Mobile Media	7.5	4	8.3	.4	14.9	5.5
4	NE	Mobile Media	7.4	5	7.8	.3	8.9	0.6
4	South	Advanced Wireless	7.8	6	.3	8.3	11.5	3.2
4	Mid	Advanced Wireless	7.8	6	8.5	8.5	10.1	1.6
4	Cent	Mobile Media	7.4	5	7.8	.3	8.8	0.5
4	West	Mobile Media	7.4	5	7.8	.4	14.3	4.9
5	NE	PageMart	7.0	3	7.4	8.3	8.7	0.4
5	South	McCaw	7.7	7	8.1	8.3	8.9	0.6
5	Mid	McCaw	7.9	7	8.5	8.5	9.5	1.0
5	Cent	Radiofone	8.1	44	8.3	.3	8.3	0.0
5	West	Westlink	8.9	15	9.4	.4	14.3	4.9
				Block 1 Total	76.2	76.2	92.6	16.4
				Block 3 Total	41.5	42.8	53.7	10.9
				Block 4 Total	40.2	42.8	53.6	10.8
				Block 5 Total	41.7	42.8	49.6	6.8
				Grand Total	199.6	204.6	249.5	44.9

MONEY OUT OF THIN AIR: THE NATIONWIDE NARROWBAND PCS AUCTION

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The Federal Communications Commission held its first auction of radio spectrum at the Nationwide Narrowband PCS Auction in July 1994. The simultaneous multiple-round auction, which lasted five days, was an ascending bid auction in which all licenses were offered simultaneously. This paper describes the auction rules and how bidders prepared for the auction. The full history of bidding is presented. Several questions for auction theory are discussed. In the end, the government collected $617 million for ten licenses. The auction was viewed by all as a huge success—an excellent example of bringing economic theory to bear on practical problems of allocating scarce resources.

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1. INTRODUCTION

"By combining cutting-edge economic theory and auction procedures, the Federal Communications Commission (FCC) wrung top prices out of bidders for the next generation of paging services." So read the *Wall Street Journal* on August 1, 1994 (p. A4) at the conclusion of the FCC's historic auction. During five days in late July 1994, the FCC held the first of a series of auctions for radio spectrum to be used for personal communication services (PCS)—spectrum needed for tomorrow's portable phones, pagers, and other wireless communication devices. The spectrum promises to revolutionize communications over the next decade. The method of allocation promises to revolutionize the way the government allocates scarce public resources.

In August 1993, the U.S. Congress passed legislation that required the FCC to begin auctioning the spectrum. After months of debate among auction experts and industry representatives, the FCC decided in March 1994 that an innovative auction form, the simultaneous multiple-round auction, would best serve the FCC's objective of

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efficiency. This auction form was proposed by auction experts Paul Milgrom and Robert Wilson of Stanford University and Preston McAfee at the University of Texas. A simultaneous multiple-round auction is similar to a traditional ascending-bid "English" auction, except that, rather than selling each license in sequence, a large set of related licenses is auctioned simultaneously. In every round, a bidder can bid on any of the licenses being offered. The auction does not close until bidding has ceased on all licenses that is, until a round goes by in which there are no new bids on any of the licenses. There are three critical features of this method. First, the ascending-bid aspect allows the bidders to react to information revealed in prior rounds. This reduces the winner's curse, enabling the bidders to bid more aggressively. Second, by auctioning a large set of related licenses simultaneously, bidders are able to condition on relative prices across licenses. Since bidder valuations depend on the combination of licenses held, providing this price information on related licenses is essential to the formation of efficient aggregations of licenses. Some licenses are complements, whereas others are substitutes. The simultaneous sale of related licenses in an ascending-bid auction gives the bidders the flexibility they need to express these value interdependencies. In addition, it assures that similar licenses will sell for similar prices. Third, keeping the bidding on all licenses open until there are no new bids gives the bidders the most flexibility in switching among license aggregations as prices change.[1]

The FCC decided to begin with the simplest of the auctions, the auctioning of ten nationwide narrowband licenses.[2] The ten licenses not only are small in number, but since they are nationwide licenses, the aggregation issues are much simpler. Unlike the other licenses, geographic aggregation is not an issue with nationwide licenses. The sole aggregation issue comes from the fact that a bidder can acquire up to three nationwide licenses. However, despite the small number of licenses the auction is an important one. The ten licenses amount to over 40% of the total narrowband PCS spectrum to be auctioned.

1. See McMillan (1994a) and Chakravorti et al. (1995) for a discussion of the FCC's auction design decision. It should be emphasized that the FCC's objective in designing the auction was not revenue maximization. Rather, the FCC seeks to maximize social welfare by allocating the spectrum in the most efficient way possible. If revenue maximization were the goal, the FCC would auction just a single license in each region, which would be inconsistent with the public interest.

2. Narrowband refers to the relatively narrow slice of spectrum (about 50 kHz) associated with each of these licenses in contrast to broadband licenses, which have a bandwidth of as much as 30 MHz (almost 1,000 times that of the narrowband licenses). Narrowband is ideal for advanced paging services, voice messaging, and e-mail. The wider bandwidth of broadband is necessary for real-time voice communication.

From a consumer viewpoint, it made sense to allocate these high-value licenses first to hasten the development of narrowband PCS services.

This first auction was viewed by everyone as an experiment. The stakes were enormous. If the auction failed, it would mean that the FCC would have to rethink its entire auction strategy. Firms and consumers would have to tolerate further delays and more uncertainty. Fortunately, the auction was a huge success. Not only did the U.S. Treasury collect $617 million, ten times more than preliminary estimates,[3] but the licenses went to the bidders that valued them the most—the bidders most apt to make the best use of the spectrum. The time required to conduct the auction was just five days.

In the past, licenses were awarded by "comparative hearings," an FCC administrative proceeding, conducted by an administrative law judge. Comparative hearings could take years to award a license. Often the selection among similar applications was based on arbitrary factors. In 1982 Congress granted the FCC the authority to use lotteries, and in 1984 the Commission switched to lotteries to award cellular licenses. As with comparative hearings, rent seeking was common in the lottery process. The FCC received nearly 400,000 applications for cellular licenses. This onslaught of applications reduced the one apparent advantage of lotteries: speed. Moreover, in terms of awarding licenses to the firms that are best able to develop the spectrum, lotteries may be even worse than comparative hearings, since selection is random. Even when resale is allowed, lotteries are inefficient because a lottery winner has a strong incentive to misrepresent its private value of the license in negotiations with potential buyers (Cramton et al., 1987). In the cellular industry, it took ten years for efficient license aggregations to form through resale.

Economists have been arguing for auctions for decades.[4] This July they finally got their way. Perhaps more surprising is that firms also lobbied for auctions. One might think that the firms would prefer being "given" the spectrum. The problem is that neither comparative hearings nor lotteries would necessarily award spectrum to firms with legitimate spectrum needs. These firms had to buy the spectrum from the lucky few that were given spectrum. With comparative hearings or lotteries, the firms still pay for the spectrum, but in a process

3. It should be emphasized that the preliminary estimates made by the Congressional Budget Office and the Office of Management and Budget were based on uninformed speculation. The estimates do not reflect any analysis of either the supply or demand for PCS services. In contrast, the firms' bids are based on detailed demand studies and substantial research and development in PCS services and technologies.

4. See Coase (1959), Kwerel and Felker (1985), and Kwerel and Williams (1993).

fraught with rent seeking and delay. Firms, consumers, and taxpayers all benefit from the allocation of spectrum by auction (see McMillan, 1994b).

The goals of this paper are modest. I begin by describing the auction rules and discussing some design issues (Section 2). Then in Section 3, I describe how firms prepared for the auction. In Section 4, I present a detailed history of the bidding in the nationwide narrowband auction. The bidding history raises many theoretical questions, which are discussed in Section 5. I do not offer a full theoretical analysis of the simultaneous multiple-round auction, nor do I review basic auction theory.[5] There are no new theorems here. Rather my intent is to present some of the issues and provide all of the data in the hope that this will stimulate future theoretical and empirical work based on these auctions.

2. Auction Rules

The auction rules for the nationwide narrowband auction were detailed in the FCC's Third Report and Order (1994). Ambiguities were then resolved in subsequent public notices. In what follows, I summarize the rules that were used in the nationwide auction.

2.1 What is Being Auctioned?

There are eleven nationwide narrowband licenses. The licenses come in three different types: 50/50 kHz paired licenses, 50/12.5 kHz paired licenses, and 50 kHz unpaired licenses. With the "paired" licenses, the first number denotes the amount of outbound capacity (from transmitter to consumer unit), and the second number denotes the amount of inbound capacity (from consumer unit to transmitter). An unpaired license consists of only outbound capacity. Inbound spectrum is not the same as outbound spectrum. The inbound spectrum, which is in a very quiet (low interference) part of the spectrum (900 MHz), can only be used for low-power transmissions. This makes it ideal for transmission from small consumer devices but ill-suited for transmission from network transmitters, which must use greater power to reach the low-power consumer devices. Hence, one 50/50 kHz paired license is not the same as two 50 kHz unpaired licenses. There are five 50/50 kHz licenses (lot numbers 1 to 5), three 50/12.5 kHz

5. However, I can direct the reader to several excellent surveys of auction theory: McAfee and McMillan (1987), Milgrom (1987, 1989), Wilson (1992b), and Rothkopf and Harstad (1994). The reader should also consult the seminal work of Milgrom and Weber (1982).

licenses (lot numbers 6 to 8), and three 50 kHz licenses (lot numbers 9 to 11). License 9, one of the 50 kHz licenses, was not up for auction because it had been set aside for Mtel as a Pioneer's Preference award.[6]

An auction winner gains the exclusive right to use the spectrum in accordance with FCC rules for a period of ten years. Licenses typically are renewed without charge provided the licensee has adhered to FCC rules and met build-out requirements. A bidder can win up to three licenses.

The licenses are auctioned simultaneously. In any round, a bidder can bid on any subset of the licenses for which it has applied, such that the number of bids in any round is no more than the bidder's current eligibility.

2.2 Designated Entities

To encourage broad participation in PCS markets, firms controlled by women or minorities (so called "designated entities" or DEs) are given a 25% bidding credit on licenses 5, 8, and 11. This discount is designed to offset any discrimination these firms may face in raising capital and offering PCS services.

2.3 Payment Rules

Payments are received by the FCC at three times: (1) An upfront payment before the bidding begins assures that the bidder is serious. Any withdrawal penalties are taken from the bidder's upfront payment. (2) A down payment of 20% is paid within five business days after the close of the auction. (3) A final payment of the remaining 80% is paid within five business days of the award of the license.[7]

The upfront payment, due two weeks before the auction begins, defines the bidder's maximum eligibility in any round of bidding.[8] Each bidder must make an upfront payment of $350,000 per license

6. Pioneer's Preference awards were intended to be rewards to innovative firms for their "pioneering" technology. In practice, the Pioneer's Preference process suffers from the same rent-seeking problems as "comparative hearings." Under pressure from Congress, it has since been abandoned. See footnote 31.

7. Licenses are awarded one to three months after the auction. The time until award depends on whether a party files a "petition to deny" the award of the license, in which case an additional review process must be carried out.

8. Significant upfront payments are important to assure that the applicant is a serious bidder. The Interactive Video Data Services (IVDS) auction, held on July 27–28, was marred by several defaults by winning bidders (*Washington Post*, August 31, 1994, p. F1). The defaults were apparently the result of bidders not fully understanding the auction rules before the auction. A large upfront payment, which can serve as a penalty in the event of default, provides an incentive for bidders to be well prepared.