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Vickrey Auctions in Practice: From Nineteenth-Century Philately to Twenty-First-Century E-Commerce

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In his seminal work on auction theory, William Vickrey (1961) pointed out three types of auctions used in practice: the English ascending-bid auction, the (first-price) sealed-bid auction, and the Dutch declining-price auction. He first compared the sealed-bid auction, in which all bidders submit sealed bids and the highest bidder wins at his bid price, to the Dutch auction, in which prices are called out in a descending order until a bidder claims the item at the current price. Applying game theory to the study of auctions, Vickrey showed that these two auctions are strategically equivalent; that is, a bidder in the Dutch auction should wait until the price falls to the exact amount she would have bid if she had been participating in a sealed-bid auction. He also showed how to compute Nash equilibrium bid strategies for bidders; in both the sealed-bid and Dutch auction formats, each bidder should bid strictly less than her maximum willingness to pay for the good. The amount that the bid should be discounted from the maximum willingness to pay will depend on one's beliefs about the distribution of bids by others; a rational bidder will bid less if she expects the other bids to be relatively low.

Next, Vickrey considered the well-known English ascending-price auction, in which bidders raise each other's bids until only one bidder remains. Vickrey showed that in this type of auction, each bidder's dominant strategy is to keep bidding until the price reaches her maximum willingness to pay for the good, and then to drop out of the auction. The highest-value bidder then ends up winning the good, and paying a price equal to the second-highest bidder's value (plus one bid increment, to guarantee victory). This equilibrium differs from those of the Dutch and sealed-bid auction formats: the optimal strategy for a bidder is to reveal her full

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value for the good (except for the winner, who wins before the auction actually reaches her dropout price), rather than bidding strictly less than her value. Optimal bidding in the English auction is simpler and more robust because it involves dominant strategies; that is, one's optimal bidding strategy does not depend on the bids submitted by one's rivals.

Vickrey then asked whether there existed a sealed-bid procedure that would be strategically equivalent to the English ascending-price auction, in the way that the standard first-price sealed-bid auction was equivalent to the Dutch descending-price auction. He answered in the affirmative, proposing the rules for a "second-price" sealed-bid auction (so named to distinguish it from the standard "first-price" sealed-bid auction) in which each bidder would again have a dominant strategy to bid equal to her own value. As Vickrey wrote: "It is easily shown that the required procedure is to ask for bids on the understanding that the award will be made to the highest bidder, but on the basis of the price set by the second highest bidder."

This second-price sealed-bid auction is frequently called the "Vickrey auction" by economists. Indeed, the economics profession has generally credited Vickrey with being the first to propose this auction format (for example, Milgrom, 1989; McAfee and McMillan, 1987). There seemed to be no examples of a second-price sealed-bid auction occurring prior to Vickrey's 1961 article. In the article, Vickrey discusses the use of the English auction as a standard auction format for various types of goods, the use of the Dutch auction in selling flowers in the Netherlands, and the use of first-price sealed-bid auction for sales of real estate and securities, but nowhere does he indicate that a second-price sealed-bid auction had ever been used. Similarly, an extensive survey of the various types of bidding procedures in practice, by Cassady (1967), makes no mention of the second-price sealed-bid auction.

Indeed, Vickrey auctions have appeared to be so uncommon in practice that Rothkopf, Teisberg and Kahn (1990) were inspired to write an article asking, "Why Are Vickrey Auctions Rare?" They follow tradition by crediting Vickrey with inventing the format: "a sealed second-price procedure (now sometimes called 'Vickrey auctions') that he devised." They also present some examples from the last few decades which are similar in flavor to the Vickrey format: uniform-price auctions of Treasury bills and other securities (that is, the bills are all sold at one price, not at the prices bid by the highest bidders); certain proposed auctions for electric power generation; and stamp auctions, which I will focus on in this paper. Rothkopf, Tiesberg and Kahn note: "In some auctions of collectible items such as stamps and autographs, the auction involves mailed-in sealed bids based on a catalog listing as well as oral bids," and that winning mail bidders pay one bid increment higher than the second-highest bid received.[1]

[1] Thiel and Petry (1995) perform a test of auction theory based on similar stamp auctions. They use an interesting and original data set of bids submitted by mail bidders in stamp auctions from 1923 to 1937. They characterize these auctions as "second-price," recognizing the equivalence discussed in this paper, though their auctions include an English bidding floor in addition to the mail bids.

It turns out that the Vickrey auction has actually been used more often than previously thought. While researching commercial Internet auctions, I came across a website for the company Antebellum Covers, which advertised an auction by mail for Civil War memorabilia. I was intrigued to read that the auction used the second-price sealed-bid rule. I contacted the auctioneer to ask how he came to use this rule, and he replied that it was a standard procedure that had been going on for years in the markets for paper collectibles, from Civil War soldiers' letters to postage stamps. As I investigated further, I found that auctioneers in the stamp market had utilized the second-price sealed-bid auction mechanism for decades, and understood its equivalence to the English ascending-bid auction. In fact, several hundred auctioneers used the pure Vickrey auction, accepting no oral bids whatsoever, as their primary method of business before Vickrey ever wrote his 1961 article—some even before Vickrey was born![2]

This paper presents my research into the history of the Vickrey auction in the market for collectible stamps, and a discussion of possibilities for the expanded use of the Vickrey format in the future.

Precursors to the Vickrey Auction: The Stamp Auctions of the 1870s

The first adhesive postage stamp (the "Penny Black") appeared in England in 1840; the first U.S. postage stamp was issued in 1847; and the hobby of stamp collecting began in earnest in the 1850s. The first 100 stamp auctions took place from 1870 to 1882, most of them in New York City. In the 1890s, such auctions became common, with over 2,000 auctions held worldwide by 1900.[3]

These auctions generally used conventional English ascending-price auction rules. However, from the earliest years, accommodations were made to individuals who wished to bid without having to travel to the auction in person. The first auction catalogue of stamp dealer William P. Brown, New York City, 1878, reads as follows:

> That out-of-town collectors may have equal facilities for purchasing with city collectors, bids may be sent to the auctioneers, Messrs. Bangs & Co., or to William Erving, P.O. Box 3222, N.Y. City, who will either of them represent their bids the same as though they were personally present, and without charge. Thus, supposing either of these parties receives two bids on one lot of 20 and 25 cents apiece, they would start the lot at 21 cents, at which price it would be given to the person sending the 25 cent order, unless some one

[2] Moldovanu and Tietzel (1998) have discovered an even earlier example of a second-price-type mechanism, designed by Goethe in 1797. Goethe's procedure was to pit a single bidder (a publisher) against a secret reserve price, to get the publisher to reveal his true willingness to pay for the manuscript. Unfortunately, Goethe's agent failed to carry out the procedure correctly.

[3] Telephone conversation with Dr. Herbert A. Trenchard, September 1998.

> present advanced, when they would continue to bid, stopping at the limit of 25 cents. Collectors can safely entrust these parties with their bids as strictly confidential, and we trust they will find it more satisfactory than paying the usual dealers' commission of ten per cent for purchasing. Persons sending bids should give the number of the lots and the highest price they are willing to give, when the lot will be bought for them as low as possible consistent with the representation of other bids.

The phrase "usual dealers' commission" refers to the fact that quite a few other stamp auctions had previously offered a "mail bid" service, charging a fee of 10 percent to serve as the bidder's agent on the auction floor. Brown appears to be the first to have waived this fee, with the intention of treating mail bidders exactly the same as floor bidders. This practice is common at many auction houses today, not just with stamps, but also in auctions of wine, art, and other collectibles. Clearly, this absentee bidding anticipates the Vickrey auction in both spirit and effect, because it results in the absent bidder's price being determined by the second-highest bid.

The 1870s also saw the beginning of "mail sales" in the stamp market: sales with no floor bids, but only sealed bids submitted through the mail.[4] The first such sales, held around 1877, were "tender sales," or what economists today would call first-price sealed-bid auctions. Dr. Herbert A. Trenchard, who maintains one of the world's most comprehensive collections of stamp auction catalogues, reports: "Most of these early mail sales were held by stamp dealers in small towns, selling inexpensive stamps, and usually listed in the stamp journals of the time. The major stamp dealers were in the large cities, and they held conventional auctions."[5]

Vickrey Auctions for Stamps: From 1893 to the Present

A Vickrey auction is a natural extension of the two precursors discussed above. Certain standard auctions allowed absentee bidders to submit maximum bid amounts, and awarded goods to winning absentee bids at the price of one increment over the second-highest bid. Other sales accepted only sealed bids, but the winner paid the highest price bid. The Vickrey auction combines these two ideas:

[4] A note on usage: Economists and practitioners differ in their usage of the term "auction." During the course of this research, I interviewed a number of collectors and dealers in the stamp market, and everyone found it puzzling that I used the term "auction" to describe sealed-bid sales of stamps. Due to legal regulations, an "auction"—meaning an English auction with oral bids—can only be conducted by a licensed auctioneer, while a "mail sale" is totally unregulated, assuming it avoids use of the term "auction." Auction regulations vary from one state to another, but this distinction appears to hold in most areas. In the early years of stamp auctions, the stamp dealer who wrote up the catalogue (such as William P. Brown, above) was a separate entity from the auction house (such as Bangs & Co., above) hired to conduct the auction. Today, however, almost all stamp auctions are run by stamp dealers who have obtained their own auction licenses.

[5] Letter from Dr. Herbert A. Trenchard, September 1998.

a sealed-bid-only sale that awards the good at the price of one bid increment over the second-highest bid.

The earliest Vickrey auction I have been able to identify was held by Wainwright & Lewis, of Northampton, Massachusetts, in 1893. Their sale announcement, published in the stamp journal *Golden Star* in March 1893, reads as follows:

> Catalogue of a Collection of U.S. and Foreign Stamps To be sold WITHOUT RESERVE except where noted. Bids will be received up to 4 P.M., May 15, 1893. Bids are for the LOT, and, contrary to the usual custom in sales of this kind, we shall make this a genuine AUCTION sale; that is to say, each lot will be sold at an advance of from 1c to 10c above the second highest bidder. Address all bids to Wainwright & Lewis, Northampton, Mass.

The phrase "an advance of from 1c to 10c above the second highest bidder" indicates that the final price would be one minimum bid increment above the second-highest bid. In calling this a "genuine AUCTION sale," Wainwright & Lewis are indicating their recognition that "selling at one advance over the second highest bid" is the key feature of a standard English ascending-price auction (as contrasted with the "usual" sealed-bid sale, which used a first-price rule).

Wainwright & Lewis appear to have held no further auctions, but the same concept was used by others. In 1897, the pioneering stamp dealer William P. Brown of New York, earlier noted as the first to offer no-fee mail bids, became the first major stamp dealer to hold a Vickrey auction, with his Auction Sale No. 2. The Terms of Sale listed in the catalog describe the public reserve prices used in the auction (referred to as the dealer's own offer to buy), the minimum bid increments (5 cents for bids under $1, 10 cents for bids from $1 to $5, and so on), shipping arrangements, and the following description of the pricing rule:

> These goods are not sold publicly to those who come in person, but to those who send or hand us their offers, which are confidential until after the sale. The highest offer secures the purchase. . . . At the time appointed for the sale all the offers received will be examined and awarded to the highest competitor. For instance we will suppose lot No 2006 has on it our offer of $1.50; and we find three others, one for $1.60, one for $2, and one for $10.00. The $10. offer receives it for $2.10, which is the lowest price at which he could obtain it if all the competitors were present.

The Vickrey auction format spread gradually to other stamp dealers. Several companies established long-running businesses based on Vickrey-style "mail sales," including B.L. Voorhees of Blue Island, Illinois (starting with Sale 7 in 1906); Western Stamp Co. of Omaha, Nebraska (starting with Sale 15 in 1907); Toledo Stamp Company of Toledo, Ohio (starting with Sale 15 in 1907); The Postage Stamp Company of San Francisco, California (starting with Sale 1 in 1913); and Henry Wendt of Earlville, Iowa (starting with Sale 142 in 1920). Most of these companies had started out with first-price sealed-bid auction rules, but switched to second-price rules at the dates indicated.

Through 1920, such "mail sales" remained small relative to the conventional English auction business in stamps, in terms of both price and quantity. Even among the mail sales, Vickrey auctions remained less common than first-price sealed-bid auctions. However, some of the Vickrey-style auctioneers took great care to explain the benefits of their auction format to their bidders. Toledo Stamp Company, for example, wrote in its 15th Mail Auction Sale catalog in 1907:

> To those who have never bid on Auction Sales before we wish to say that this is one of the best ways to add to your collection of stamps that you would not be able to purchase at the price otherwise. You say just how much you wish to pay for a lot, and if no one else has overbid you, you get the stamps. If your bid is too high we buy for you at a small advance over the next highest bid, so you are protected in any case.

The 1930s saw mail sales become larger and more frequent. Some traditional stamp auction houses began to run mail sales in parallel with conventional auctions. For example, Y. Souren Co. announced its "First Mail Sale" in a catalog dated 1936, and Max Pool announced its "New System Mail Sale No. 1" in 1940. Both used the Vickrey second-price rule.

From the 1930s to the present, the majority of mail sales of stamps have used the Vickrey second-price rule. The rule became so standard that it no longer had to be explained. For example, in 1935 the Belmont Stamp Company of Dallas, Texas (appropriately enough, located on "Vickery [sic] Blvd."!) stated the rule in its First Mail Auction as follows: "All lots will be sold to the highest bidder at a slight advance over the next highest bid." Nearly identical language can be found in numerous other mail-sale catalogs from the 1930s to the present. In other cases, the price rule is even less explicitly stated. For example, several catalogs tell the bidder that "in submitting your bids, you understand that we will purchase the items for you at the lowest price possible."

On the basis of his collection of stamp sale catalogues, Dr. Trenchard estimates that at least several hundred different stamp companies ran second-price auctions by mail prior to the publication of Vickrey's paper in 1961.

The Future of the Vickrey Auction

Despite the attractive theoretical properties of the Vickrey auction format and its prominence in the stamp business, it is rare in the economy. Rothkopf, Teisberg and Kahn (1990) propose two explanations for the scarcity of Vickrey auctions: 1) bidders may fear truthful revelation of information to third parties with whom they will interact after the auction; and 2) bidders may fear auctioneer cheating.

They present a formal model of the first of these two reasons, while Rothkopf and Harstad (1995) model the second.

In the course of my research on stamp auctions, I have found that bidders do fear auctioneer cheating in second-price auctions. Once you have submitted your maximum willingness to pay, the auctioneer has an incentive to cheat, and pretend that another bid was received just under your maximum amount.

Dr. Trenchard, a longtime participant in stamp auctions and mail sales, indicates that he is reluctant to reveal his true willingness to pay in a Vickrey auction. "Unless I have confidence in the company," he writes, "I will not send any mail bids. And it's risky to send an outlandishly high mail bid, because you alert [the auctioneer] to information you don't want him to have. For mail sales, I try to make more conservative bids." He expresses the same wariness of mail bids sent to an auctioneer for a floor auction: "Never send a mail bid to an auctioneer. If you give him an outlandish bid, he'll wonder why, look at the lot and perhaps discover what I know that he didn't know. He can then withdraw it!"

Of course, a bidder doesn't face this problem when attending an English ascending-price auction, since there is no need for the winner to reveal how high he would have been willing to bid. If a bidder is unable to attend an English auction, hiring an auction agent is another option. The absent bidder tells his agent his maximum willingness to pay, and the agent represents the bidder at the auction, thus avoiding any unnecessary revelation of private information. In the stamp market, agents usually charge a 1 to 5 percent commission on the purchase. Since compensation is a percentage of purchase price, the agent does have some financial incentive to submit higher bids, but this incentive is small compared with the business that would be lost because of a reputation for being an untrustworthy agent. For comparison, the auctioneer's revenue in a consignment auction is typically around 25 percent of the sale price, including both buyer's and seller's fees. Frequently, the auctioneer may own the stamp himself, in which case he earns 100 percent of any increase in the auction price.

Jeff Purser, of Purser Associates in Connecticut, is an auction agent who used to be a stamp auctioneer. In the 1980s, his auction company ran public auctions and mail sales for stamps. He has firsthand experience with the incentives for auctioneer cheating in Vickrey auctions:[6]

> I swore I would never do many of the things I'd seen other auctioneers do as far as how they handled mail bids. My terms of sale were the same as all the others when it came to this issue. I assured prospective bidders they could bid with confidence since all mail bids "would be reduced to one advance over the next highest bid." And in the beginning, that is what we did. But I found there are inherent conflicts of interest every auctioneer must deal with in his role as agent for both the consignors and the bidders, and I'm ashamed to admit I

[6] The following e-mail message is from Jeff Purser in September 1998. He gave me permission to attribute the quotation to him.

> did not handle those conflicts very well. Looking back, I learned the mind is amazingly creative when it comes to rationalizing bad behavior.
>
> After some time in the business, I ran an auction with some high mail bids from an elderly gentleman who'd been a good customer of ours and obviously trusted us. My wife Melissa, who ran the business with me, stormed into my office the day after the sale, upset that I'd used his full bid on every lot, even when it was considerably higher than the second-highest bid. She threw his invoice on my desk and said, "I thought we weren't going to do this crap!" I glanced at the paperwork and without even thinking about it, said, "I don't like having to do this, honey, but you know our bank loan is due tomorrow." After some thought, she said, "Okay, I'll do this, but only if you agree to change the rules in our next auction to read, 'All lots are sold to the highest mail bidder at one advance over the second highest bid, *unless we need the money*.' " With that one sentence she stripped me of all my rationalizations and excuses. She held a mirror up to my conduct and I hated what I saw. I had no choice but to recalculate all our invoices for that sale to conform with our rules. That's when I decided to leave the business of running auctions.

These anecdotes offer evidence that bidders in a Vickrey auction may fear revealing their true willingness to pay, because the auctioneer might inflate the reported second-highest bid, or because the auctioneer might withdraw the good from the market if a high bid signals that the good might be more valuable than the auctioneer had originally thought. If bidders fear that their sealed-bids will be used against them, then they will bid more conservatively, and therefore the bids in a Vickrey auction will tend to be lower than an in-person English auction, where the fear of this kind of cheating would be absent.[7]

But if one of the main deterrents to using Vickrey auctions is fear that the bids are not truly secret, a technological fix may be at hand. Vickrey-like features have been appearing in auctions on the Internet. (See Lucking-Reiley, 2000, for a survey of Internet auction institutions.) Most Internet-based auctions involve English ascending bids, but several have begun to offer a feature called "proxy bidding." The largest auction site on the Internet, eBay, was selling approximately $200 million in goods per month as of July 1999, with a growth rate of over 10 percent per month. EBay explains proxy bidding in colorful language, to illustrate the potential benefits to bidders: "Instead of having everyone sit in front of their computers for days on end waiting for an auction to end, we do it a little differently. Everyone has a little magical elf (aka proxy) to bid for them and all you need to do is tell your elf the most you want to spend for that item and he'll sit there and outbid other elves for you, until his limit is reached."

[7] Even in an English auction, there some potential for auctioneer cheating. When only one bidder is left, auctioneers have sometimes been known to invent a "phantom bidder" or "take bids off the chandelier" to drive up the price. On the other hand, this form of cheating is public, in full view of the bidders, and therefore more difficult. A sealed-bid auctioneer can cheat in private.

Proxy bidding is offered as a convenience: a bidder with a high willingness to pay need not check back at the site repeatedly to keep raising the bid as necessary. From the point of view of auction theory, proxy bidding looks like a sealed-bid, second-price Vickrey auction.

My own experience indicates that the system seems to work. In May 1998, for example, I placed a proxy bid of $800 for a piece of used computer software at eBay, which resulted in my winning the auction at a price of only $550. Of course, it is possible that the second-highest bidder submitted a bid considerably less than $550, so that cheating might be present without being total. However, eBay publishes a web page with a list of the losing bidders, their maximum bids, and their e-mail addresses, thus providing a potential verification system (at least assuming that the auction site does not employ an army of confederates to serve as losing bidders, a system which would seem relatively difficult to maintain).

Internet auctioneers like eBay also have relatively low commissions compared to traditional auctioneers—typically 5 percent or less compared to 25 percent or more. Internet auctioneers also deal with a much larger circle of bidders, potentially involving hundreds of thousands of customers. Both of these traits reduce the incentive of Internet auctioneers to run up the price compared to their traditional auctioneer brethren: the increase in commissions from a higher price would be relatively smaller for an Internet auctioneer, and the costs of losing reputation among hundreds of thousands of online customers would likely be larger. In addition, on-line auction customers have public access to the results of each auction—including the losing bids. In this setting, fears over cheating auctioneers may diminish, and the use of Vickrey auctions may become correspondingly more important.

Conclusion

I do not wish to detract from William Vickrey's considerable contributions to economists' understanding of auctions. In his 1961 article alone, Vickrey made a number of major contributions: deriving the Nash equilibrium for a first-price sealed-bid auction, demonstrating equivalence of expected revenue between first-price and English auctions, and proposing the second-price auction as a mechanism strategically equivalent to the English auction. It is only the last of these contributions that I address in this paper.[8] I find that although Vickrey was the first economist to point out the formal equivalence of the Vickrey auction to the conventional English ascending-price auction, stamp auctioneers made the same clever discovery independently and at least 65 years earlier.

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[8] Interestingly, Vickrey himself did not consider his work on auctions to be especially important. Arnott (1998), who provides a survey of Vickrey's many contributions to applied economics, notes that Vickrey "perversely insisted that this paper was among his lesser contributions."

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