

# **Auctions on the Internet: What's Being Auctioned, and How?**

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August 14, 1999

## **Abstract**

This paper is an economist's guide to the recent phenomenon of auctions taking place on the Internet. I present a brief history of the development of Internet auctions as a type of electronic commerce, and give the results of an extensive survey of 142 different auction sites operating during autumn 1998. I estimate the size distribution of the sites, and find that revenues at the largest sites have been growing at more than 10% per month in 1998-99. Other issues addressed here include the business models the auction sites use, what goods they offer for sale, and what kinds of auction mechanisms they use. These new Internet auction institutions pose questions for economic theory, and give opportunities where auction theory might be used to improve Internet auctions in practice. I also present detailed data on the 1999 competition between the large incumbent eBay and the recent well-funded entrants Yahoo! and Amazon, and demonstrate that the different types of fees charged by auctioneers have measurable incentive effects on sellers' choices and transaction outcomes.

*JEL*: D44 (Auctions)

Keywords: Online Auctions, Internet, Electronic Commerce, eBay

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## **I. Introduction**

Auctions on the Internet have become a fascinating new type of exchange mechanism. Every day hundreds of thousands of different auctions take place online, for goods ranging from Star Wars action figures to laboratory ventilation hoods. Internet technology has lowered the costs of organizing an auction and of participating as a bidder, which appears to be causing auctions to be used for more and more transactions over time. Indeed, online auctions currently trade billions of dollars' worth of goods per year, and are growing at a rate of more than 10% per month. Online auctions have recently captured the attention of the public and the popular press,<sup>1</sup> and they represent a rich subject of study for economists who wish to understand the variety of different exchange mechanisms used in practice.

Online-auction technology provides several benefits relative to traditional auctions. Internet auctions give bidders increased convenience, both geographic and temporal, relative to traditional auctions. Instead of having to come to an auction house to participate fully in the bidding, the bidder can stay at his home or office. Traditional auctions require all bidders to participate at the same time (synchronous bidding), tying each bidder up for the entire length of the auction, but Internet auctions typically have asynchronous bidding lasting days or weeks, giving bidders much more flexibility about when to submit bids. These increased conveniences can also benefit the seller, by creating a larger market for the auctioned good. On the Internet, one easily can obtain a relatively large group of bidders on short notice, rather than scheduling an auction a month in advance and being restricted to local bidders who could travel to the auction at the scheduled time. Furthermore, search engines and clickable hierarchies of categories for browsing make it more convenient for a bidder to find the goods she's looking for. The computer technology makes it easier for

one to find a single item from the two million listings on eBay than in a paper catalog of a mere thousand items from an auction house.

Internet auctions also have their disadvantages relative to in-person auctions. First, it is hard for bidders to inspect the goods before bidding in an Internet auction. Online auctioneers try to mitigate this problem by using technology in several ways: sellers can post electronic images of their items, provide large amounts of text descriptions, and answer bidders' questions via email. Another difficulty with Internet auctions is the potential problem of fraud. When the auction takes place in person, money can be exchanged for the good before the winning bidder leaves the room. By contrast, a winning Internet bidder must trust that the seller will actually send the good in return for the payment of the bid amount. Indeed, there have been a number of cases of fraud reported by bidders in online auctions. However, the amount of fraud is tiny compared with the number of transactions which take place, and online auctioneers have pursued a number of ways to minimize fraud (such as encouraging third-party escrow services).

Beyond traditional auctions, a second point of comparison for Internet auctions is classified advertisements. Many of the items sold by individuals at auction sites such as eBay are similar to items typically found at a garage sale or in a newspaper classified ad. In part, this is because online auctions are relatively cheap to run. In fact, an online auction can be even cheaper than a traditional newspaper ad (partly because online auction listings are type-it-yourself, thus saving labor costs).<sup>2</sup> By matching buyers and sellers, Internet auctions can improve efficiency: an item which might have been relegated to the trash heap in Shreveport, for lack of local interest, can now find its way to an enthusiastic collector in Boise. Further, by using an auction, the seller is relieved of the responsibility of choosing

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<sup>1</sup> For example, a *BusinessWeek* cover story on May 31, 1999, notes that some 63 million U.S. adults recognize the brand name of eBay, the largest of the online auction sites.

<sup>2</sup> Fixed-price classified ads are also moving to the Internet. Examples can be found at the Web sites of many city newspapers, as well as at national sites such as Excite's <http://classifieds.excite.com/>. Excite has added auctions as an option in its classified-ad system, but currently has a niche with users who tend to prefer fixed-price ads to auctions, according to an Excite executive I interviewed in May 1999.

a price for an item with uncertain demand. Rather than risking a too-low guess which gives a “steal” to the first person to answer the ad, or a too-high guess which causes the good to go unsold, the seller can use an auction to let the market tell him what price to set. Because of Internet technology, auctions are being used to trade more and different types of goods than ever before.

I present a tour of the online auction market, paying particular attention to features of interest to economists. What are the volume of trade, the types of auction formats used, the types of goods sold, and the fee structures of the online auctioneers? The growth and change of this market are so dramatic that I cannot do much more than give a snapshot of it at a given point in time. I focus on the market as it existed in the autumn of 1998, approximately three years after the appearance of the first Web-based auctions. I present data on all 142 of the auction sites that my research assistants and I were able to identify during that time period. With online auctions still in their infancy, perhaps this document will someday be of historical interest to those studying the history of Internet auctions (in the distant future, say perhaps five years from now!).

The remainder of this paper is organized as follows. Section II gives a brief history of the development of auctions on the Internet. Section III estimates how many goods are being auctioned online, and Section IV discusses what types of goods. Sections V through VII describe the business models utilized by the auction sites and the fees they charge for auction services. Sections VIII through XII describe the basic types of auction mechanisms used online: dynamic versus sealed-bid, multi-unit auction rules, time duration, and other parameters. Sections XIII and XIV discuss various ways that participants in online auctions have found to “cheat” or game the system, though these methods seem to be infrequently used. Section XV presents updated data from summer 1999 on the competition between three large auction sites, and gives results on the way variation in fee structure leads to interesting incentives with measurable effects on seller behavior. Section XVI concludes.

## II. History of Internet Auctions

These days, many people mistakenly equate the World Wide Web with the Internet, but Internet auctions took place even before the Web was widely available. Before NCSA Mosaic (the first Web browser for the Windows and Macintosh platforms) was released at the end of 1993, there were already a number of auctions taking place on text-based Internet newsgroups and email discussion lists. I first became acquainted with auctions on the Internet in early 1994, when I observed a year-old newsgroup devoted to the trading of collectible trading cards for the game *Magic: the Gathering*. The newsgroup, originally called rec.games.deckmaster.marketplace, can now be found at rec.games.trading-cards.marketplace.magic.auctions. Hundreds of different sellers ran auctions on this newsgroup, each auction lasting days or weeks. Each seller typically auctioned dozens of independent card lots simultaneously in an ascending-bid auction format: bidders would submit their bids via email, and sellers would post daily updates of their high bids. There were some variations in the auction rules used: for example, one auction might close at a fixed end date, while another might keep the bidding open on a good until it had gone three days without a bid raise. See Lucking-Reiley (1999) for more details about auctions via newsgroups.

The earliest Web-based auctions appear to have been Onsale, opened in May 1995, and eBay, opened in September 1995. These were the first to take advantage of the technologies offered by the Web, including the use of automated bids entered through electronic forms, and search engines and clickable categories to allow bidders to locate their items of interest. Just like the newsgroup auctions, Web auctions were (and continue to be) auctions which last between several days and several weeks each, allowing bidders to participate when and where it is most convenient for them.

Onsale started as a merchant site, selling its own goods, mainly refurbished computers and electronics. Onsale CEO Jerry Kaplan indicated that he felt auctions would

provide entertainment value for shoppers, and that the competitive nature of the transaction would appeal to males, who were not typically drawn to shopping for entertainment. This business model was not nearly as successful as that of auction-listing site eBay, and Onsale shifted its strategy. In 1997, Onsale began to supplement its merchant site with an auction-listing service similar to that of eBay, later transferring this person-to-person auction service to Yahoo! In 1998, Onsale announced that it would begin to offer fixed-price selling of electronics at wholesale prices (now distinguishing its Onsale atCost from its Onsale atAuction service), and in July 1999 it announced a merger (and incorporation into) Egghead, another online retailer.

By contrast, eBay started out by encouraging individuals to list their own auctions online. From the beginning, most of the items on eBay have tended to be collectibles (Pez dispensers, Beanie Babies, sportscards, comic books, etc.), but there are many other types of items as well (see Section IV below). Sellers on eBay may choose a number of different parameters for each auction: number of days it will run, minimum bid level, and an optional secret reserve price. The site has grown very rapidly, at a rate of approximately 12% per month.<sup>3</sup> During the month of July 1999, eBay hosted just under 10 million different auctions, with a total dollar volume of \$190 million. There are other auction sites with similar business models, but none has come close to the size of eBay.

In the past year, two large Web-based companies, Yahoo! and Amazon, have announced their own person-to-person auction services very much like eBay's. It will be interesting to see whether these well-funded later entrants will be able to take business away from eBay. eBay appears to have a first-mover advantage in a market with significant economies of scale: sellers prefer to list their goods where the most buyers visit, and buyers prefer to visit sites with large selections of goods. Competition between auctioneers has generated recent interest by auction theorists (see, for example, Lu and

McAfee (1996)), though I have not yet seen a theory which addresses the issue of network externalities with competing auction exchanges. Internet auctions are potentially rich sources of study both for economic theorists and for empiricists.

### III. Size Distribution of Auction Sites

One important goal in this survey was to estimate the size of the online auction market, and if possible to measure the dollar volume of transactions at each individual site. This task is much easier to accomplish for online auctions than it is for almost any other type of business, since online auctions by nature display quite a bit of information about prices and quantities. On the other hand, estimating revenues was still a difficult task, much harder than classifying the type of auction format used or the types of goods auctioned. No auction site gives an automated summary of the number of dollars being transacted overall on the site. See Appendix 1 for details on the data collection for this survey.

Table 1 shows the estimated size distribution of the 142 auction sites in this survey. This measurement is of the gross value of total transactions concluded, in dollars per month.

**Table 1: Size distribution of auction sites**

<i>Monthly volume (\$)</i>	<i>Number of sites</i>
Under 10,000	83
10,001 to 100,000	27
100,001 to 1,000,000	21
Over 1,000,000	7

The table shows that 58% of the auction sites were relatively small, each resulting in less than \$10,000 in sales per month. Some of these sites served small niche markets (such as the Antebellum Covers auction of century-old autographs and letters), but most

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<sup>3</sup> From November 1 1998, to July 1, 1999, eBay's transaction volume grew from \$70 million to \$190 million per month, a growth rate of 13% per month. From early June to early August, 1999, eBay's

appeared to be designed with optimistic plans for growth. From ABC Live Auction to Virtual Nostalgia Auction Gallery, we found sites with comprehensive lists of categories of items, each of which had few items up for auction and even fewer receiving bids.

There were also quite a few sites with significant amounts of revenue: 15% of sites in the survey had sales of more than \$100,000 per month, and 5% had sales larger than a million dollars per month. These seven largest sites are displayed in Table 2. Overall, the total volume of trade through Web-based auctions, as of autumn 1999, appears to have been almost \$100 million per month.

**Table 2. The largest online auction sites in August 1998.**

Site	Monthly Revenue
eBay	\$70,000,000
First Auction	5,000,000
Onsale	5,000,000
uBid	2,000,000
Going-Going-Sold	1,800,000
AuctionVine	1,500,000
Encore Auction	1,300,000

#### **IV. Types of Goods Sold**

The variety of goods sold at auction on the Internet is quite impressive, a much wider variety of goods than has ever been auctioned before. I have seen auctions of items as diverse as spreadsheet software, darkroom print washers, car stereos, autographed baseballs, used paperback books, sold-out concert tickets, deer-shaped toothpick holders, sofas, clarinets, characters in the Ultima Online virtual gaming world, even a date with an attractive woman looking to raise money for credit-card-debt reduction! Some of these items (paperback books, cheap ceramics, etc.) are very inexpensive (under \$10), and would more likely have been seen at garage sales or flea markets rather than at traditional auctions. For the convenience of bidders who wish to browse, auction sites often classify

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listings grew from 2.1 million to 2.6 million listings on the site, a growth rate of 11% per month.

their auction listings into categories (“collectibles,” “arts and entertainment,” “sports”) and even sub-sub-categories (“Nintendo game software,” “vintage Fiestaware”). Different sites often chose different sets of categories, so in the end we created our own set of categories by which to define the types of goods sold at each site. Our list of categories can be found in Table 3. The second column of the table indicates how many different sites (out of 142) had auctions in each category. Some sites specialized, auctioning goods only from a single category on the list, figures for the various single-category sites are contained in the third column.

**Table 3. Types of items sold at auction**

Category	Sites featuring that category	Sites specializing in that category
Collectibles	90 <sup>4</sup>	56 <sup>3</sup>
Antiques	40	10
Celebrity memorabilia	16	7
Stamps	11	5
Coins	17	2
Toys	17	0
Trading cards	14	0
Electronics & computers	48	9
Jewelry	17	1
Computer software	16	0
Used equipment	15	7
Sporting goods	13	4
Travel Services	7	5
Real Estate	4	2
Wine	3	2

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<sup>4</sup> This figure includes all of the sites listed as featuring the various subcategories of collectibles - and there is plenty of overlap, with some sites featuring both memorabilia and toys, for example. It also includes several other sites with types of collectibles (postcards, phone cards) not large enough to warrant their own subcategories.

The largest category by far was that of collectibles: more than 60% of all the sites in the survey included auctions for collectibles. Therefore, we also developed subcategories for the most important groups of collectibles: antiques, celebrity memorabilia, stamps, coins, toys, and trading cards. Even the 60% figure may not capture the category's true importance, in terms of total transactions. Since eBay conducted at least 75% of all online-auction transactions in this survey, we took a closer look at transactions by category on that site. We estimate that at eBay, collectibles accounted for at least 85% of listings and 75% of revenues (or \$52 million per month).<sup>6</sup> The largest individual subcategories of collectibles at eBay were toys (one third of all collectibles listings, many of them Beanie Babies) and trading cards (one tenth of all collectibles listings).

I believe that Internet auctions have significantly increased the total volume of economic transactions of collectibles, though it would be extremely difficult to estimate the total volume of offline transactions. Before the advent of online auctions, buyers would have found many of these items either through a chance encounter at a garage sale or in a few highly specialized dealer shops, so online auctions do quite a bit to improve matching of buyers to sellers. Most of the collectibles traded at eBay and other sites are relatively inexpensive, with median prices far below \$100 and almost no items trading for more than \$1000. High-priced collectibles (valuable art and antiques) have remained in the purview of traditional (offline) auction houses such as Sotheby's and Christie's. That may change in the near future, however. In April 1999 eBay purchased upscale auction house Butterfield & Butterfield, and in June 1999 Amazon announced a joint venture with

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<sup>5</sup> This figure includes all of the sites specializing in a single subcategory of collectibles (the ten specializing in antiques, the five specializing in stamps), in addition to sites which sold several of the subcategories of collectibles, but no other top-level categories of goods.

<sup>6</sup> On a check in November 1998, we found 121,000 of 142,000 daily closings to be for collectibles. The eBay site did not have a top-level category which included all the types of "collectibles" in our categorization scheme; our figure pools together several eBay categories. Our rough estimates of the average prices in this category tended to be lower than for items in other categories (particularly computers & electronics), so they accounted for only about 75% of eBay revenues.

Sotheby's, with both business moves apparently aimed at producing online auctions of goods worth \$500 and up.<sup>7</sup>

As can be seen in Table 3, a large number of sites in our survey (97 of 142) specialized in a single category of goods. Antique Country specialized in collectibles, Quixell in electronics, Galaxy Gold in jewelry, and so on. Some sites were particularly specialized in a way that cannot be captured by the classification system: Basketball Bonanza in basketball trading cards and memorabilia, Going-Going-Sold in used laboratory equipment, Golfclub Exchange in golf clubs, and Cyberhorse in horses and equine equipment.

Instead of specializing, 46 of the sites followed a broad strategy, featuring goods in multiple categories. Modern technological tools make this feasible, as users may either perform a text search for an item of interest or use a clickable menu of categories, subcategories, and sub-subcategories to arrive at items of interest. Of the seven largest auction sites identified in Table 1, five have multiple categories of goods. EBay features well-developed menus of subcategories in collectibles, electronics, jewelry, and other miscellaneous types of goods. Onsale, uBid, and Encore Auctions have all had the bulk of their auctions in computers and electronics, particularly refurbished items, but featured other categories (sports, travel) as well. First Auction, sponsored by the Internet Shopping Network, has featured a substantial amount of jewelry and home furnishings (the latter being unusual among Internet auctions), with numerous other categories as well.

Internet auctions pose an important question for economic theory: What types of goods ought to be auctioned? As Internet technology lowers the cost of running an auction relative to using other pricing mechanisms (posted-offer retailing, bilateral negotiations), we should expect to see new types of goods be auctioned. The very young market of

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<sup>7</sup> For details, see the CNET news articles <<http://www.news.com/News/Item/0,4,35623,00.html>>and <<http://www.news.com/News/Item/0,4,37888,00.html>>. An interesting empirical question is how the revenues at these new Internet auctions will compare to those in traditional auctions by the same auction houses.

Internet auctions has already begun to auction large classes of goods, especially inexpensive collectibles, which were rarely auctioned before. Some characteristics of Internet-auctioned goods stand out: most tend to be used (action figures, unwanted software, refurbished laser printers) rather than newly manufactured.<sup>8</sup> The items also tend to be small and relatively easy to ship, as most of these transactions take place through parcel delivery. As the market develops out of its infancy, we might well expect to see more additions to the list of auctioned items. Economic theory (e.g., Wang (1993)) has compared auctions to other pricing mechanisms in terms of strategic behavior and equilibrium price distributions, but to my knowledge, the literature has not yet examined the question of *what types of goods* sellers would prefer to auction (rather than setting posted prices). Auctions are useful for reaching a market-clearing price and an efficient allocation of goods, but posted prices can be more convenient for buyers, who might prefer not to wait for the results of the auction and not to be uncertain about the eventual price to be paid.

I hypothesize that auctions will be used most often for goods in limited supply where the demand is unknown to the seller, because these are the circumstances under which the benefits of a flexible, market-determined price are likely to be greatest. In particular, I believe that in the future we may see much more auctioning of services: movie tickets, hotel reservations, plumbing services, and so on. Services are particularly attractive for auctions because they are in relatively fixed supply – unlike durable goods, one cannot store surpluses or draw down inventory in order to meet fluctuating demand. With this in mind, we looked carefully for services in our survey, but found few of them: several relatively small sites auctioning travel and vacation packages, plus occasional

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<sup>8</sup> The goods at First Auction (and several other merchant sites like it) are an exception to this rule. Auctions would seem to provide relatively little social benefit in the case of newly manufactured items, because the supply of such items is not fixed, so the retailer can adjust prices or quantities in response to observed demand. By contrast, used and rare items are in relatively fixed supply, so auctions can be valuable in determining the correct price and allocation in the face of uncertain demand. This informal

miscellaneous services at eBay, such as concert tickets for resale. One obstacle to auctions of services is that many services (movies, plumbing) are essentially local, while most auction sites are currently national or international in scope.<sup>9</sup> Perhaps as Internet usage becomes more ubiquitous, thick local markets will encourage the development of auctions for local services. On the national front, the career service Monster.com recently developed an auction facility to supplement its resume-listing service, so that job-hunters can have potential employers bid for their services.<sup>10</sup> Time will tell whether this auction venture will be successful. In the meantime, the question of what types of goods lend themselves most easily to auctions is one wide open for economic theory.

## **V. Business models: Merchant and Listing-Agent Sites**

Having addressed the question of “what’s being auctioned,” I now turn my attention to the question of “how.” The two primary business models for Internet auctions are those of merchant sites and listing-agent sites. A merchant site, such as Onsale, offers its own merchandise for sale, acting as a retailer who happens to conduct its transactions through auction. A listing site, such as eBay, acts as an agent for other sellers, allowing them to register their items and running the auctions on their behalf. The listing site usually neither possesses the auctioned goods nor handles their payment and shipment; all the transaction details are worked out by the buyer and seller on their own. Some auction sites combine both types of business: auctioning their own merchandise while also allowing

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argument indicates that auctions at eBay may provide considerably more social welfare than those at First Auction.

<sup>9</sup> CityAuction is a notable exception. This site was designed to allow sellers to list auctions as being restricted to particular local areas, in order to facilitate auctions for large or otherwise difficult-to-ship items. However, in our survey we found that almost all sellers on the site were choosing to auction easily shippable items in geographically unrestricted (national) auctions. Very recently (summer 1999), eBay has also begun to develop local auctions, beginning with a Los-Angeles-specific auction area.

<sup>10</sup> A precedent occurred in April 1999, when a sixteen-person software-development team put themselves up for auction on eBay to the highest bidder, in a well-publicized auction with a minimum bid of \$3.14 million. The sellers aborted the auction after a change of heart, but not before generating considerable publicity. One can still view the auction listing at at eBay: <http://cgi.ebay.com/aw-cgi/eBayISAPI.dll?ViewItem&item=96369441>.

others to list independent auctions on the same site. The ownership distinction is not always clear, as some of our “merchant” sites may actually sell goods owned by others, through a consignment system. Also, some “agent” sites have the listing process take place offline, by contrast with eBay’s Web-based listing system. We attempted to maintain a consistent definition of a “listing” site as one where clearly independent sellers had listed their own auctions, and a “merchant” site as one where the goods were not clearly from an independent seller.

Our survey of 142 Internet auctions found 96 listing sites, 25 merchant sites, 11 combination agent/merchant sites, and 10 sites where the available information did not enable us to make a clear categorization. The largest merchant sites include Onsale, First Auction, uBid, and Encore Auction, all relatively general in that they featured several different categories of items. We also found some smaller, more specialized merchant sites, such as SportsAuction and Hollywood Auction, which each featured goods within a single category. The largest listing-agent sites include eBay, AuctionVine, Going-Going-Sold, and Auction Universe.<sup>11</sup> Some agent sites, such as AuctionVine and Going-Going-Sold, allowed only qualified dealers to put items up for auction. These tended to specialize in single categories of goods. By contrast, eBay, Auction Universe, and a number of similar listing-agent sites have developed user-friendly interfaces to enable any individual to add an auction listing to the site.<sup>12</sup> Their offerings tend to be broader, with a diversity of product offerings fueled by the imaginations of individual sellers.

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<sup>11</sup> Auction Universe was not quite large enough to make it into Table 2, but at an estimated \$600,000 per month, it is still one of the largest sites in the sample. This site, operated by a consortium of newspaper publishers, is an online extension of the newspapers’ traditional classified ads. Auction listings placed by customers at one newspaper can be shared in the Auction Universe listing service to provide a national pool of bidders, appearing on the Web sites of the participating newspapers as well as at the independent Auction Universe Web site. The site offers a broad variety of categories of goods.

<sup>12</sup> While some sites have developed their own proprietary software, others have purchased their auction software from a surprisingly large number of auction software providers. See Appendix 2 for details on the market for auction software.

## **VI. Business-to-Business Auctions**

This survey tended to focus on auctions with bidding by individual consumers, but business-to-business online auctions also appear to be growing rapidly.<sup>13</sup> The goal of this survey was to collect as much data as possible on the state of the Internet auction market by visiting the auction sites and watching auctions in progress. Business-to-business auctions are more difficult to investigate in this way, because they tend to focus on private auctions to a small group of customers rather than on public visibility. Some business-to-business auctions gave enough information to have been included in this survey: FastParts (double auctions for surplus electronic parts), Going-Going-Sold and LabX (both English auctions for used laboratory equipment), and Intermodal Exchange (Dutch auctions for cargo containers).

Since the conclusion of this survey, I have learned of several other examples of new business-to-business auctions online. These include Freemarkets Online, a system which allows businesses to run procurement auctions, particularly for manufacturing parts they wish to purchase. This firm claims to have conducted nearly \$1 billion in transactions in 1998, approximately the same size as eBay. Freemarkets did not appear in our survey because their auctions take place not via the World Wide Web, but rather via proprietary software which must be downloaded by the suppliers after they have agreed to participate in the bidding.

Other business-to-business auctions include Inventory Locator Service, a system of online classified ads for aircraft parts which has begun to conduct a monthly online auction as well. The National Marine Exchange has recently established itself as a double auction for marine equipment (both “wanted to buy” and “wanted to sell” listings allow one to specify a price). Farms.com has developed procurement auctions for agricultural chemicals

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<sup>13</sup> A 1998 report by Forrester Research, based on interviews with a sample of businesses (manufacturers, distributors, independent auctioneers) that the business-to-business segment was undergoing “triple-digit growth.”

and feed products, as well as Dutch auctions for cattle and cattle embryos. AdAuction.com holds English auctions for advertising in various media, particularly Web advertising. As of July 1999, none of these auctions appears to be terribly large, at least by eBay standards, but they illustrate interesting possibilities for the future of online auctions.

## **VII. Auctioneers' Fees**

While merchant sites derive their income directly from the sale of their items, agent sites derive their operating revenues from fees charged to buyers and sellers. These fees tend to be an order of magnitude lower for Internet auctions than they are for traditional auction houses. Sotheby's, for example, charges a buyer's premium of 15% over the final bid price, and a standard (though negotiable) seller's commission of 20% of the bid price. By contrast with this total fee of more than 30% of the final bid price, the total fees at agent sites like eBay are only around 5% of the final bid price. Although the type of service is less comprehensive at an Internet auction than at a full-service auction (with appraisal services, well-appointed viewing areas, and bidding floors), it is still remarkable how much lower the costs of auction services have become since the debut of Internet auctions.

At eBay, there is no buyer's premium; all fees are paid by the seller. There are two components to the seller's fees. First is an insertion fee for the auction listing, ranging from \$0.25 to \$2.00, depending on the size of the minimum bid or reserve price. Second is a percentage of the amount of the final bid price. The percentage declines with the size of the sale: 5% of any amount under \$25, then 2.5% of any additional amount between \$25 and \$1000, then 1.25% of any additional amount in excess of \$1000. Some additional fees are charged for optional promotional services, such as a boldface listing for the auction (\$2), a featured location within a category (\$14.95), or a featured location on the eBay site overall (\$99.95).

Most of the general-purpose listing-agent sites have charged similar fees to those of eBay; there is some variation, but few charge more than 5% in commissions. A few sites,

in an effort to build up their business, charged no fees at all; examples include AuctionX and Up4Sale.<sup>14</sup> Agent sites specializing in goods which are more traditionally auctioned, such as antiques and wines, tended to charge considerably higher fees, matching those of traditional auction houses. For example, AuctionVine and Antique Canada charged commissions of 15%, while CyberHorse and Going-Going-Sold charged 10%.<sup>15</sup> Perhaps competition will drive these commissions down as the market continues to evolve.<sup>16</sup>

In all, 62 of the 107 agent or agent/merchant sites charged a seller's commission as a percentage of the final selling price. Of these 62 sites, 28 had commissions of 5% or less, 18 had commissions ranging from 7% to 20%, and the remaining 18 did not give information on the size of the commission. In addition, 23 different sites charged a flat listing fee to the seller. Buyer's premiums, common at traditional auction houses, are much less prevalent on the Internet: only 18 of 142 surveyed firms used a buyer's premium. Six of these were merchant sites, while the others were listing-agent sites. The buyer's premiums were generally in the range of 10% to 15% of the purchase price, with two exceptions (5% and 8%, respectively). Only eight of the sites in the survey charged both a buyer's premium and a seller's commission.

## **VIII. Auction Formats**

In our survey of different sites, we found several different auction formats: English, Dutch, sealed-bid, and double auctions. See Table 1 for the distribution of formats. The English ascending-bid auction is the most familiar type of auction to almost

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<sup>14</sup> Up4Sale, with its slogan "Free Auctions Forever," indicates that it intends to make a profit only by charging sellers for "premium services," mainly featured listings which make their auctions stand out from the crowd.

<sup>15</sup> These sites sometimes offered more services in return for the fees (for example, AuctionVine's offered advertising services for wine consignors). None of these sites charged any buyer's premium, so their overall charges are still less than half the norm at Sotheby's or Christie's.

<sup>16</sup> Given that the auction is no more costly to run for a \$100 item than for a \$10 item, it is noteworthy that the commissions are increasing in the price of the good. One would not expect this type of price discrimination to be possible under perfect competition. (Percentage commissions have long been the norm at traditional auction houses, as well.)

everyone, so it is perhaps not surprising that this is also the most common format used by Internet auctioneers. Of the 142 sites, 121 used English ascending-price auctions, 21 used sealed bids<sup>17</sup>, three used Dutch descending-price rules, and four were continuous-trading double auctions. Six of the sites had more than one auction format available, which explains why the sum adds to more than 142. For example, the Auction Nation site gave sellers a choice between running an ascending-bid auction or a “silent” (or sealed-bid) auction where the high bid is not made public until the closing time.<sup>18</sup> The English auction format is even more dominant than it first appears in the raw statistics. Of the eight sites with a dollar volume of at least \$1,000,000 per month, all use an English format.<sup>19</sup>

### **VIII. A. English Auctions**

Ascending-bid auctions are by far the most prevalent on the Internet, and they make bidder participation relatively easy. Once the bidder finds the item she’s interested in, she can view the current high bid, and decide whether to raise it by filling out her own bid amount in a text box in her Web browser. After submitting her bid, she will see an automatic update of the auction status, showing her whether she successfully became the current high bidder. She can then leave the site as the winning bidder, and return at any time before the close of the auction to check on its status again. Most of the larger auction sites make it easy for bidders to return to their auctions of interest, giving one-click access to a list of “auctions in progress on which you have bid.” Also, most of these sites provide

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<sup>17</sup> We have chosen to include in the “sealed-bid auction” category some auctions which were problematic to categorize. Four of these auctions were primarily traditional English auctions with a bidding floor, but these auctions also encouraged absentee participation by Internet bidders. In each case, a Web-based bidding form allowed Internet bidders to submit their bids in advance, which would be executed on their behalf at the live auction. Thus, the experience for the Internet bidders was that of a sealed-bid auction, even though the participants on the bidding floor experienced an ascending-bid auction. Of the four auctions in this category, two appear to use a first-price rule for Internet bidders (pay your bid), while the other two used a second-price rule (pay one increment over the highest bid on the floor). The use of a second-price rule for absentee bids at a “live” English auction has been common at traditional auction houses as well; see Lucking-Reiley (1999b) for examples from the stamp auction market.

<sup>18</sup> A quick scan of the listings at Auction Nation indicated that most, if not all, sellers chose the English ascending format.

automated “outbid notification” email messages to let bidders know instantly when they are no longer the high bidder in an auction.

In a traditional English auction with the bidders present in the same room, the auctioneer closes the auction using the traditional “going... going... gone!” procedure. English auctions on the Internet are somewhat different, with geographically diverse bidders generally placing their bids over a period of days or weeks. A live auctioneer would never bother specifying a closing time for his auction, because it will generally end in a matter of seconds or minutes, but on the Internet sellers appear to prefer a closing time and date set in advance. For example, at eBay sellers typically run auctions which end 7 days after they begin (measured to the exact minute). This poses an incentive problem: if the auction closes at a fixed date, then what incentive does a bidder have to place any bids early in the auction? Indeed, many Internet auction bidders have engaged in “sniping”: the practice of waiting until the last minute before the auction ends, and trying to submit a bid which just barely beats the high bid and gives the rival bidder no time to respond. Submitting an early bid is dominated by the strategy of submitting the same bid just before the auction ends. If all bidders were to follow the rational sniping strategy, the game would become equivalent to a first-price, sealed-bid auction, with all the bids submitted at the very last minute. This destroys the English auction’s attractive feature that bidders have a dominant strategy to bid up to their maximum willingness to pay, making the optimal bidding strategy a complicated guessing game. As a result, two alternative strategies have been developed to encourage early participation in the English auction and restore the mechanism’s desirable properties.

The first of the two alternatives is to offer a short “extension period” to the auction. The most common extension period is five minutes long, meaning that if there is any bidding activity in the last five minutes of the auction, then the auction’s closing time will

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<sup>19</sup> One of the nine, Encore Auctions, lists a “non-published” or sealed-bid auction as an alternative to the English auctions on its site, but I have never seen Encore actually run such an auction for its merchandise.

be extended by an additional five minutes.<sup>20</sup> This process may iterate if bidding continues, so the auction does not end until five minutes have passed without a new bid. Such an extension period effectively adds a “going, going, gone!” activity rule to the auction, gives bidders the opportunity to protect themselves against “snipers.” We found this solution used at a number of sites, including Onsale, Paulus Swaen (antique maps), and Surplus Auction (computer software). A disadvantage of this solution is that it obligates any serious bidder to return to the auction at its closing time and stay until the auction is over – this removes the convenience of asynchronous bidding, which in principle gives Internet bidders the flexibility to enter their bids at any time. Asynchronous bidding convenience can be improved by lengthening the extension period,<sup>21</sup> but longer amounts of extension time also decrease the convenience of having a predictable end time for the auction.

An alternative solution is for the auction site to implement a “proxy bidding” mechanism. EBay explains its proxy bidding system as follows: “Everyone has a little magical **elf** (aka proxy) to bid for them... 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.” We found proxy bidding at 65 of the 142 sites, and the idea has grown in popularity: Onsale, for example, added a proxy-bidding feature called “Bid Maker” in 1998, after years without one. Proxy bidding serves to “Vickrify” the auction, making the fixed-length English auction resemble the Vickrey second-price sealed-bid auction. This eliminates incentives for “sniping,” and restores the dominant strategy of bidding one’s maximum willingness to pay.<sup>22</sup>

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<sup>20</sup> One site, Lightning Auction, used a very short extension period, only one minute long.

<sup>21</sup> We saw extension periods up to one hour in length in our survey of Web-based auctions. In addition, newsgroup-based auctions for Magic cards still frequently have an activity rule requiring up to five days with no bid raises before the auction can close.

<sup>22</sup> This discussion implicitly assumes a private-values model of auction bidding, so that bidders know with certainty their own values for the items. Other models of auction bidding, such as Milgrom and Weber’s (1982) affiliated-values model, do not involve strict equivalence between English and second-price sealed-bid auctions.

## VIII. B. Sealed-bid Auctions

There are two types of sealed-bid auctions to be found on the Internet, corresponding to the two types most studied in auction theory. In a first-price sealed-bid auction, the winning bidder pays his bid amount. In a second-price sealed-bid auction, the winning bidder pays one increment over the second-highest bid received.<sup>23</sup> We found seven of the former and five of the latter. The remaining eight sealed-bid auctions in our sample of twenty could not be classified with certainty, but are most likely also first-price auctions.<sup>24</sup> The first-price auctions included Timeshare Resale International's auction of vacation timeshares, as well as several listing sites which gave sellers the (seldom-used) option of running a first-price sealed-bid instead of an English auction. Second-price auctions included Antebellum Covers (manuscripts and ephemera), Sandafayre (stamps),<sup>25</sup> and Nauck's Vintage Records.

## VIII. C. Dutch Auctions

We found three examples of Dutch auctions<sup>26</sup>, in which the price starts at some relatively high level and continues until the first bid determines the winner. We were never able to observe an actual transaction on any of these sites, however. Intermodal Exchange describes its Dutch auction rules for a relatively specialized product: cargo containers for transoceanic shipping. Despite our interest in this unique auction, we were never able to

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<sup>23</sup> Two of the first-price auctions and two of the second-price auctions fit into the unusual category discussed in footnote 5 above.

<sup>24</sup> During the initial survey in the autumn of 1998, we mistakenly assumed that any sealed-bid auctions would use a first-price rule, so we neglected to record the price rule carefully. Upon reexamination in the summer of 1999, eight of the sealed-bid auctions from our sample were no longer operating, with apparent consolidation in the Internet auction market. For example, AntiquePhoto.com cited "overwhelming competition from eBay" as the reason why it ceased its auction operations, while Diamond Light Photos decided to move its own auction listings to eBay rather than trying to continue operating its own auction site.

<sup>25</sup> Stamp auctions and autograph/manuscript auctions have made use of second-price auctions for decades; see Lucking-Reiley (1999b) for the history of the development of stamp auctions, with second-price sealed-bid auctions as appearing early as 1893.

<sup>26</sup> Many other sites misleadingly indicate that they run Dutch auctions. In these cases, "Dutch" turns out to be common usage for the use of a uniform-price rule in a multi-unit auction, rather than the economist's

observe an auction in progress there. At the other end of the spectrum, Klik-Klok Auctions specializes in three-minute Dutch auctions for various consumer goods (food, jewelry, collectibles, electronics, furniture, etc.) running simultaneously in several categories, 24 hours a day. Upon entering one of these auctions, one sees a description of the good, a listing of the total quantity available (frequently 5-10 units), a clock displaying the time remaining in the auction, and the current price, lowered every five to ten seconds. Over a three-minute period, the price declines by a total of approximately 15 to 20 percent, which does not appear to be low enough to stimulate bidding. During several hours of watching these auctions in the various categories, I never once saw the “quantity available” change to reflect a bid. Several times I saw the same merchandise I had seen previously, as it cycled back through the auction schedule. As the merchandise is not terribly unique (the items resemble those offered on home-shopping television), one would not expect bidders to feel much urgency in bidding, because the same items are likely to come up for “auction” again soon. Bid.com has an almost identical format for its Dutch auctions, which similarly appear to result in no transactions.

The Dutch auction software at these two consumer-oriented sites seems well designed; it seems a shame that this format does not manage to sell more merchandise. It would be interesting to see it used for auctions of relatively unique merchandise (such as the used items on eBay), and/or to see the auction price to fall far enough to generate bidder interest and regular traffic. One potential disadvantage to these Dutch auctions is that, since they take place so quickly, they do not allow for the convenience asynchronous bidding. However, there is no reason why, in principle, the Dutch auction could not take place with a very slowly falling price clock, to match the week-long timescales of most Internet auctions.<sup>27</sup> Indeed, the catalog clothing retailer Land’s End runs a weekly Dutch auction

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usage to mean a declining-price auction. Typically, a “Dutch” auction on the Web will be an English ascending-price auction where each winning bidder pays the amount of the lowest accepted bid.

<sup>27</sup> In Lucking-Reiley (1999a), I report the results of slow Dutch auctions (approximately a 5% decline per day) run via email for cards from the game Magic: the Gathering. Interestingly, the Dutch auctions tended

of overstocked items, though we did not cover this site in our Autumn 1998 survey. The feature, called “On the Counter,” begins with a listing of items every Saturday with “initial offer prices” around 30-60% below retail; these prices fall by 25% on Monday, 50% on Wednesday, and 75% on Friday (relative to the initial offer price). The store does not post the quantity available for each item, but merely indicates when each item has been sold out.

#### **VIII. D. Double Auctions**

Finally, we found four examples of Web sites that had set up “trading floors” for double auctions. These sites allowed continuous updating of offers by sellers as well as bids by buyers. The examples we found tended to specialize in a single type of good: FastParts traded electronic components, LabX traded laboratory equipment, and Dallas Gold and Silver Exchange (DGSE) traded jewelry. By contrast, the site BidNAsk has an elaborate description of its ability to set up a new “trading floor” for any type of good whatsoever, but in repeated visits to the site we never saw any active trading floors. Traditional double auctions take place with multiple buyers and sellers trading multiple units of the same commodity, but both LabX and DGSE were curiously dominated by listings of unique items by individual sellers. This made their auctions similar to single-sided auction listing sites like eBay, except that sellers had the formal ability to lower their ask prices (or minimum acceptable bids). We never saw evidence of actual trades on these two sites.

The only successful double-auction on the Web appears to have been FastParts, which had hundreds of listings of both “parts for sale” and “parts wanted to buy.” The continuous-trading nature of the site made it difficult to observe transactions to get even an order-of-magnitude estimate of trading volume. However, a July 1999 telephone call to FastParts indicated that their auction site has 13 employees, approximately 1000

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to raise greater revenues than the English auctions, suggesting that Internet auctioneers might do well to experiment with the slow Dutch format.

subscribers (all pre-screened before they can participate in the exchange), and annual trading volume in the millions of dollars.

## **IX. Multi-unit Auctions**

Auctions which allocate multiple units of a good have received increasing attention in the theoretical economics literature on auctions (see, for example, Ausubel and Cramton (1997)). Internet auctions frequently have auctions for multiple identical units of a good. Internet technology increases the feasibility of ascending-bid multi-unit auctions: in an auction for 10 units, the computer gives automatic status updates which conveniently show the 10 highest bids and the bid amount required to displace one of them. Of the 120 English auction sites we surveyed, at least 41 included multi-unit auction capabilities.

### **IX. A. Multi-Unit Pricing Rules in Ascending-Bid Auctions**

There are two different pricing rules used in multi-unit ascending-bid auctions. First, there is the discriminatory or pay-your-bid rule, where each winning bidder pays the amount of her own bid. Second is the uniform-price rule, typically called a “Dutch auction” online,<sup>28</sup> where each winning bidder pays the amount of the lowest accepted bid. The discriminatory rule tends to be used at the merchant sites (Onsale, uBid, Encore Auction), while the uniform-price rule is fairly standard for multi-unit auctions at the listing sites.<sup>29, 30</sup>

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<sup>28</sup> Despite economists’ usage of “Dutch auction” to mean a declining-price auction, online auctioneers use it to mean a multi-unit ascending-price auction. Onsale first used this term in 1995 to describe its pay-your-bid multi-unit auction, but after receiving several complaints about confusion with a descending-price auction, they introduced their own name, “Yankee Auction.” Many auction sites continue to use the term “Dutch auction” to describe a multi-unit auction, almost always with a uniform-price rule. Sites with pay-your-bid rules tend not to use the term “Dutch.”

<sup>29</sup> Some listing sites, such as Auction Port and Boxlot, give the seller a choice between the two price rules.

<sup>30</sup> The uniform-price rule appears to be considered a substitute for the proxy-bidding system available on single-unit auctions, since a winning bidder in either case generally has her price determined by the bids of lower bidders. In fact, eBay does not enable proxy bidding in its multi-unit auctions. An important difference from proxy bidding is that the highest bid amounts are public, rather than secret, in an ongoing

At first blush, one might expect the two formats to produce roughly equivalent results, if each bidder follows the sensible strategy of always bidding just enough to stay among the winning bids. (For example, if the ten current winning bids consist of four bids of \$90 and six bids of \$100, the minimum increment is \$10, and I am willing to pay up to \$150, I would submit a bit of \$100 to displace the current high bidder for the time being.) Ignoring the discreteness of bid increments, one would expect such a strategy to result in all participants paying the amount submitted by the lowest accepted bidder – regardless of whether the format were uniform-price or pay-your bid.

However, it is easy to find examples of both types of multi-unit auctions online where the winning bids have a spread of more than one minimum increment. For example, a recent uniform-price auction for six identical Beanie Babies at eBay had winning bids ranging from \$100 to \$115, with a minimum increment of only \$2.50. Similarly, a recent pay-your-bid auction for ten identical video-capture devices has winning bids ranging from \$42 to \$57, with a minimum increment of only \$5. Easley and Tenorio (1999) have collected a data set on bidding behavior at Onsale and uBid, which shows that jump bids are quite prevalent – they propose the cost of bid submission as an explanation for this behavior. Under these circumstances, the pay-your-bid auction might appear to generate higher revenues on average, assuming that bidders would use the same bidding strategies in either format, but it is not clear to me (either theoretically or empirically) whether that assumption should hold.

## **IX. B. The Possibility of Demand Reduction**

One recent topic in auction theory is that of demand reduction in multi-unit auctions (Engelbrecht-Wiggans and Kahn (1998), Ausubel and Cramton (1997)). When bidders

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uniform-price auction at eBay. Revelation of these bids could cause problems, such as increased opportunities for shills. My view is that eBay would do well to integrate proxy bidding with its multi-unit auctions, so that bid amounts are kept secret until they have been outbid (proxy bidding exists in multi-unit auctions at several merchant sites, including Onsale and uBid).

have multi-unit demand for a good with multi-unit supply, there will be an incentive for bidders to pretend their demand is low, potentially causing allocative inefficiency.<sup>31</sup> This problem can be solved with the Vickrey multi-unit sealed-bid auction format, which is a relatively complicated mechanism such that, if bidders understand it, they have incentive to reveal their full demand and restore efficiency of the auction.

Lawrence Ausubel (1997) has proposed an ascending-bid clock auction designed to be equivalent to the Vickrey multi-unit auction. It has a dominant strategy for each bidder to drop out of the bidding at his full willingness to pay, and is easier to understand than the sealed-bid Vickrey auction.<sup>32</sup> The idea is that as the auction progresses and rival bidders begin to drop out, there will come a point where a bidder who demands several units will have “clinched” winning at least one of the units. At this point, the auction locks in the price to that bidder for the units he has clinched, even as prices continue to rise on the rest of the units still up for auction. Thus, the efficient mechanism may require the same winning bidder to pay different amounts for different units. In the Appendix to this paper, I illustrate that current Internet multi-unit auctions have incentives for demand reduction, but this incentive problem could be fixed with a version of the Ausubel auction that would require very little change from current practices in the market. This is an example where Internet auctioneers might be able to benefit from the insights obtained in the economic theory of auctions.

### **IX. C. OpenIPO: A Sealed-bid Multi-Unit Auction**

The above discussion focuses on English auctions rather than other auction formats, because those were the only examples of multi-unit auctions we found in our survey. Since the completion of the survey, however, an interesting online business called

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<sup>31</sup> List and Lucking-Reiley (1999) and Kagel and Levin (1999) provide experimental evidence that bidders do indeed respond to demand-reduction incentives in uniform-price auctions.

<sup>32</sup> See Kagel and Levin (1999) for a discussion of how ascending-auction rules are more transparent than sealed-bid auction rules for subjects in economic experiments.

OpenIPO has opened, conducting initial public offerings of corporate stock through sealed-bid multi-unit auctions. Founded by investment banker William Hambrecht, the business aims to achieve new efficiencies in IPOs. Investment banks, they claim, have trouble picking the correct opening price for a new issue of stock, and they prefer to err on the side of setting the price too low. The investment bank then rations the underpriced shares to its best institutional clients, who get a windfall gain as their shares rise to the fair market price on the first day of trading. They claim that this is bad both for individual investors (who can't get in on the opening price) and for the companies (who raise less capital than they could if the price were set correctly). In order to solve this problem, OpenIPO has proposed to auction shares, with individual investors able to participate in a sealed-bid online auction. OpenIPO opened its first IPO (Ravenswood Winery) in February 1999, selling 1 million shares of stock at an auction price of \$10.50 per share. In July 1999, OpenIPO's is conducting its third initial public offering via auction.

OpenIPO uses a uniform-price rule, charging the amount of the lowest accepted per-share bid to each of the winning bidders. Ironically, just as economists have been exploring the topic of strategic demand reduction in uniform-price auctions, OpenIPO has started touting its uniform-price auction as economically efficient. Their information page states, "The OpenIPO auction is actually a modified version of an auction developed by William Vickrey. In 1996, he won the Nobel Prize in Economics for his work on designing auctions that bring new efficiencies to the marketplace." This ignores the fact that the uniform-price auction is not the correct demand-revealing generalization of the single-unit Vickrey auction (a result which Vickrey himself (1961) described, for the case where individuals might want multiple units). Demand reduction might actually cause inefficiencies and revenue losses in IPO auctions, relative to the outcome of a true multi-unit Vickrey auction. On the other hand, a major selling point for OpenIPO is that it "levels the playing field" for individual investors. "With OpenIPO," their Web site states, "shares are allocated in a completely even-handed way. Your allocation is based on what you are

willing to pay rather than on the size of your brokerage account.” However, the efficient multi-unit Vickrey auction would generally give discounts to high-demand bidders to give them enough incentive to reveal their high demand (see the example in the Appendix to this paper). I suspect that OpenIPO’s managers are not aware of the recent results on demand reduction in the economics literature, but perhaps it doesn’t matter. OpenIPO might prefer, for marketing reasons, to avoid an auction, however efficient, which appears not to “level the playing field.”

#### **IX. D. Package Bidding**

Another interesting topic addressed by auction theory is that of bidding on combinations of related items. (See, for example, Forsythe and Isaac (198x)). We did find one example on the Internet of an auction that encourages such “package bidding” on combinations of goods: the Winebid online auction of wines. This site frequently organizes the auctioned wines into groups which might be more valuable to some bidders if they were together in combination. For example, individual lot numbers 103a, 103b, and 103c might represent the 1992, 1993, and 1994 vintages of a Cabernet Sauvignon from a particular winery in California. In addition to allowing bidding on those individual bottles, the auction also encourages interested bidders to submit bids on lot number 103, a “vertical collection” of the three different vintages from that winery. Ascending bids proceed separately on the individual items and on the full package. For example, I observed an auction in progress where the high bids on the 1992, 1993, and 1994 vintages of a Cabernet were \$115, \$65, and \$85 respectively, held by three different bidders. A fourth bidder had the high bid of \$330 on the collection of three bottles. If the auction were to end at this point, the fourth bidder would win the three-bottle collection, because his \$330 bid exceeds the \$265 total of the three individual bottle bids. The high bidders on the individual bottles would win nothing in this case.

## **X. Time Duration of Auctions**

In our survey, 86 different sites gave us enough information to be able to estimate the length of time the average auction remained open. These are fairly rough estimates - for example, if a site had auctions lasting from one to five days, we used an unweighted estimate of three days as an estimate for that site. Most listing sites give sellers the opportunity to choose their own auction length. At eBay, for example, sellers can choose a length of 3, 5, 7, or 10 days for their auctions. The mean length of auctions at the different sites in this survey was 9.3 days, with a modal length of 7 days (occurring at 36 of 86 sites). The very short auctions took place at merchant sites, and were few in number relative to the regular several-day auctions at the same sites; they include Onsale's 60-minute "express auctions" and First Auction's 3-minute "flash auctions." The longest auctions in the survey, with lengths up to 90 days, were auctions for government surplus items at the WW Sales site.

## **XI. Minimum Bids and Reserve Prices**

Internet auctions usually specify a minimum acceptable bid amount, below which no bids will be accepted. On listing-agent sites, the individual seller chooses this as a parameter in the auction listing. In addition, many sites also feature a secret "reserve price," specified in advance but not revealed to the bidders until after the auction. If the highest bid does not exceed the amount of the reserve price, then the good will not be sold.

Of the 142 sites reviewed in our study, practically all of them used nonzero minimum bid levels, and 55 also allowed the use of reserve pricing. Typically (in at least 44 of 55 cases), an auction in progress on the Web site will indicate to bidders when it has a reserve price in use. On eBay and the majority of other English auction sites, the message changes from "the reserve price has not yet been met" to "the reserve price has been met" at the appropriate point in the bidding. Auction Universe has a somewhat unusual version of this: they indicate the presence of a reserve price with a red R icon next

to the auctioned item, and once the bidding reaches 15% below the reserve price, the icon turns green. Once the reserve price has been met, the reserve-price icon disappears entirely. A minority of English-auction sites give no feedback about the reserve price; in these cases the winning bidder does not know whether he has yet exceeded the reserve until the auction ends.

An interesting question is what effect the reserve price has on the auction. The conventional wisdom appears to be that reserve prices can be useful to the seller in the following way. The apparent model is that starting out the bidding at a falsely low minimum bid might generate interest and build bidding momentum, sending the bidding up past the reserve price. Had the reserve price been a public minimum from the start, the auction might never have got going. As Auction Universe indicates in its seller instructions, “A Reserve Auction is an auction format that allows a seller to enter a low starting price in the hopes of generating interest and bids on their item; however, the seller is not obligated to proceed with the sale until their ‘reserve’ price is met.”

This conventional wisdom seems at first to be positing a kind of irrationality on the part of bidders, who would be willing to pay more for the same good depending on whether the reserve price were made public or kept secret. However, a “winner’s-curse” model of privately uncertain, affiliated bidder values might be able to explain this behavior with a rational model. The low-minimum, high-reserve auction would give a bidder more opportunity to observe the bidding of others than would the high-minimum auction, so the “linkage principle” of Milgrom and Weber (1982) indicates that more aggressive bidding might actually be rational in the low-minimum, high-reserve auction. On the other hand, it is not clear whether the types of goods being sold in Internet auctions really involve bidders being uncertain of their own values. (A used laser printer presumably has a known value to the bidder who wants to buy it. Some collectibles might be speculative investments with uncertain future value, but others involve privately known values to bidders who wish urgently to complete their collections.)

In addition, to the extent that bidding requires costly effort, reserve prices might actually drive away bidders. At the auction site One Web Place, the discussion of the reserve price feature states, “Most buyers do not like reserve price auctions and will avoid them at all costs. It is very upsetting to win an item only to be told that your winning bid was not high enough... overuse of high reserves will force people to bid on other items.” I believe it is an interesting empirical question whether secret reserve prices benefit the seller more than an equivalent public minimum bid. Data from eBay and other online auction sites might be able to shed light on this topic, indicating not only whether such a phenomenon exists, but also whether reserve prices matter more for some types of goods than others.

## **XII. Buyout Prices**

A few English auctions in our survey actually specified a *maximum* acceptable bid level, or “buyout price.” Examples include One Web Place (agent site for collectibles), Mackley and Company (merchant/agent site for jewelry), and LabX (agent site for lab equipment). This procedure was also common with the newsgroup auctioneers I observed in 1994 and 1995. The idea of the “buyout price” is to allow the buyer to buy an early end to the auction by submitting a sufficiently high bid. The effect is somewhat similar to a classified ad which lists an item for sale for “\$500 or best offer,” although here it occurs in the context of a formal auction. When a “buyout” actually occurs, it benefits buyer and seller by bringing the auction to a close early (a savings of perhaps days or even weeks). The buyer gets certain victory, but does not know whether she might have been able to pay less had the auction continued. The seller gets a certain high price, but gives up the possibility that bidding might have gone even higher had the auction continued. Although sellers tend to set these prices quite high, I have seen buyers meet them on several occasions. Bob Kafato, president of LabX, indicates that in auctions where sellers choose to set an “Auction Stop” price (LabX’s term for a “buyout”), a bidder chooses to invoke

this option in about 10% of cases. I point out this institutional detail as a potential item of interest to theorists, for I am not aware of any theoretical literature which examines the effect of such a “buyout price” in an auction.

### **XIII. Strategic Manipulations: Shilling and Bid Shielding**

There have been some examples of Internet auction users using strategic manipulations to “game the system.” Shilling is an attempt by the seller to drive up the price of the good, while “bid shielding” is a technique designed to allow a bidder to get a “steal” on an item at a low price. Both practices are against the rules on Internet auction sites, but these rules can be difficult to enforce. It is unclear how frequently these manipulation strategies are used: they might not be terribly common at all, but there have been documented examples of both.

Shilling is nothing new; there have been incidents of shilling reported in traditional English auctions for many years. The concept is that when only one bidder remains in the auction, the seller can try to drive the auction price higher by bidding against her. Most auctioneers (including eBay) do not allow the seller to submit bids on their own goods while the auction is in process, but sellers have been known to circumvent this restriction by asking other agents to bid on their behalf. A number of states make shilling illegal, but this is a difficult law to enforce. Enforcement against shilling can be even more difficult in Internet auctions, where the bidders cannot see each other: a seller might invent a false identity with a new email address, and use that identity to bid in his own auction. One disadvantage for the seller is the possibility that he will “overshoot” the high bidder’s willingness to pay, and thus prevent himself from selling the good at all.<sup>33</sup> The seller can circumvent this problem by retracting his shill bid after the auction (perhaps claiming it was a typo), because most auction sites react to a withdrawn high bid by having the seller sell

the item to the second-highest bidder at the amount of her final bid. Of course, a seller whose auctions consistently have bidders retracting their bids will look suspicious to eBay, whose policy is to suspend the account of any seller caught shilling. Enforcement of anti-shilling rules has some effect, though it is not likely to be perfect.

Bid shielding is, in a sense, the inverse of shilling. Like shilling, bid shielding also involves artificially high bids – but by a buyer, not by the seller. The bidder puts in an early lowball bid (say \$10) on an item he’s interested in, and then gets a friend (or a false identity) to put in an extremely high bid (say \$500) on the same item. The high bid acts as a “shield” of the lowball bid, keeping anyone else from bidding in the auction. Just before the end of the auction, the bidder retracts the \$500 bid, leaving his \$10 bid as the winning bid on an item that should have gone for a higher price.<sup>34</sup> Unless the seller is paying close attention, she might never realize what happened, as the retracted bid typically does not show up in the bid history. Bid retractions are generally not permitted without good reason (such as an obvious typo), but this can be hard for the auctioneer to enforce if the individuals use false identities to place their manipulative bid shields. This practice appears not to be terribly widespread so far, but sites such as eBay might want to consider requiring bidders to guarantee their bids with credit-card deposits, in order to discourage strategic false bidding (both shills and bid shields).

## **XIV. Fraud**

Another issue of interest to economists is the possibility of fraud in online auctions. In particular, the listing-agent sites leave the actual transaction up to the seller and the winning bidder. The standard procedure is for the buyer to mail a check or money order to the seller, and wait for the seller to mail the goods in return. But how does the buyer know

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<sup>33</sup> The seller might just run another auction for the same good, but this does incur a cost on sites which charge a listing fee whether or not the item sells.

she can trust the seller? For example, I recently mailed a check for \$550 to a seller whom I'd never met, for a piece of software I'd won at eBay; was this a foolish move? I shared eBay's faith that "people are basically good," and was happy to find that my seller did indeed ship the good as promised. Despite most economists' instincts, there appears to be very little fraud in online auctions; the norm is for individuals to honor the terms of their transactions with each other. So far, at least, dishonest sellers have been few and far between.

In addition to the social norm of honesty, there are several formal mechanisms which help discourage fraud. First, eBay and other auction sites actively discourage fraud, encouraging users to file formal complaints with Attorneys General or the U.S. Post Office. A recent conviction in California indicates that online auction fraud cases will be taken seriously by the courts. Second, eBay pioneered a feedback and rating system, emulated by several other sites, that encourages buyers and sellers to rate each other at the close of a transaction. These ratings and comments are publicly available; when viewing an auction listing one also sees a numeric feedback rating (equal to the number of positive comments about a seller minus the number of negative comments about the seller registered by previous winning bidders). Similarly, a seller may see the feedback rating of the bidders in her auction, and always has the option to reject bids from any bidder. A single click allows one to view the entire history of written comments. A feedback rating of -4 results in automatic suspension of that user's account, and such events are rare. Many sellers have positive feedback ratings numbering in the hundreds; a fair number appear to be making full-time careers as sellers on eBay. Whether high ratings affect bidders' willingness to pay for an item is an interesting empirical question which could be studied with eBay data.

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<sup>34</sup> For documentation of one such instance, see the MSNBC news article available at <http://www.msnbc.com/news/293918.asp>.

Third, eBay and other auction sites encourage users to use a third-party escrow service if they fear the possibility of fraud. The buyer sends payment to the escrow agent, who verifies payment before the seller ships the good to the buyer. The buyer then has a short examination period, to make sure that the item meets its description in the auction. After the buyer indicates consent to the transaction, the escrow agent releases the funds to the seller. Founded in 1997, i-Escrow is the dominant firm in the Internet-auction escrow market, recommended by eBay and several other sites. It accepts payments via credit card as well as by check or money order, charging fees of between 1% and 6% of the transaction amount. I-Escrow President Sherman Kwok indicated in July 1999 that his firm's average transaction size is approximately \$300, and that their sales volume has been growing at a rate of approximately 25% per month.<sup>35</sup> (For comparison, my most recent estimates of eBay sales indicate that the average price of a good is \$30 and that eBay transaction volume is growing at around 12% per month. This indicates that escrow services are generally used only for the most expensive transactions, and seem to be growing at a rate faster than that of online auctions themselves.)

## **XV. 1999 Update: eBay, Yahoo!, and Amazon**

As online auctions have received increasing amounts of popular attention, two of the biggest consumer brands on the Internet have moved into the listing-agent market to compete with eBay. Yahoo! introduced its person-to-person auction listings in October 1998, and Amazon opened its own auction listings in March 1999. Both companies boasted millions of regular users at their existing sites, and they sought to leverage these user bases to create a large enough auction site to enjoy the same economies of scale already enjoyed by eBay. Amazon and Yahoo! entered the auction market too late to be part of our original autumn 1998 survey, but this competition has generated so much

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<sup>35</sup> Financial details on I-Escrow come from the CNET news story "I-Escrow set to acquire rival Trade

attention that it seemed worthwhile to perform an updated survey of these three large auction sites: eBay, Yahoo!, and Amazon.

To produce updated volume estimates for summer 1999, we sampled hundreds of auction listings at each of the three sites. The results can be found in Table 4. In terms of revenues, eBay is still 100 times as large as Amazon and 10 times as large as Yahoo! Both of the new sites have quickly grown large enough to make the list of the ten largest auction sites on the Internet, but in the meantime eBay's size has more than doubled (with a continued growth rate of approximately 12% per month).

**Table 4: Size estimates for eBay, Yahoo!, and Amazon, Summer 1999.**

(estimated standard errors in parentheses<sup>36</sup>)

	Auctions closing per day	Revenues per month
eBay	340,000	\$190,000,000 (\$18,000,000)
Yahoo!	88,000	\$19,000,000 (\$7,900,000)
Amazon	10,000	\$2,000,000 (\$620,000)

The two newcomers have a lot of similarities to eBay: similar categories of goods, similar fixed-length English auction bidding rules, and similar auction-listing procedures. All three sites offer proxy bidding, but they differ in their treatment of the end of the

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Direct" <http://www.news.com/News/Item/0,4,39244,00.html>

<sup>36</sup> We computed these estimates by choosing a day in June or July to visit each site, observing the number of auctions closing that day, and taking a sample of closed auctions to estimate the average revenue per auction closing. Sample sizes were 1232 auctions at eBay, 259 auctions at Yahoo!, and 241 auctions at Amazon. (At Amazon and Yahoo!, we obtained simple random samples of goods, while at eBay we took a stratified sample over 12 different categories, computing weighted averages instead of simple averages). compute monthly revenues from daily estimates, we multiplied by 30. Standard errors are based on sampling variation in the revenues per auction listings. We did not make a formal estimate of the sampling error in the number of auctions closing per day, because it was too difficult to obtain separate estimates on a large sample of different days. On eBay, where the past 30 days' results are relatively easy to obtain, we estimated that the standard deviation of the number of auction closings per day is approximately 25% of the mean number of closings (though this was abnormally high due to an unusual eBay system outage which prevented auctions from closing on June 10-11, 1999.)

auction: Amazon has a 10-minute extension period when there is bidding activity at the end of the auction, Yahoo! gives the seller the option of a 5-minute extension period or a hard close time, and eBay continues to use a hard close time. Another difference is that eBay generally gives the user more options for searching through the auction data, such as the option of browsing through any auction which closed in the past 30 days according to date and time as well as category. A third difference is in fee structure. Amazon and eBay both charge sellers a listing fee and a percentage commission, while Yahoo! charges no fees at all (presumably a strategy designed to increase auction traffic and generate additional advertising revenue for the site).<sup>37</sup>

This difference in fees has an important effect on sellers' incentives and behavior. Because Yahoo! does not charge fees for auction listings, a seller has less incentive to make sure that her auction results in an actual transaction. Indeed, a quick check reveals that most Yahoo! auctions have very high reserve prices, with the sellers apparently hoping for a "sucker" to come along and be willing to pay their high price. By contrast, at eBay and Amazon, sellers know that they will incur a listing fee whether the item sells or not, so they have an incentive to set reasonably low reserve prices to create a higher probability of resulting in a transaction. Indeed, our summer 1999 data indicate that this is the case: eBay has 54% of all auctions result in a sale, Amazon's fraction is 38%, while Yahoo!'s fraction is only 16%. With five-sixths of its auctions failing to receive any acceptable bids, Yahoo! has a significantly<sup>38</sup> lower auction transaction rate than either eBay or Amazon. It seems puzzling at first that Amazon's transaction rate is also lower than eBay's, but the reason appears to be a special "SummerDime" promotion run by Amazon. During summer 1999, Amazon's listing fees are only \$0.10 per auction, instead of their regular rates (which

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<sup>37</sup> Yahoo! also has an automatic relisting option, so that if a seller's auction fails to have any bids, the seller can have that same auction renewed again for an additional week (or however many days the seller originally chose for the auction), and a seller can do this indefinitely. By contrast, both eBay and Amazon allow only one "second chance" to the seller: one free relisting for an item which didn't sell (with the original listing fee having already been paid).

match eBay's) of \$0.25 to \$2.00 per listing. So incentives appear to be working in the predicted direction: the higher the listing fee, the more careful sellers are to design an auction listing which actually results in a transaction.<sup>39</sup> This presents an interesting dilemma for the sites trying to compete with eBay: one can try to attract more sellers to the site by lowering one's listing fees, but this will tend to make sellers less serious about making a sale, which may in turn lead to reduced bidder enthusiasm for the site.

## **XVI. Conclusion**

Auctions on the Internet represent one of the most interesting developments in electronic commerce. In this paper, I have attempted to present an economist's guide to Internet auctions, based primarily on a comprehensive survey of Internet auctions as they appeared in autumn 1998. The volume of transactions (on the order of \$1 billion in transactions in 1998) is impressive, especially in a market with such a brief history. Equally impressive is the diversity of goods auctioned, from obscure collectibles to used computers to travel services, with some interesting indications that even more types of goods (such as software developers' services) may be auctioned in the near future.

I have focused particular attention on the details of the auction mechanisms used, trying to point out the relationships between the actual auction institutions on the Internet and the large existing body of auction theory literature. Most Internet auctions are English ascending auctions, but there are also examples of sealed-bid and Dutch declining-price auctions online. In addition to several true Vickrey (second-price sealed-bid) auctions, many of the English auctions employ proxy-bidding systems which make them resemble Vickrey sealed-bid auctions. Quite a few sites conduct auctions for multiple identical units, and these might be able to benefit from recent developments in multi-unit auction theory.

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<sup>38</sup> The difference is statistically as well as economically significant. With the sample sizes obtained in this study, the p-values for comparisons of Yahoo! to the other two sites are both less than  $10^{-6}$ .

<sup>39</sup> It will be interesting to see whether, if Amazon returns to an eBay-style fee schedule, its transaction rate will rise to match eBay's.

Minimum bids and reserve prices in Internet auctions provide interesting fodder for empirical research, while buyout prices represent a feature not yet tackled by auction theory. I have discussed the institutional features designed to promote trust in transactions between agents who are unknown to each other. I have also presented examples of strategies (shilling, bid shielding) used by Internet auction participants to manipulate the results of the auctions, and discussed possible mechanism designs which auctioneers can use to prevent such subversion of the auction's goals.

Another interesting aspect of Internet auctions is the economic competition involved. In addition to the obvious competition between rival bidders, there is also competition between the auctioneers, and even competition between the software developers who provide software for auctioneers. The competition between auctioneers is made even more interesting by the possible presence of network externalities: sellers tend to prefer to auction items at the site visited by the most bidders, and vice versa. To examine the most important example of competition between Internet auctioneers, I collected detailed data on the three largest general-purpose auction sites: eBay, Yahoo!, and Amazon. After a period of months of competition from two well-funded rivals, eBay remained ten times larger than Yahoo! and one hundred times larger than Amazon. The most interesting result from that data was the evidence that sellers at the sites clearly respond to the incentives provided by the auctioneers' fee structures; imposing a cost on sellers for failed auctions tends to make sellers more serious about selling.

Internet auctions raise a variety of interesting questions for economists to investigate. How large are the network externalities involved in providing an auction site? What is the likely outcome of competition between auctioneers? Do seller reputations on eBay have a measurable effect on bidding behavior? Will Internet auctioneers find it profitable to incorporate results from multi-unit auction theory into their auction mechanisms? Does a secret reserve price benefit the seller more than the equivalent minimum bid? What types of goods should we expect to be auctioned, and which will

continue to be transacted at fixed prices? My hope is that this survey will serve as a useful snapshot of the early days of Internet auctions, and perhaps inspire further research in this exciting area.

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## Appendix 1: Data Collection

The method of data collection was to locate as many auction sites as possible on the World Wide Web, and visit them to collect data of interest to economists, particularly auction theorists. My research assistants and I exhausted the list of auctions turned up by the search engines at <http://www.yahoo.com> and <http://www.snap.com>, as well as those at the Internet Auction List at <http://www.internetauctionlist.com>, and also added any additional auction sites we ran across in our travels across the World Wide Web. Perhaps not surprising to those who use the Internet regularly, we found many of the listed sites to be no longer operational by the time we visited (between September and November, 1998). Many of the listings turned up by search engines and catalogs under “auction” are, of course, not Web-based auctions per se, but rather Web pages that discuss more traditional auctions where bids are executed in person or via the postal service. For purposes of this study, I define an “Internet auction” as being an auction that accepts bids via the Internet (usually through a Web-based form, but occasionally via email). After excluding defunct sites<sup>40</sup> and non-Internet auctions, we found a total of 142 Web-based auction sites for our survey. A complete list of these sites and their Internet URLs can be found in Appendix 4.

All of the data described herein come from the Web pages at the auction sites themselves. Most sites described their auction formats in detail in a “bidding rules” section; some failed to do this explicitly, so we attempted to infer the rules by watching auctions as they progressed and as they finished. For some sections of analysis, the number of auctions described is less than 142, because we were not able to find a satisfactory answer to certain questions on certain sites. In order to estimate the dollar volume of transactions per month at each site, we typically counted up the number of auctions currently taking place on the site (a task sometimes facilitated by automated descriptive statistics provided by the site). Next, we took a sample of auction listings (typically between 50 and 100)

which had already closed,<sup>41</sup> and used this sample to estimate both the mean revenue per auction and the mean number of days per auction. From these figures, we could estimate the approximate transaction revenues per day and per month.

Some sites make it easier than others to estimate revenues. The eBay site is a particularly good source of data, making available the results of all completed auctions from the past month, including bid histories which indicate the prices at which each bidder dropped out. On eBay, we were able to take a sample of all closed auctions, use that sample to estimate the mean revenue per closed auction, and scale by the number of items closing per day (this figure being available on the site) in order to compute a monthly revenue estimate. On other sites, the task was not so simple: sometimes completed auctions were unavailable, so we had to estimate the results using the auctions which were about to close. Sometimes it was difficult even to estimate how many items were available on the site, because such summary statistics were unavailable. Sometimes it was difficult even to tell whether a particular auction had actually resulted in a sale or not (we tried not to include any item that never had a winning bidder). Each site had its own format for presenting data, which made the process quite time-consuming. Some of our samples of prices or of quantities per month may have been unrepresentative, particularly at sites where the volume of transactions fluctuated significantly over time.<sup>42</sup> Because of the difficulty of the task and the potential vagaries of the data, our goal was modest: to provide estimates of revenues that would be accurate to within an factor of ten. Any estimated standard errors from our samples would likely be underestimates of the amount of

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<sup>40</sup> Quite a few Web sites appeared to be fully functional auctions, but had no items listed, and very little detail about the rules of bidding. These sites were excluded from our survey as well.

<sup>41</sup> Sometimes the site did not allow viewing of closed auctions. In these cases, we sampled items which were within a few minutes of closing, and assumed that this would give us the approximate final price.

<sup>42</sup> For ease of data collection we usually took our sample of prices from auctions closing at a given point in time (sometimes a period of time as short as ten minutes). If auction revenues fluctuate significantly over the course of a day, week, or month, then our estimates of mean revenues could be inaccurate. I choose, therefore, not to present standard errors for our estimates, believing it to be more honest to give the subjective but conservative order-of-magnitude estimates of error. (For example, on one week we estimated Patriot Auctions' revenues to be approximately \$9,650, while two weeks later the number of auctions (and revenues) were estimated to be nearly 10 times greater.)

uncertainty, so I prefer to state that the revenue estimates in this survey are accurate only to within an order of magnitude. For the top ten sites, we expended more effort, so those estimates are likely accurate to within  $\pm 50\%$ . The goal was to give as complete a picture of the online auction market as possible within a relatively short time horizon.

## **Appendix 2: The Market for Auction Software**

Although many auction sites on the Internet use their own proprietary software to run auctions, a number of more recent sites have enlisted the services of auction software providers. A surprising number of firms specialize in providing auction engines, including OpenSite, Fairmarket, Moai Technologies, Netmerchants, and Beyond Solutions. In addition, both Microsoft and IBM announced new auction tools in 1998 for their electronic commerce software products (Site Server Commerce Edition and Net.Commerce, respectively).

OpenSite sells three versions of its product OpenSite Auction, ranging in price from about \$5,000 to about \$100,000, providing bid-processing services and Web-page development tools for the would-be auctioneer. This software runs the auctions for several of the sites in our survey, including CyberHorse, Pacific Book Auction, Galaxy Gold (jewelry), and Winebid. OpenSite also offers Bidstream.com, a search engine that allows bidders to search the listings available on all auction sites powered by OpenSite, an attempt to allow OpenSite's customers to work together to overcome the economies of scale enjoyed by giants like eBay, with many buyers and many sellers.

Netmerchants' Auctioneer and Beyond Solutions' Visual Auction are relatively similar to OpenSite Auction, as is Moai's Live Exchange. Moai has differentiated itself by targeting customers interested in hosting business-to-business auctions, including AdAuction.com (media advertising) and PaperDeals.com (wholesale paper). Fairmarket AuctionPlace product differs from the others; it is a complete auction-hosting service rather than a piece of auction software. They run auctions on their own computers, but the auctions appear at the sites of their clients. Their clients currently include computer retailers CompUSA, Dell, and Outpost.com (none of which were included in the autumn 1998 survey).

### Appendix 3: Applying the Ausubel Auction on the Internet

How does the efficient Ausubel auction compare to the actual multi-unit ascending-bid auctions used on the Internet? Ausubel uses a “clock auction” similar to that introduced by Milgrom and Weber (1982), where a price clock suggests progressively higher prices to the bidders, and the bidders merely indicate whether they intend to stay in or drop out. Since real-world bidders may find a clock auction less familiar than the traditional bid-raise auction, I prefer to think about a bid-raise auction which is essentially equivalent to the Ausubel auction (in the same sense that the Milgrom-Weber clock auction is essentially equivalent to the traditional single-unit English auction). Such an auction might work by keeping track separately of each of the units on which a bidder is bidding. For example, suppose there are 4 units up for auction, and that there are four bidders: George (interested in purchasing up to 2 units), Helen (1 unit), Isabelle (1 unit), and Jack (3 units). Suppose that the auction has a minimum bid increment of \$1, and that the current high bids are as follows:

George	\$50
George	\$50
Helen	\$50
Isabelle	\$50

Now Jack, a fourth bidder, is willing to pay even more than \$50 each for three units, so he submits three bids of \$51, displacing Helen and Isabelle, as well as one of George’s bids:

Jack	\$51
Jack	\$51
Jack	\$51
George	\$50

At this point, it turns out that Helen is not willing to bid above \$50, so she will not enter any further bids. Therefore, although nobody knows it yet, Jack has just clinched a unit (since there are 4 units available and his remaining rivals, George and Isabelle, only demand 3 units between them). That means Jack should only have to pay \$51 for one of

his units. Let's see how this would work. It's now Isabelle's turn to bid, so she submits a bid of \$51 to get into the winner's category, displacing George:

Jack	\$51
Jack	\$51
Jack	\$51
Isabelle	\$51

On George's turn, he submits two bids of \$52:

George	\$52
George	\$52
Jack	\$51
Jack	\$51
Jack	\$51

Isabelle responds with her own bid of \$52:

George	\$52
George	\$52
Isabelle	\$52
Jack	\$51

Now it's Jack's turn. He is willing to purchase three units at a higher price, but he need not displace his own (currently lowest) bid. So he places two new bids of \$53. The tricky part is that the computer auctioneer not only keeps Jack's \$51 bid for him, it "staples" Jack's lower, earlier bid to his new, higher ones, and actually gives it a higher priority than the later bids. This gives Jack the "clinching" advantage he deserves as the highest-quantity bidder:

Jack	\$51
Jack	\$53
Jack	\$53
George	\$52

Next Isabelle submits a bid of \$53 to get back into the action. Note that Jack's bids are still at the top, since he was the first to submit a \$53 bid:

Jack	\$51
Jack	\$53
Jack	\$53
Isabelle	\$53

George responds with two \$54 bids:

George	\$54
George	\$54

Jack	\$51
Jack	\$53

Isabelle reciprocates:

George	\$54
George	\$54
Isabelle	\$54
Jack	\$51

In order to retain his advantage, Jack must stay in the bidding,<sup>43</sup> adding two more \$55 bids to go with his \$51 bid:

Jack	\$51
Jack	\$55
Jack	\$55
George	\$54

Isabelle adds a bids of \$55:

Jack	\$51
Jack	\$55
Jack	\$55
Isabelle	\$55

At this point, George drops out, so there are no more bid raises, and the auction ends. Note that this gives the same results as the Ausubel clock auction: Jack wins one unit at his clinch price of \$51 (when Helen dropped out), plus two more units at \$55 each (clinched when George dropped out). Similarly, Isabelle wins a unit for \$55 (clinched when George dropped out).

In practice, the mechanisms used by Internet auctioneers do not give high-quantity bidders this sort of advantage, allowing them to “clinch” lower prices on some of their units. No Internet auction of which I am aware gives a single bidder the opportunity to submit different bids (or pay different prices) on different units of the same good.<sup>44</sup> In particular, in a pay-your-bid auction at Onsale, Jack in our example above would have been forced to displace his own \$51 bid in order to place additional higher bids.

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<sup>43</sup> It might seem onerous for Jack to have to monitor the auction closely enough to avoid missing his turn and losing his “clinching” advantage. However, this problem could easily be avoided if the auction site were to implement a proxy bidding feature to bid on his behalf up to his maximum bid amount.

Faced with standard Internet-auction multi-unit rules, bidders may have an incentive for strategic demand reduction. To see this possibility, suppose that Jack's reservation price was \$58 for each of three units<sup>45</sup>, Isabelle's \$56 for one unit, George's \$55 for each of two units, and Helen's \$50 for one unit. If everyone were to have bid up to his or her full demand under standard Internet auction rules, it would have resulted in an auction price of \$55 for all three of Jack's units and both of Isabelle's units. The surplus earned by each bidder would have been \$9 for Jack, \$1 for Isabelle, and \$0 for George and Helen.

As an alternative strategy, each of the multi-demand bidders (George, Isabelle, Jack) could have pretended to want only a single unit. Then George would have bid on one unit, Helen one, Isabelle one, and Jack one, for a total of five units, and no one would have raised the price above the starting price of \$50. This would have given a surplus of \$5 to George, \$0 to Helen, \$3 to Isabelle, and \$16 to Jack, so everyone would be better off under this strategy of demand reduction than under a strategy of full demand revelation. Furthermore, this demand reduction strategy is a Nash equilibrium, and can be supported as a subgame-perfect equilibrium with trigger strategies that have everyone revert to full-demand-revelation in case anyone deviates and submits a bid for two units. Note that the demand-reduction equilibrium is inefficient, and also results in lower revenues for the auctioneer than would be obtained in the "clinch" auction. Furthermore, such an equilibrium could feasibly be supported in practice, even if bidders did not know each others' reservation values.<sup>46</sup> Bidders could begin the auction by bidding on only one unit each, in hopes of arriving at a low-revenue demand-reduction equilibrium, and switch to multi-unit bidding only if they observe other bidders bidding on multiple units.

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<sup>44</sup> Tenorio (1997) models the incentives for demand reduction in an environment where bidders are constrained in this way, having to bid identical price amounts for each unit of the good.

<sup>45</sup> This assumes that Jack (and the other bidders) has constant marginal valuations (flat demand) for the three units. This is not required; the analysis would also hold if multi-demand bidders had decreasing marginal valuations (downward-sloping demand).

<sup>46</sup> The assumption of only 4 bidders competing for 4 units in the example may seem like an unusually thin market, but I have actually seen quite a few multi-unit Internet auctions with approximately as many bidders as units available.

Since the ascending-bid multi-unit auctions found on the Internet result in a winning bidder paying identical amounts for all units she wins, we might argue equivalence of these auctions to the uniform-price sealed-bid auction studied in the literature.<sup>47</sup> This allows us to invoke the Inefficiency Theorem of Ausubel and Cramton (1997), which guarantees demand reduction and inefficiency in any Nash equilibrium (assuming certain technical conditions are met). This analysis indicates that Internet auctioneers could improve their auctions, and likely increase their revenues, by using results from auction theory to make small changes to their auction design.

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<sup>47</sup> Ausubel and Cramton (1997) make a similar argument concerning the FCC spectrum auctions.

## Appendix 4: List of Surveyed Auction Sites

Auction Site	URL
4a Travel	<a href="http://www.4a.com/auction">http://www.4a.com/auction</a>
AB!C Absentee Auctions	<a href="http://nas.net/~draaks/anindex.html">http://nas.net/~draaks/anindex.html</a>
ABC Live Auction	<a href="http://www.abcliveauction.com">http://www.abcliveauction.com</a>
ABQ	<a href="http://www.abq.com">http://www.abq.com</a>
Advantage Auction	<a href="http://advantageauction.com">http://advantageauction.com</a>
Affiliated Computer Auction	<a href="http://remarketing.com/auction/index.html">http://remarketing.com/auction/index.html</a>
American Fine Arts On-Line	<a href="http://www.afaol.com">http://www.afaol.com</a>
American Image gallery	<a href="http://www.diamondlightphotos.com">http://www.diamondlightphotos.com</a>
Antebellum Covers	<a href="http://www.antebellumcovers.com">http://www.antebellumcovers.com</a>
Antique Canada	<a href="http://www.antiquecanada.com">http://www.antiquecanada.com</a>
Antique Country	<a href="http://www.antiquecountry.com">http://www.antiquecountry.com</a>
Antique Photo.Com	<a href="http://antiquephoto.com">http://antiquephoto.com</a>
Art Auction	<a href="http://www.artauction1.com">http://www.artauction1.com</a>
Arte Ptrimivito	<a href="http://www.arteprimitivo.com">http://www.arteprimitivo.com</a>
AucitonX	<a href="http://www.auctionx.com">http://www.auctionx.com</a>
Auction 2000	<a href="http://www.auction2000.net">http://www.auction2000.net</a>
Auction Bidding	<a href="http://auction-bidding.com/main.cfm">http://auction-bidding.com/main.cfm</a>
Auction Hoss Town	<a href="http://www.auctionhosstown.com">http://www.auctionhosstown.com</a>
Auction Inc.	<a href="http://wwcd.com">http://wwcd.com</a>
Auction InfoCom	<a href="http://auction.infocom.net">http://auction.infocom.net</a>
Auction MCW	<a href="http://www.auctionmcw.com">http://www.auctionmcw.com</a>
Auction Nation	<a href="http://www.auctionnation.com">http://www.auctionnation.com</a>
Auction Network	<a href="http://auction-network.com">http://auction-network.com</a>
Auction Port	<a href="http://auctionport.com">http://auctionport.com</a>
Auction Sales	<a href="http://ai.wwcd.com/auction/wof/index-wwcd.html">http://ai.wwcd.com/auction/wof/index-wwcd.html</a>
Auction Texas	<a href="http://auctiontexas.com">http://auctiontexas.com</a>
Auction Universe Inc.	<a href="http://auctionuniverse.com">http://auctionuniverse.com</a>
Auction Ware	<a href="http://auctionware.com">http://auctionware.com</a>
Auction Works	<a href="http://auctionworks.com">http://auctionworks.com</a>
Auction-123	<a href="http://auction-123.com">http://auction-123.com</a>
AuctionAddict.com	<a href="http://auctionaddict.com">http://auctionaddict.com</a>
AuctionNet	<a href="http://auction.net/electronic">http://auction.net/electronic</a>
Auctions U-Auction-It	<a href="http://uauction.com">http://uauction.com</a>
AuctionVine	<a href="http://Auctionvine.com">http://Auctionvine.com</a>
AutographAuction	<a href="http://autographauction.com">http://autographauction.com</a>
Autographs & More	<a href="http://autografs.com">http://autografs.com</a>
Awardmasters	<a href="http://www.awardmasters.com">http://www.awardmasters.com</a>
B2B Auction	<a href="http://b2b-auction.com">http://b2b-auction.com</a>
Basketball Bonanza	<a href="http://basketballbonanza.com">http://basketballbonanza.com</a>
bid n ask	<a href="http://bidnask.com">http://bidnask.com</a>
Bid.com	<a href="http://www.bid.com">http://www.bid.com</a>
BidAway	<a href="http://bidaway.com">http://bidaway.com</a>
Biddernet.com	<a href="http://biddernet.com">http://biddernet.com</a>
Biddington's	<a href="http://biddingtons.com">http://biddingtons.com</a>
BidnBuy	<a href="http://www.bidnbuy.com">http://www.bidnbuy.com</a>
Boxlot Online Auction	<a href="http://boxlot.com/index.html">http://boxlot.com/index.html</a>

Buffalo Bid	<a href="http://www.buffalobid.com">http://www.buffalobid.com</a>
Carousel Auction	<a href="http://carousels.com">http://carousels.com</a>
CityAuction	<a href="http://cityauction.com">http://cityauction.com</a>
Coin Universe	<a href="http://auction.coin-universe.com">http://auction.coin-universe.com</a>
Collectors Auction	<a href="http://www.collectorsauction.com">http://www.collectorsauction.com</a>
Cool Auctions	<a href="http://www.coolauctions.com">http://www.coolauctions.com</a>
Cyber Auctions	<a href="http://www.cyber-auctions.com">http://www.cyber-auctions.com</a>
Cyberhorse	<a href="http://www.cyberhorse.com">http://www.cyberhorse.com</a>
Cyberswap Auction House	<a href="http://www.cyberswap.com/7z7i2aNd">http://www.cyberswap.com/7z7i2aNd</a>
Dallas Gold & Silver Exchange	<a href="http://www.dgse.com">http://www.dgse.com</a>
Dan's Online Auction	<a href="http://abg.com/antiques/index.html">http://abg.com/antiques/index.html</a>
Dargate	<a href="http://www.dargate.com">http://www.dargate.com</a>
Dealerauction	<a href="http://www.dealerauction.com">http://www.dealerauction.com</a>
Dealsdeals	<a href="http://www.dealsdeals.com">http://www.dealsdeals.com</a>
Double J Sports & Auctions	<a href="http://doublejsports.com">http://doublejsports.com</a>
Down-Jersey	<a href="http://www.down-jersey.com">http://www.down-jersey.com</a>
drblank Engineering Textbook Auction	<a href="http://www.drblank.com/coeta.htm">http://www.drblank.com/coeta.htm</a>
eBay	<a href="http://www.ebay.com">http://www.ebay.com</a>
Egallery	<a href="http://www.egallery.com">http://www.egallery.com</a>
Encore E-Z Auction	<a href="http://www.encoreauction.com">http://www.encoreauction.com</a>
Fair Auction	<a href="http://www.fairauction.com">http://www.fairauction.com</a>
Fair Market	<a href="http://www.fairmarket.com">http://www.fairmarket.com</a>
Fast Parts	<a href="http://www.fastparts.com">http://www.fastparts.com</a>
Fidelity Pacific	<a href="http://www.fidpac.com">http://www.fidpac.com</a>
First Auction	<a href="http://www.firstauction.com">http://www.firstauction.com</a>
Galaxy Gold	<a href="http://galaxygold.com">http://galaxygold.com</a>
Global Auction Online	<a href="http://global-auction.com/index.htm">http://global-auction.com/index.htm</a>
Going, Going Sold	<a href="http://www.going-going-sold.com">http://www.going-going-sold.com</a>
GoingGoingGone	<a href="http://www.goinggoinggone.com">http://www.goinggoinggone.com</a>
Golden Age	<a href="http://www.goldnage.com">http://www.goldnage.com</a>
Golfbids	<a href="http://www.golfbids.com">http://www.golfbids.com</a>
Golfclub Exchange	<a href="http://www.golfclubexchange.com">http://www.golfclubexchange.com</a>
Golfweb Auction	<a href="http://www.golfweb.golfaction.com">http://www.golfweb.golfaction.com</a>
Haggle	<a href="http://www.haggle.com">http://www.haggle.com</a>
Hollywood Auction	<a href="http://travel.to/hollywood">http://travel.to/hollywood</a>
Interactive Auction Online	<a href="http://www.iaoauction.com">http://www.iaoauction.com</a>
Intermodal Exchange	<a href="http://www.intermodalex.com">http://www.intermodalex.com</a>
John Morelli Auctioneers	<a href="http://abcauction.com">http://abcauction.com</a>
Just Glass	<a href="http://www.justglass.com">http://www.justglass.com</a>
Keybuy	<a href="http://www.keybuy.com">http://www.keybuy.com</a>
Klik-Klok	<a href="http://www.klik-klok.com">http://www.klik-klok.com</a>
LabX	<a href="http://www.labx.com">http://www.labx.com</a>
LightningAuction	<a href="http://www.lightningauction.com">http://www.lightningauction.com</a>
Live Auction	<a href="http://www.liveauctiononline.com">http://www.liveauctiononline.com</a>
Live to Play	<a href="http://www.livetoplay.com">http://www.livetoplay.com</a>
Livebid	<a href="http://www.livebid.com">http://www.livebid.com</a>
Mackley & Company	<a href="http://mackley.com">http://mackley.com</a>
Manion's Auction	<a href="http://www.manions.com">http://www.manions.com</a>
Mile High Comics	<a href="http://www.milehighcomics.com">http://www.milehighcomics.com</a>

Miles of History Civil War Auction	<a href="http://www.collectorsnet.com/miles/auction/index.html">http://www.collectorsnet.com/miles/auction/index.html</a>
National Auction Properties Inc.	<a href="http://auctionz.com/index.shtml">http://auctionz.com/index.shtml</a>
Nauk's Vintage Records	<a href="http://78rpm.com">http://78rpm.com</a>
NetMarket	<a href="http://netmarket.com">http://netmarket.com</a>
New Spirit Jewelers & Crystal Gallery	<a href="http://wehug.com">http://wehug.com</a>
Northerbys	<a href="http://www.northerbys.com">http://www.northerbys.com</a>
Numisma Mynthandel	<a href="http://www.web.idg.no/numisma">http://www.web.idg.no/numisma</a>
One Web Place	<a href="http://www.onewebplace.com">http://www.onewebplace.com</a>
Online Auction Warehouse	<a href="http://auctionwarehouse.com">http://auctionwarehouse.com</a>
Onsale	<a href="http://www.onsale.com">http://www.onsale.com</a>
Pacific Book Auction	<a href="http://www.nbn.com/~pba/index.html">http://www.nbn.com/~pba/index.html</a>
Patriot Auctions	<a href="http://www.patriotauctions.com">http://www.patriotauctions.com</a>
Paulus Swaen	<a href="http://www.swaen.com">http://www.swaen.com</a>
PC Buyer	<a href="http://www.pcbuyer.com">http://www.pcbuyer.com</a>
Peddleit	<a href="http://www.peddleit.com">http://www.peddleit.com</a>
Peter Johnson	<a href="http://www.pjcurrency.com">http://www.pjcurrency.com</a>
Pinocchio Productions Inc.	<a href="http://member.aol.com/PinocProd/auction.html">http://member.aol.com/PinocProd/auction.html</a>
Playle's Postcard Auction	<a href="http://www.playle.com">http://www.playle.com</a>
Quixell	<a href="http://www.quixell.com">http://www.quixell.com</a>
Rotman Collectibles	<a href="http://www.wwcd.com/rotman">http://www.wwcd.com/rotman</a>
Roy Reynolds Coins	<a href="http://members.aol.com/coins96/auction.htm">http://members.aol.com/coins96/auction.htm</a>
Sandafayre	<a href="http://www.sandafayre.com">http://www.sandafayre.com</a>
Sceoppa.Com	<a href="http://sceoppa.com">http://sceoppa.com</a>
Sell and Trade	<a href="http://www.sellandtrade.com">http://www.sellandtrade.com</a>
Sporting Auction	<a href="http://www.sportingauction.com">http://www.sportingauction.com</a>
Sports Auction	<a href="http://SportsAuction.com">http://SportsAuction.com</a>
Stamps, Coins and Phonocards Auction	<a href="http://www.actcom.co.il/unistamps">http://www.actcom.co.il/unistamps</a>
Stein Auction	<a href="http://www.steinauction.com">http://www.steinauction.com</a>
Surplus Auction	<a href="http://surplusauction.com">http://surplusauction.com</a>
Target Auction	<a href="http://www.usbusiness.com">http://www.usbusiness.com</a>
The Sporting News Auction	<a href="http://auctions.sportingnews.com">http://auctions.sportingnews.com</a>
Then and Now Auction	<a href="http://www.thenandnow.com">http://www.thenandnow.com</a>
Timeshare Resales International	<a href="http://www.tri-timeshare.com/AUCTIONS/Auctions.htm">http://www.tri-timeshare.com/AUCTIONS/Auctions.htm</a>
Travel to Hollywood	<a href="http://www.travel.to/Hollywood">http://www.travel.to/Hollywood</a>
Travelbids	<a href="http://www.travelbids.com">http://www.travelbids.com</a>
Travelfacts Auction	<a href="http://bid4travel.com">http://bid4travel.com</a>
Trinity Minerals Company	<a href="http://www.trinityminerals.com/auction/auction.htm">http://www.trinityminerals.com/auction/auction.htm</a>
U Auction	<a href="http://www.uauction.com">http://www.uauction.com</a>
UBID	<a href="http://ubid.com">http://ubid.com</a>
Universal Studios	<a href="http://unistudiosauction.com">http://unistudiosauction.com</a>
Up 4 Sale	<a href="http://www.up4sale.com">http://www.up4sale.com</a>
US Auctions	<a href="http://www.usauctions.com">http://www.usauctions.com</a>
Virtual Nostalgia Auction Company	<a href="http://vnostalgia.com">http://vnostalgia.com</a>
Wall of Fame	<a href="http://ai.wwcd.com/auction/wof/index-wwcd.html">http://ai.wwcd.com/auction/wof/index-wwcd.html</a>
Wine Cellar Auction	<a href="http://">http://</a>
winebid.com	<a href="http://winebid.com">http://winebid.com</a>
World Wide Auction	<a href="http://wwauction.com">http://wwauction.com</a>
WW-Sales	<a href="http://www.ww-sales.com">http://www.ww-sales.com</a>