

technical characteristics than broadband PCS licenses, such an EICA would provide valuable experience for later application to broadband PCS.

D. Bidding Competition

Because of the multiplicity of PCS licenses being auctioned, bidding competition (the number of bidders) for some licenses is likely to be weak. This could be the case, for example, for licenses in rural areas. In such a situation, a party might obtain a license for far less than the price at which that party actually values it, thus reducing the revenue to the government from that license, and conceivably the economic efficiency of the auction process.

The Commission discusses a reserve price as a means of protecting the expected return to the government, and royalty payments by winning bidders as one of several alternative payment methods, especially for use by designated entities. Because both a reserve price and a royalty payment can affect expected revenues, NTIA believes that these mechanisms could be viable alternative safeguards against awarding licenses for trivial sums.⁴⁵ Although both alternatives pose implementation and efficiency issues, the Commission should consider their use. Doing so would be consistent with the provisions of the Budget

⁴⁵ See NTIA Staff Paper at 38-40.

Act designed to guard against "unjust enrichment" as a result of the methods employed to distribute spectrum.⁴⁶

A reserve price is a price below which a "seller" (in this case the Commission) will not agree to the "sale" of the asset being auctioned.⁴⁷ A properly set reserve price can increase revenue. It also creates the possibility that the Commission will not assign a license at all if no bids meet the reserve price.⁴⁸ Such a "loss" potentially could distort an efficient assignment of PCS licenses. Moreover, as the Commission notes, estimating the appropriate reserve price could be difficult.⁴⁹

Alternatively, the Commission could set a royalty rate and solicit bids on an up-front, initial payment.⁵⁰ A royalty rate

⁴⁶ See Budget Act, § 6002(a), to be codified at § 309(j)(3)(C), (j)(4)(E).

⁴⁷ A reserve price differs from a "minimum bid" in that the former is customarily not disclosed to bidders prior to completion of the auction. We interpret the Commission's discussion in the Notice as applicable to a "reserve price." See Notice, paras. 66-67.

⁴⁸ If the Commission used a reserve price, it would not permanently decline to assign the license. It could evaluate the results of successful bidding for similar licenses, adjust the reserve price, and hold a new auction when it chose to award the license.

⁴⁹ Notice, para. 67.

⁵⁰ For many federal government oil and gas leases, for example, a royalty is set in advance, and the bid is only for the bonus, or up-front payment. The royalty is based on gross revenues, and based at least in part on an estimate of what the royalty would have been in a private negotiation. For example, 43 U.S.C.

(continued...)

can increase both efficiency and the number of bidders for a license, because it would shift to the federal government a portion of the risk that the PCS enterprise will be successful. Because a bidder will bear less risk with a royalty rate payment, and will require less up-front capital to participate in bidding, the result could be more bidders, more aggressive bidding and, therefore, a higher expected revenue.

Compared to a reserve price, NTIA prefers a royalty as a method to ensure revenue to the government because it does not raise the possibility that the PCS license will go unassigned. Thus, the public interest benefits of the rapid provision of PCS would be preserved. However, as the Commission notes,⁵¹ setting an appropriate royalty rate may be difficult, and could require the Commission to establish accounting rules or revenue reporting requirements for entities that use PCS licenses as part of an integrated communications service. Moreover, a royalty would result in a lower initial payment to the federal government for PCS licenses than a lump-sum payment. Nevertheless, despite these difficulties, NTIA believes that the Commission may be

⁵⁰ (...continued from preceding page)
§ 1337 grants the Secretary of the Interior authorization to promulgate regulations for the awarding of certain types of Outer Continental Shelf and gas leases through competitive bidding. Section 1337(a)(1)(A) allows a "cash bonus bid with a royalty at not less than 12½ per centum fixed by the Secretary" Other subsections permit additional formulations of bids.

⁵¹ Notice, para. 70.

justified in employing either a reserve price or a royalty rate in order to avoid assigning PCS licenses for trivial sums.

III. TREATMENT OF DESIGNATED ENTITIES

The Budget Act directs the Commission to consider the needs of small businesses, rural telephone companies, and businesses owned by members of minority groups and women in the competitive bidding process.⁵² NTIA believes that this is an important objective for the federal government, and encourages the Commission to develop rules to implement competitive bidding for PCS that will provide greater opportunities for participation by these groups, particularly those that are constrained from full participation in bidding because of a lack of available capital.

Among other things, the Commission seeks comment on the extent to which it should, and has the authority to, extend preferences to minorities and women.⁵³ Under the governing legal standard, the Commission must demonstrate that preferences for minorities and women are substantially related to the objectives of the Budget Act.⁵⁴ As the Commission notes, extending preferences to small businesses and other small entities could

⁵² Budget Act, § 6002(a), to be codified at 47 U.S.C. § 309(j)(3)(B), (j)(4)(D).

⁵³ Notice, para. 74.

⁵⁴ Notice, para. 73 (citing Metro Broadcasting, Inc. v. FCC, 497 U.S. 547 (1990); Richmond v. J.A. Croson Co., 488 U.S. 469 (1989); Fullilove v. Klutznick, 448 U.S. 448 (1980); Lamprecht v. FCC, 958 F.2d 382 (D.C. Cir. 1992)).

indirectly promote opportunities for women and minorities. However, preferences tied to status regardless of economic circumstances could pose legal problems, depending on the applicable legal standard of judicial review.⁵⁵ In the discussion that follows, we do not address the constitutional issues raised by the Commission, but focus on policy issues.

The Commission requests comment on measures proposed by the Small Business Advisory Committee in its report on PCS licenses.⁵⁶ NTIA agrees generally with the intent and direction of the findings and conclusions of that report. Capital formation is one of the major barriers to full participation by small and minority businesses in the communications field, and the Commission should undertake measures to promote licensing opportunities for such capital-constrained groups. As a matter of economic theory, capital-constrained firms, such as some small businesses and many of those owned by minorities and women, are likely to assign lower values to PCS licenses than other bidders due to the effects of bidder asymmetry.⁵⁷ Hence, capital-constrained firms are unlikely to win licenses in an open bidding market. The Commission's tentative decision to set aside two PCS

⁵⁵ Notice, para. 75.

⁵⁶ Notice, para. 80 (citing Report of the FCC Small Business Advisory Committee to the Federal Communications Commission Regarding Gen Docket 90-314 (Sep. 15, 1993) (SBAC Report)).

⁵⁷ See NTIA Staff Paper at 32.

licenses in every market for bidding by designated entities will ensure greater economic opportunity for such groups.⁵⁸

NTIA supports the Commission's proposal, consistent with the Small Business Advisory Committee's report, to allow designated entities to pay for their PCS licenses in installments.⁵⁹ We believe that installment payments should be available for designated entities that win non-set-aside licenses as well as set-aside licenses.

NTIA also agrees with the Small Business Advisory Committee's recommendation to expand the Commission's tax certificate program to include PCS licenses.⁶⁰ Tax certificates should be available to investors in those Small Business

⁵⁸ See PCS Second Report and Order, para. 60 n.61; Notice, para. 125. NTIA urges the Commission to structure its preferences for minorities and women in a fashion that minimizes abuse. We agree with the Small Business Advisory Committee that minority- and female-backed applicants should be 51% controlled by minorities or women, SBAC Report at 22, and that licenses awarded to designated entities should be subject to an anti-trafficking provision.

⁵⁹ Notice, para. 68. There are also bidding competition issues for the set-aside blocks analogous to those discussed supra at p. 22. NTIA therefore supports the use of royalty payments, if the Commission believes them appropriate, for designated entities as a way of encouraging greater participation for the bidding on such licenses, while also preventing them from being assigned for trivial sums.

⁶⁰ We agree with the Commission, however, that it should implement specific procedures to prevent unjust enrichment to parties that obtain licenses pursuant to some specific provision designed to ensure their participation in the provision of spectrum-based services. See Notice, paras. 83-84.

Investment Companies (SBICs) and Specialized Small Business Investment Companies (SSBICs) that specialize in telecommunications and agree to commit funds to PCS firms and related enterprises.⁶¹ The SBICs and SSBICs, which are chartered by the Small Business Administration, would have greater access to capital, which could be used to provide start-up financing to small businesses and businesses owned by minority groups and women that win PCS licenses through competitive bidding. The investors in such SBICs and SSBICs would be entitled to defer capital gains upon selling their interests.

⁶¹ We believe the Commission has the legal authority to extend its tax certificate policy in this fashion. See Budget Act, § 6002(a), to be codified at 47 U.S.C. § 309(j)(D)(4); Telocator Network of America, 58 Rad. Reg. 2d (P&F) 1443, 1447-50 (1985), recon. dismissed, 1 FCC Rcd 509 (1986) (tax certificates may be issued with respect to transfers of non-wireline cellular interests). See also SBAC Report at 19-20.

IV. CONCLUSION

NTIA supports the Commission's efforts to establish an appropriate auction mechanism for PCS licenses. Accordingly, NTIA respectfully requests that the Commission adopt the recommendations contained in these comments.

Respectfully submitted,

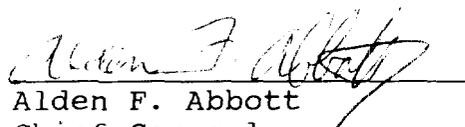
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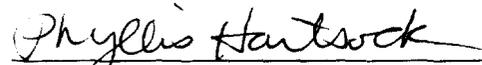
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November 10, 1993

Attachment 1

ISSUES IN IMPLEMENTING A PERSONAL COMMUNICATIONS SERVICES AUCTION

Office of Policy Analysis and Development

Staff Paper

By

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with assistance from William Maher

November 10, 1993

National Telecommunications and Information Administration

The views expressed herein are those of the authors, and do not necessarily reflect the views of the National Telecommunications and Information Administration. The authors would like to thank Carol Matthey and Cynthia Nila for their assistance in preparing this paper.

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I. Introduction

An "auction" is a market mechanism with an explicit set of rules for determining resource apportionment and price based upon bids from market participants. In the upcoming months, the Federal Communications Commission (Commission) must select an auction mechanism¹ for assigning Personal Communications Service (PCS) licenses. This paper addresses the most important economic issues the Commission must consider in selecting such an auction and, based upon this assessment, recommends the most appropriate auction form. The paper also analyzes some of the Commission's tentative recommendations regarding the form of the auction, both generally and with respect to PCS in particular.²

This paper is organized in the following manner. Section II discusses the nature of the property rights (i.e., the "auction instrument") acquired by a PCS license winner. Recognizing that the Commission has recently decided much about the nature of

¹ The auction design process seeks to accommodate uncertainty about the value of the item being auctioned. For instance, if the Commission knew how much a PCS license was worth to each bidder, then the optimal market mechanism would be to announce a nonnegotiable price for such a license which is just below the highest bidder's valuation. Because the Commission does not know these valuations, it must choose among auction mechanisms that will likely yield results that are suboptimal compared to the situation in which all relevant information (i.e., vector of prices) is available.

² Implementation of Section 309(j) of the Communications Act Competitive Bidding, Notice of Proposed Rulemaking, PP Docket No. 93-253, FCC 93-455 (released Oct. 12, 1993) (Notice).

these rights, in later sections we focus on how some of its decisions will affect the outcome of the auction. Section III acquaints the reader with essential auction theory nomenclature, including the auction design challenges resulting from certain special features of PCS licenses and auction selection criteria. For instance, the value that a bidder places on being awarded a PCS license will, in many instances, depend on what other geographically adjacent licenses it has also won. If not handled properly, this "value interdependency" feature of a PCS auction will cause the auction to be "economically inefficient" (i.e., licenses will not be assigned to those bidders that value them the highest) and will have poor revenue generating capability.

Section IV discusses the so-called "common" versus "private value" distinction in auction design and analyzes which of these settings best characterizes the source of the differences in bidders' valuations for PCS licenses. This distinction is important because private and common value auctions have different efficiency and revenue generating characteristics.

Section V addresses whether all the PCS license bidders are likely to draw their PCS license valuations from the same statistical distribution and, if not, the effect of this "bidder asymmetry" on auction performance. Section VI discusses bidding competition and methods of reducing the unfavorable effects of "too few" bidders. Section VII discusses whether all bidders

have the same risk preferences or whether bidders react to uncertainty in different ways. The answers to the questions raised in Sections IV - VII will have a profound impact on bidder behavior and thus auction performance. Section VIII addresses the issue of bidding complexity in an oral auction versus a first-price sealed-bid auction. Section IX discusses and analyzes the Commission's proposed auction mechanism. Finally, in Section X we offer a summary and our recommendation regarding the best auction form.

II. PCS Licenses: Characteristics of the Auction Instrument and Related Commission Requirements

The characteristics of the item being auctioned, which together define the "auction instrument," help determine the most appropriate auction form.³ The Commission recently determined many of the important characteristics of PCS licenses. It will award two 30 MHz licenses in each of 51 Major Trading Areas (MTAs) in the United States. In addition, in each of the 492 Basic Trading Areas (BTAs) in the United States, the Commission will award one 20 MHz license and four 10 MHz licenses. Thus, in any given locality, there will be at most seven licensed PCS providers, although the geographic scope and amount of spectrum associated with each license will vary. The term of each license will be ten years, with provisions for a renewal expectancy similar to those that currently apply to the cellular service.

³ The relationship between these characteristics and the proper auction form is discussed in later sections.

The PCS auction involves assigning largely non-identical spectrum blocks to winning bidders. The non-uniformity in the value of PCS licenses occurs both across PCS license areas and within a given license area. Regarding the former, a PCS license for New York City will certainly be, because of its high service demand, more valuable than one covering Pine Bluff, Arkansas. With regard to the latter, as noted, the amounts of spectrum per license vary in a given geographic area (i.e., 10, 20, and 30 MHz). Moreover, within the spectrum allocated for PCS in any geographic area, fixed microwave users are sometimes distributed in a non-uniform fashion. Because of this non-uniformity and the interference that these users can sometimes create, the underlying value of spectrum licenses will differ among frequencies within some geographic areas.

The Commission has also established eligibility restrictions that will limit the ability of some entities to bid on certain PCS licenses. Within its existing service areas, each cellular licensee will be permitted to bid only on one 10 MHz license. Cellular licensees will be free to bid on any license outside of their existing service areas or in any PCS service area where they serve less than 10% of the population. Local exchange carriers will be free to bid on any PCS license, except to the extent they are precluded by their cellular interests. The Commission also has tentatively concluded that the only entities that will be permitted to bid on the 20 MHz and one of the four

10 MHz blocks of spectrum and are small businesses, rural telephone companies, and businesses owned by minorities and women.

III. Background on Auctions

Economists classify auctions according to the different rules that govern the asset's exchange. These rules are important because they can affect bidding behavior and, therefore, the terms (i.e., revenue) and the efficiency of an exchange. The two most general auction categories are "continuous" or "oral" auctions and "static" or "sealed-bid" auctions. A continuous auction is one in which the bidder may alter its bid in response to the bids of others, or the failure of a bid to be accepted. The term "continuous" is used to convey the fact that the auction process continuously makes available bid information so as to allow bidders to either update or place an initial bid. A "static" auction is one in which a bidder has only a single opportunity to win the item at auction. In such an auction, bids are submitted to a seller which ranks all bids and announces the winning bidder's identity and the price at which the auctioned item was won.

A large number of auctions fall within each of these two categories. For instance, the two principal continuous auctions are the oral ascending-bid auction ("English" auction) and the oral descending-bid auctions ("Dutch" auction). In the English

auction, a prospective buyer begins by announcing a bid. Bidders successively raise the standing bid until no more bids are forthcoming. The item is then awarded to the highest bidder at the price bid. In the Dutch auction, the seller begins by asking a price judged to be well in excess of what the highest bidder is willing to pay, and lowers the price until the first buyer accepts. The item is then awarded to that buyer at the price accepted.

Similarly, the two primary static auctions are the first-price sealed-bid auction and the second-price sealed-bid (or "Vickrey") auction. In a first-price sealed-bid auction, the seller collects sealed bids and awards the asset to the highest bidder at a price equal to its bid. In a second-price sealed-bid mechanism, the seller would award the asset to the highest bidder at a price equal to the second highest bid.

Economic theory permits the four major auction forms to be ranked according to expected revenue when a single unit is offered at auction and under other simplified conditions.⁴

⁴ W. Vickrey, Counterspeculation, Auctions, and Competitive Sealed Tenders, 16 J. of Finance 8-37 (1961) (Vickrey, Counterspeculation). Vickrey showed that, under certain conditions, the four major auction forms yield the same revenue for the seller. These conditions are: (1) risk neutrality among bidders; (2) private values model; (3) private values are independently drawn from a common distribution; (4) payment is a function of bids alone (i.e., no royalties). See McAfee & McMillan, Auctions and Competitive Bidding, 25 J. of Econ. Literature 706 (1987) (McAfee & McMillan, Auctions).

However, because an auction's performance is sensitive to slight changes in its design and the bidding environment in which it is used, the superiority of any one auction form becomes less clear under conditions that are likely to exist in a PCS auction. For instance, because the strategic value of owning a PCS license may differ among bidders, some bidders can be expected to place, on average, a higher value on a PCS license than other bidders. According to theory, in such a bidding environment both a second-price sealed-bid and an English auction always assign the object to the bidder that values the item most highly and, therefore, are economically efficient, but the first-price sealed-bid auction may not assign the object to such a bidder.

A. Multiple-Unit Issues

The preceding definitions of the four major auction forms assume that a single item is up for auction. However, in many situations, as in the monthly Treasury Bill auction, multiple units of an item are offered at auction. The PCS auction is a multiple unit auction because the Commission will be awarding thousands of PCS licenses.⁵

⁵ More technically, a multiple-unit auction consists of at least two single-unit subauctions in which a bidder may submit losing bids in several subauctions yet still win one or more units by placing the highest bid in one or more of the remaining subauctions. See T. Palfrey, Multiple-Object, Discriminatory Auctions with Bidding Constraints: A Game-Theoretic Analysis, 26 Mgmt. Sci. 935-46 (1980).

Each of the four major auction forms has a multiple-unit counterpart.⁶ Unfortunately, because of the existing complexities of the single unit forms, very little systematic research has been conducted on their multiple-unit analogues. What little research there is either assumes the bidders are interested in acquiring multiple units of a homogeneous good (e.g., Treasury Bills), or that bidders are interested in acquiring at most one unit of the non-identical good.⁷ We are

⁶ Both oral and sealed auctions are employed to exchange multiple units that are considered to be identical (e.g., the sale of stocks and bonds in the securities markets). When the auctioned items are considered "non-identical," the units are sometimes sold sequentially at auction (e.g., the sale of different lots of Australian wool). The Department of the Treasury uses a sealed-bid auction mechanism to sell its Treasury Bills. Participants submit both a bid and quantity for the auctioned security. Such bids, which are in the form of yields (i.e., discount rate for bill auctions), are ranked in ascending order. The highest bids are accepted until the offering has been fully placed. "Competitive bidders" (i.e., institutional bidders) whose bids are accepted pay a price equal to their bids. Submitting an informed bid in the competitive auction is difficult and costly. For bidders unable to pay these costs (i.e., small institutional and individual investors), the Treasury designed an alternative method for auction participation: a "non-competitive" bidder can submit a request for securities up to a pre-designated limit. These requests are satisfied at a price corresponding to the weighted average yield of accepted competitive bids. See U.S. Dep't of the Treasury, U.S. Securities and Exchange Commission, and Board of Governors of the Federal Reserve System, Joint Report on the Government Securities Market (Jan. 1992).

⁷ See K. McCabe, S. Rassenti, & V. Smith, Auction Institutional Design: Theory and Behavior of Simultaneous Multiple-Unit Generalizations of the Dutch and English Auctions, 80 Am. Econ. Rev. 1276-83 (1990); G. Demange, D. Gale, & M. Sotomayor, Multi-Item Auctions, 94 J. Pol. Econ. 863-72 (1986).

unaware of any research that evaluates the efficiency and revenue characteristics of any auction that is used to sell multiple non-identical goods to buyers that are interested in acquiring at least one of these goods.⁸

Due to the lack of research, it is not clear whether the efficiency and revenue characteristics of the single-unit forms will carry over to their multiple-unit counterparts. Consider a Vickrey auction involving the simultaneous auctioning of two identical units and where bidders have an interest in acquiring more than one unit.⁹ When a single unit is auctioned, each bidder in a Vickrey auction has the incentive to submit a bid that is equal to the value it places on the auctioned item.¹⁰ However, when two or more units are offered at auction, and when bidders have an interest in acquiring more than one unit, bidders may not have the incentive to bid their true valuations on each unit.¹¹

⁸ The multiple-unit counterparts of the four major auction forms are not well understood. Moreover, the PCS auction is complicated by the fact that it involves awarding licenses whose collective value, in many areas, exceeds the sum of their individual values.

⁹ See infra pp. 51-66 for examples of English auctions (both simultaneous and sequential) in which single-unit auction results do not obtain in a multiple-unit context.

¹⁰ Vickrey, Counterspeculation, at 8-37.

¹¹ The single-unit results extend to the multiple-unit case in which each bidder submits a bid for one of Q identical units. See Vernon Smith, Auctions, in The New Palgrave: A Dictionary of Economic Theory and Doctrine 140 (J. Eatwell, M. Milgate, & P. Newman eds., 1987) (Smith,

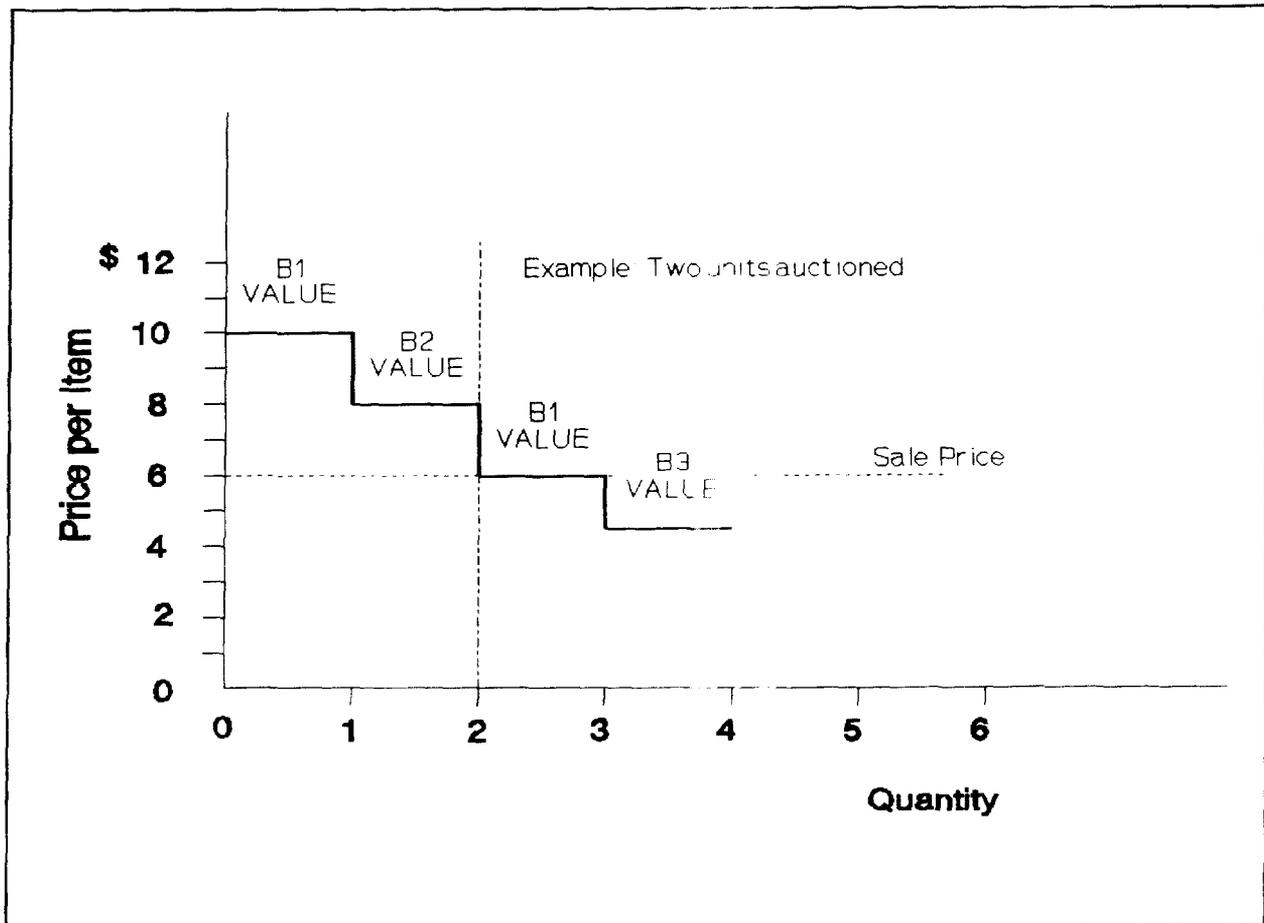


Figure 1: THIRD-PRICE SEALED-BID AUCTION¹²

To explain this further, Figure 1 contains a set of bidder valuations (e.g., B1 = Bidder #1) that are arrayed in descending order and an auction size equal to two units. Since bids are

Auctions).

¹²

When a single unit is for sale, a Vickrey auction is termed a second-price auction because the item is sold at a price equal to the second highest bid (i.e., the highest rejected bid). By extension, a Vickrey auction is a third-price auction when two units are for sale because the item is sold at a price equal to the third highest bid.

made independently, bidders do not know each others' bids prior to submitting their own bids. The top two bids are accepted and the auctioned units are sold at a price equal to the highest rejected bid (i.e., the third highest bid). In this example, Bidder #1 wishes to acquire two units of the auctioned item. If Bidder #1 had known Bidder #2's bid, Bidder #1 could have lowered its bid on its second unit (i.e., the third highest bid), thereby increasing its earnings on its first unit. Therefore, in this third-price sealed-bid auction, Bidder #1 may not have the incentive to bid its true valuation for each unit desired. Unfortunately, we know of no research on the best way for bidders to formulate their bids in this environment.¹³

B. Special Features: PCS License Nonhomogeneity and Value Interdependencies

The PCS auction is a "special" type of multi-object auction. As noted above, in an "ordinary" multi-object auction, the objects being auctioned are identical (e.g., U.S. Treasury Bills). The identical nature of the auctioned items means that bidders do not have to keep track of the identities of the objects being auctioned. From the bidder's perspective, one item is the same as another. The PCS auction is special, in part, because the objects being auctioned -- different PCS licenses -- have different technical and economic characteristics. This

¹³ This example assumes that the items at auction are homogenous. Because the PCS auction involves the sale of non-homogenous items, the results of this example may not apply to such an auction

feature means that the bidder must keep track of the identities of the objects being auctioned. When the items at auction have different characteristics, it is customary to treat their simultaneous sale as a collection of independent auctions.¹⁴

The PCS auction is also "special" because the value bidders place on acquiring a particular spectrum license will depend on what other geographically adjacent licenses they have also won. This interdependency in the value of PCS licenses is due to the value PCS users place on being able to "roam" from one license area to another.¹⁵ As a result, the value of a collection of geographically adjacent spectrum licenses will likely be greater than the sum of their individual values. The existence of this "synergy" means that it is inappropriate to treat the assignment of multiple PCS licenses as a collection of independent auctions. If so treated, the resulting allocation of spectrum licenses will fall short of the most economically efficient assignment of such licenses.¹⁶

¹⁴ R. Engelbrecht-Wiggans & R. Weber, An Example of a Multi-Object Auction, 25 Mgmt. Sci. 1272-77 (1979).

¹⁵ Such value interdependency may also be due to the presence of economies of scope in providing PCS service over large geographic areas. The paper, however, emphasizes roaming-induced value interdependency because this source of interdependency has been clearly demonstrated in the cellular industry, while the economies of scope source of such interdependency is less clear.

¹⁶ Put another way, the bidder that values a group of licenses most highly is not necessarily the bidder that values each individual license most highly. If bidders

Similarly, interdependencies may exist among the spectrum blocks being licensed in any geographic area. Such interdependencies may arise, for example, if PCS providers find that they need more than 30 MHz to offer service in an area. The Commission recognizes this possibility by permitting bidders (other than some incumbent cellular providers) to aggregate up to 40 MHz of spectrum in any area.

A "combinatorial auction" and a "contingent bid auction" are alternative mechanisms for capturing the synergies between PCS licenses. In a combinatorial auction, bidders submit bids for one or more combinations of PCS licenses in different geographic areas (or for different spectrum blocks in an area).¹⁷ In a contingent bid auction, each bidder submits a list of bids, where each bid in the list corresponds to some assumed auction outcome. For example, a bidder may submit a bid which will be in effect

are only permitted to bid on individual licenses in a sequential fashion, the bidder that values the collection of licenses most highly may not win each auction. The resulting allocation would, therefore, be inefficient.

¹⁷ The combinatorial auction was initially designed to handle a resource allocation problem involving airport takeoff and landing time slots. Airlines wish to acquire flight-compatible takeoff and landing rights at airports located at distinct city-pairs. Taken individually, a takeoff or landing right is worthless to airlines. An efficient solution to this allocation problem requires allowing airlines to express their combined valuations for takeoff and landing rights. See K. McCabe, S. Rassenti, & V. Smith, Smart Computer-Assisted Markets, 254 Science 534-38 (1991).

assuming it has also won the auction involving a PCS license for an adjacent geographic area. On the other hand, the same bidder may submit a lower bid which will be in effect assuming it has lost the auction regarding the adjacent PCS license.

Combinatorial and contingent bid auctions have similar abilities to capture the interdependencies in PCS license values. In order to capture these interdependencies, the seller must elicit from bidders a menu that lists the valuation each bidder places on different bundles of PCS licenses. Both the combinatorial and contingent bid auctions elicit such information from bidders. In contrast, a "sequential" auction, in which licenses are auctioned one by one, fails to elicit such valuations.¹⁸ Moreover, because the two auction forms will elicit similar bids from the same bidder, the combinatorial and contingent bidding auction forms will have similar performance properties.¹⁹

C. Auction Selection Criteria

Prior to selecting an auction form, the FCC must establish the criterion by which to compare the various auction forms.

¹⁸ See discussion infra pp. 61-66.

¹⁹ See J. Banks, J. Ledyard, & D. Porter, Allocating Uncertain and Unresponsive Resources: An Experimental Approach, 20 *Rand J. Econ.* 15 (1989). Because the contingent auction requires bidders to present a menu that lists the valuation each bidder places on all the different bundles of PCS licenses, it is more complex than the combinatorial auction.