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디지털 경제에서의 효율적 시장 메커니즘에 대한 연구: 가격부착 시장과 경매에 대한 가상 실험

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In Search of an Efficient Market Mechanism for a Digital Economy: Virtual Field Experiments on Posted-price Markets and Auctions

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Abstract

In recent years, many retail businesses jumped on the Internet auction bandwagon and paid substantially high fees to learn and develop proper business strategies for this new environment. Unlike what most businesses in the real world presume, this research shows that discriminatory-price ascending-bid auctions in a digital economy might be not very beneficial for the sellers on the Internet, if sellers sell the identical digital products through both a typical posted-price market and an auction.

Using an extensive technology infrastructure along with suitable incentives and rules for market agents, we found that a discriminatory-price ascending-bid auction, which is the most popular auction mechanism on the Internet, serves consumers better than it does the sellers or producers in the digital economy. That is, the average prices for digital goods in these auctions are substantially lower than the prices in a posted-price market. This shows that it is not so wise for sellers to jump on the bandwagon of Internet auctions, if there is a market place with posted-price mechanisms which sells comparable items, or if a seller does not have special advantages or strategies in this new market institution.

Electronic market mechanisms provide powerful means of understanding and measuring consumer characteristics including willingness-to-pay and other demographics for sellers or producers. Many concern that sellers may extract the entire surplus from the market by using customization on the Internet, thus consumers will be worse off in this digital economy. We found that these sellers who can customize their products and prices fail to capture the whole consumers surplus and cannot exercise a monopoly. One major explanation for this phenomenon is that the competition among the sellers prohibits them from charging prices according to customers demand for each product, where switching from one seller to another is not so difficult for the customers, and reselling products among the buyers are prohibited.

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1. Introduction

We live in an era of rapid change in economic institutions (Choi et al. 1997, Shapiro and Varian 1999, Tapscott 1995). Markets play a crucial role in the economy, facilitating the exchange of information, goods, services, and payments. In this process, they create economic value for buyers, sellers, and market intermediaries like malls or portals in electronic markets. The existing markets, such as traditional retail stores, malls, and catalog businesses, have expanded and changed, and new markets, the Internet malls including many auction sites, have opened in response to advances in information technology.

Because new technologies and media provide distinctive features such as customizability, lack of geographical boundaries, and easy transfer of information (products), business models and processes in a digital economy are different from traditional paradigms. To understand this new paradigm for a digital economy, we need to test new market mechanisms and underlying principles. This research seeks to provide guidelines and insights on suitable technology, market mechanisms, and incentive systems in this digital economy, using virtual field experiments.

Existing economic and marketing theory and historical experience provide little guidance because of the technical and political differences between this new market and the traditional market institutions. Laboratory experiments are too abstract to provide realistic business implications. Researchers also often find that field experiments can be costly, as well as politically risky. A virtual field experiment, a new research approach that runs experiments in the collaboratory market environment on the Internet, can conveniently serve as a test bed for this new market institution.

This research is one of the first attempts to address this research issue of a digital economy, using a realistic virtual-world environment. For this virtual field experiment, we have developed a technological infrastructure, the Experimental Digital Economy (EDE), where sellers and buyers trade information and software products using electronic cash on the Internet. Hundreds of buyers from various universities in the U.S. and Mexico participate in this electronic market to buy information and software that they can use in their course projects, just like what real businesses on the Internet do.

Using virtual field experiments, we explored the effectiveness of market mechanisms (the posted-offer and auction systems) for digital products. We found that a discriminatory-price ascending-bid auction, which is the most popular auction mechanism on the Internet, serves consumers better than it does the sellers or producers in the digital economy. That is, the average prices for digital goods in auctions are substantially lower than the prices in a posted-price market. This shows that it is not so wise for sellers to jump on the bandwagon of Internet auctions, if there is a market place with posted-price mechanisms which sells comparable items, or if a seller does not have special advantages or strategies in this new market institution.

2. Virtual Field Experiments

Traditional experiments in economics provide imaginary goods with fixed buyers' values and sellers' costs. This traditional approach works when testing market efficiency and related hypotheses. Traditional experimental settings with strict controls and strong internal validity as the consequence of strict controls may not bear much resemblance to the real world, whereas realistic (natural) situations have numerous competing explanations for their results. In contrast, sellers (companies) in these virtual field experiments will create a set of valuable information for buyers and sell these goods. Buyers buy goods, which are valuable for them to proceed with their group projects, and to gain knowledge on certain technology issues. Using this realistic environment, these experiments can test propositions in a competitive market setting and will have a higher external validity. In other words, using EDE, we can discover business strategies, consumer characteristics, and other various phenomena in the digital world, and can also test these findings and theories with high internal and external validity.

Using various control mechanisms in place, the EDE can accommodate experiments with high internal validity, as well as experiments with high external validity. The combination of database and web-based communication technologies allows experimenters to test propositions which are greatly theoretical and require high levels of controls, and to apply these tested propositions to a realistic experimental setting in an abstract environment. Under this realistic experiment, experimenters can observe complex interactions among controlled and uncontrolled variables and monitor strategic behaviors of subjects.

The electronic (virtual) community setting and market information boards deliver information that participants need to know. In most experiments in economics in the past, these pieces of information were written on a blackboard in the classroom or laboratory (Smith 1962, 1964). Conversely, this electronic (virtual) community setting and the market information boards deliver information that participants need to know.

EDE is a distributed, interactive, real-time environment for conducting large-scale, virtual field experiments where digital goods are traded through electronic market places. EDE replicates the real world in its most crucial dimensions, such as competition, regulation, decision variables, incentives, and interaction dynamics. It consists of digital goods and services, market mechanisms (E-Market, E-Auction, and E-Tailor), a virtual community, and an electronic bank. In these markets, three types of players[1] interact:

[1] In this text, I have used the masculine pronouns *he*, *him*, and *his* to refer to the sellers, and the feminine *she* and *her* to refer to the buyer.

sellers, people who produce and sell digital goods; *buyers*, who purchase and consume these goods; and *intermediaries*, who provide banking services, offer certificates for products, and regulate markets. The new technological infrastructure for virtual field experiments, EDE, has many advantages over the traditional experiment settings in economics. For instance, experimenters and participants (subjects) can be distributed geographically around the world, and experimenters can monitor participants' activities closely and adjust various market features that are control variables for an experiment. Each semester since the fall of 1998, around 20 student groups have been selling their digital products and about 400 buyers from many universities over the world have participated in these experiments.

3. market mechanisms

In an economy, markets play very important roles, including facilitating the exchange of information, goods, services, and payments. A market plays not only an intermediary role but also creates values for players like buyers, sellers, and agents. Understanding market mechanisms is the one of the crucial processes in exploring a digital economy.

Traditional markets and electronic markets (market places on the Internet or in a computer network environment) have the following three major functions: matching buyers' needs and sellers' products; facilitating the exchanges of information, goods, services and payments associated with market transactions; and providing an institutional infrastructure, such as a legal and regulatory framework, that enables the efficient functioning of the market. Electronic markets on the Internet take advantage of information technologies to perform these functions with higher effectiveness and lower transaction costs than traditional market places.

This paper discusses posted-price markets and auctions among the various market mechanisms available, because these two are the most popular systems on the Internet and in a future digital economy. This section introduces the advantages and disadvantages for these two market mechanisms.

3.1 Posted-Price Markets

Posted prices are the most common way of selling products, especially in large stores. In a posted-price market, for example, sellers quote prices on a take-it-or-leave-it basis in many retail and mail order businesses. In addition, government regulation in industries such as shipping and alcoholic beverages sometimes requires that prices be posted with the regulatory agency and that discounts not be granted (Eckel and Goldberg 1984).

Sellers initially set prices in this market. Thus, information that each seller has on consumers and market places plays a very important role in this market, at least in the early stages of product introduction. That is, for a new product in the market, the initial price of this product is determined solely by the seller's research. In addition, competition among the sellers and the transaction history on similar products in the market also play an important role, if there has been any substitute for a product in the market.

In the laboratory experiment, this trading market is called a posted-offer (PO) auction. That is, each seller independently selects a price, and buyers are called on in random order and allowed to make purchase decisions. In this virtual field experiment, each seller creates digital products and posts the price (offer) at which he is willing to sell, and each buyer accepts this offer if it is lower than her reservation price.

One advantage for consumers of using this mechanism is that they are very familiar with the whole system. In other words, since they are exposed to the system over such an extended period of time and there are not many variations in rules or market options, the consumers feel quite comfortable buying products through one of these posted-price markets. Each offer or placing of an order by a consumer in this posted-price market means a proper transaction, insofar as consumers are purchasing products they want and the information on products available in the market is appropriate. Throughout this process of placing a purchase order, there is no delay from the customer's order, to the order processing to shipping at the seller's site once a buyer places a purchase order, if the seller's electronic commerce applications support and process the purchase order immediately. In contrast, buyers have to wait until the closure of an auction to see whether their bids are winning bids. That is, buyers' actions, like placing bids, are not necessarily realized as market transactions. All the losing bids are actions that cannot be executed and only successful bids are realized as properly matched prices for buyers and sellers.

In the following subsection, we briefly review noteworthy auction rules and variations and discuss the reasons that we are focusing on discriminatory-price ascending-bid auctions.

3.2 Auctions

An auction is an institution in which both buyers and sellers can actively post (or offer) and accept (or bid) prices in a public manner. Sellers post the location of a product, a product description, minimum price, minimum bid increment, number of copies to be sold, expiration date and time, and choose an auction format (Yankee or Dutch[2]). To bid a price, buyers first enter their user IDs and passwords, while the auction is open. Some auctions can be run with reserve prices. An experimenter can choose to

[2] These are special auction formats to handle the case where the seller has multiple identical items to sell and winners have various bids. In the Yankee format, the highest bidders win the available goods at their bid price (an example can be found at http://www.onsale.com). On the other hand, in the Dutch format, the highest bidders earn the right to purchase the items at the lowest successful bid (for instance, eBay at http://www.ebay.com uses this format).

require sellers to use a certain type of auction format and market mechanism.

Auctions are of considerable practical as well as theoretical importance (Kagel 1995). In practical terms, the value of goods exchanged each year by auctions is huge. In theoretical terms, auctions play a prominent role in the theory of exchange, as they remain one of the simplest and most familiar means of price determination in the absence of intermediate market makers. In addition, auctions serve as valuable illustrations of games of incomplete information, as bidders' private information is the main factor affecting their strategic behavior (Wilson 1992, McAfee and McMillan 1987). Moreover, the popularity of Internet auction sites draws the attention of practitioners and academics.

The design and conduct of auctioning institutions has occupied the attention of many people over thousands of years. One of the earliest reports of an auction was the sale of women to be wives in Babylonia around the fifth century B.C. (Milgrom and Weber 1982). In the United States in the 1990's, auctions account for an enormous volume of economic activity. For instance, every week the U.S. Treasury sells billions of dollars of bills and notes, using a sealed-bid auction. Throughout the public and private sectors, purchasing agents solicit delivery-price offers of products ranging from office supplies to specialized mining equipment; sellers auction antiques and artwork, flowers and livestock, publishing rights and timber rights, stamps and wine.

Due to the confusion of auction terminology between economists and Internet auction businesses and the variety of auction forms, I briefly review different types of auctions and terminology in this section.

Four basic types of auctions are widely used and analyzed (Milgrom and Weber 1982, Klemperer 1999): the ascending-bid auction (also called the open, oral, progressive, or English auction), the descending-bid auction (used in the sale of flowers in the Netherlands and also known as the Dutch auction[3]), the first-price sealed-bid auction, and the second-price sealed-bid auction (also called the Vickrey auction). Given the unique characteristics of the Internet, it is highly likely that other forms of auctions will also emerge.

In the ascending-bid auction, the price is successively raised until only one bidder remains, and that bidder wins the object at the final price. This auction can be run by having the seller announce prices, or by having the bidders call out prices themselves, or by having bids submitted electronically with the best current bid posted. In the model commonly used by the auction theorists, the price rises continuously while bidders gradually quit the auction. Antiques, artwork, and sometimes houses are commonly sold using versions of the ascending-bid auction.

[3] Dutch auctions in eBay, OnSale, and other Internet auction sites refer to the second-price open-bid auction.

The descending-bid auction works in exactly the opposite way: the auctioneer starts at a very high price, and then lowers the price continuously. The first bidder who calls out that she will accept the current price wins the object at that price.

In the first-price sealed-bid auction, each bidder independently submits a single bid, without seeing others' bids, and the object is sold to the bidder who makes the highest bid. The winner pays her bid. That is, the price is the highest or first price bid.

In the second-price sealed-bid auction also, each bidder independently submits a single bid, without seeing others' bids, and the object is sold to the bidder who makes the highest bid. However, the price she pays is the second-highest-bidder's bid, or "second price."

Among these auctions, the ascending-bid auction is the most popular type of auction on the Internet. For instance, eBay (http://www. eBay. com), Yahoo! Auctions (http://auctions.yahoo. com), Amazon Auctions (http://auctions.amazon. com), and many other sites are using auctions based on the ascending-bid mechanism. As a variation to this auction, FirstAuction (http:// www.firstauction.com) and OnSale (http://www. onsale. com) use the ascending-bid auctions with overtime[4] (also called the Yankee auction[5]) and open sellers' reserve-price features. Moreover, eBay and Up4Sale (http://www.up4sale.com) also allow their sellers and buyers to use Yankee auctions with hidden sellers' reserve prices[6].

In addition to these four types of auction, double auctions and reverse auctions are explored

[4] After the scheduled closing time (8:30 a.m., for example), the auction systems with this overtime option continue to check for new bids at five-minute intervals (8:35 a.m., 8:40 a.m., 8:45 a.m., etc.) until a complete five-minute overtime period elapses with no bidding activity. Once a bid is placed in a five-minute overtime period, another complete five-minute overtime period will be added to the auction. The auction will not close until a complete five-minute overtime period elapses with no bidding.

[5] In a Yankee auction, one or more identical items are offered for sale at the same time. When the auction closes, the highest bidders win the available merchandise at their bid price. Bids are ranked in order of price, then quantity, then time of initial bid. Specifically, bids are first ranked by price. If bids are for the same price, larger quantity bids take precedence over smaller quantity bids. If bids are for the same price and quantity, then earlier initial bids take precedence over later initial bids. The product page lists the scheduled closing time for each auction. However, if there is still bidding activity on the product when the auction is scheduled to close, the auction extends into a special "Going, Going, Gone" period. This period ends and the auction closes, when five minutes pass without any further bidding activity. All bids are subject to a minimum bid and bid increment, as posted with each item.

[6] The reserve price is the lowest price at which a seller is willing to sell an item. The reserve price is not disclosed to bidders in this type of auction. In this auction a seller might specify a reserve price if he or she is unsure of the real value of the item and would like to be able to refuse to sell the item if the market value is below a certain price. During an auction, an annotation will be displayed on the item information screen if the seller has specified a reserve price. The seller specifies the reserve price when he or she lists an item. This price should be above the minimum bid price. The auction begins at the minimum bid price. When a bidder's maximum bid is equal to or greater than the reserve price, the item's current price is raised to the reserve price or higher than the reserve price. At this time, the item information will indicate the reserve price has been met. The bidder is also notified that his or her bid met the reserve. If the reserve price is not met, neither the seller nor the high bidder is under any further obligation.

by economists for theory and by practitioners for government procurement processes, respectively. In this paper, we focus on multi-unit discriminatory-price ascending-bid auctions and posted-offer auctions.

4. Virtual Field Experiments on Posted -Price and Auction Institutions

Having discussed the market mechanisms and virtual field experiments, this section discusses the experimental set-up for this experiment and the results of experiments run during the 1998-1999 academic year.

4.1 Experimental Set-Up for a Virtual Field Experiment

During the fall of 1998 and spring of 1999, almost eight hundred upper-division undergraduates or MBA students who were taking courses on information systems, such as database management, distributed computing and telecommunications, advanced telecommunications, and electronic commerce, participated in this virtual field experiment.

Each student became a member of a project group, which consisted of three to five students. Each participating project group was classified as either a seller or a buyer. Student groups in advanced-level courses became sellers and groups in introductory-level courses played the role of buyers. Seller groups or companies in these experiments created a set of valuable information for buyers and priced these goods to sell through various markets. That is, sellers created digital products that helped buyers understand underlying technologies on data communications, databases, and programming languages, according to descriptions of class projects and assignments. Buyers bought goods, which were valuable for them to proceed with their group projects, and to acquire knowledge on certain technology issues.

Participants in this experiment used digital money (electronic cash provided by a digital bank) to buy and sell products. Electronic cash (E-cash)[7] was produced by a digital bank and was a very convenient medium for buying and selling goods. This lowered the transaction costs of trading digital goods and the inconvenience of the payment process. Based on their performance in various market settings, participants got grades, cash prizes, award certificates, and best of all, acquired knowledge on various information-system-related technologies and experience in electronic commerce by producing and consuming digital goods and running an organization in a digital economy.

[7] Each group was endowed with $10,000 E-cash to run transactions and businesses on the Internet.

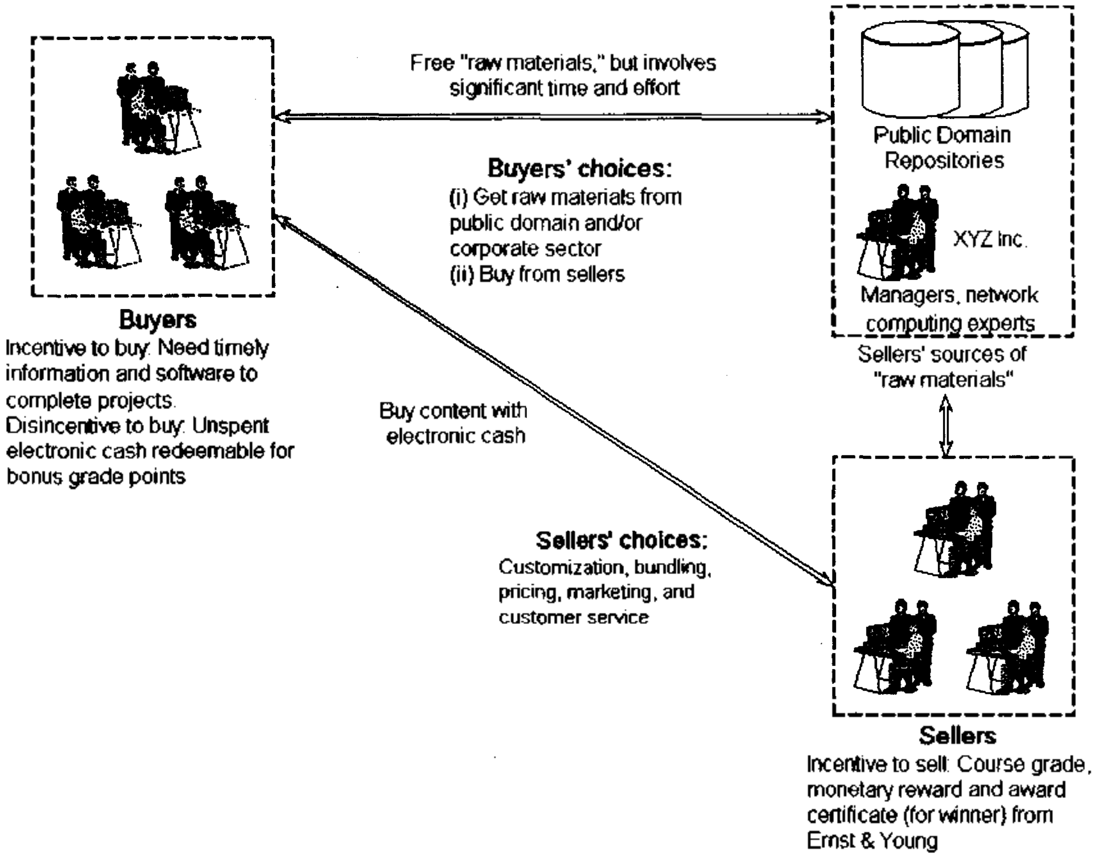

Figure 1 Participants' Choices and Incentives

4.2 Results and Analysis from Virtual Field Experiments

Using virtual field experiments, we tested several hypotheses on efficient market mechanisms including prices and transaction costs. In addition, we address the issues that cause these results and noteworthy anecdotes we have from these experiments.

Thanks to the business-transaction-related technologies available for digital goods and the fact that these goods are not bound to a format, sellers can constantly change the price of digital goods in the real world at minimal cost, to meet the consumers' needs and maximize the sellers' profit. To observe this phenomenon and test the efficiency of this posted-price market with the dynamic-price-update option, we are using an experimental setting, E-Market (a component of

EDE), where sellers can change the price of a good in real time.

The effectiveness of market institutions, such as an auction institution and a posted-price market, for trading digital goods has not yet been studied in economics. A posted-price market in EDE can be updated in real time, whereas sellers in a typical posted-price market in experimental economics cannot change prices during a session of an experiment.

Posted prices are very common in large stores. In the laboratory experiment, this trading market is called a posted-offer (PO) auction. That is, in most experimental economics settings of posted-price markets, each seller independently selects a price, and buyers are called on in random order and allowed to make purchase decisions. On the other hand, in EDE, sellers can lower and raise the price of the goods they are selling. The supply curve of this market institution is captured nicely from costs and prices stored in the business transaction module of the database, which logs changes of product and price information. As in Kim et al. (1999b)'s study, by using a proxy measure for reservation price and quantity, the demand curve also has been driven. From such curves, we calculate competitive equilibrium prices for each category of goods and compare these prices with the average market prices in the posted-price market. This test statistic will provide us with information on whether this posted-price market with the dynamic price update feature is an efficient mechanism.

Another important form of market organization is an auction institution, first experimentally studied by Smith (1962), who observed rapid convergence to competitive equilibrium when the market was repeated several times with stationary parameters. An auction is an institution in which both buyers and sellers can actively post (or offer) and accept (or bid) prices in a public manner. In EDE, sellers post the location of a product, a product description, a minimum price, a minimum bid increment, the number of copies to be sold, the expiration date and time, and choose an auction format (uniform price, uniform second price, and discriminatory price). To bid a price, buyers first enter their user IDs and passwords. While the auction is opened, buyers can bid many times and the automatic bidding agent feature [8] allows buyers to bid automatically if the highest bid is under the buyer's reservation value. An experimenter can choose or require sellers to use a certain type of auction format, termination rules, and other mechanisms. The efficiency of the one-side-sequential Dutch auction, which is the most

[8] Using automatic bidding agents, buyers can participate in an auction more conveniently than without an automatic bid option. For instance, once a buyer chooses the automatic bidding feature and specifies the reservation price for a digital product, the automatic bidding agent places bids on behalf of this buyer. Thus, if the winning bid is lower than the reservation price of this buyer, the agent places the lowest possible winning bid for the product and helps the buyer win the auction at a minimum cost. When a buyer uses this feature, he or she can win an auction without attending or observing an auction for the whole auction period.

popular auction market mechanism on the Internet, is calculated as we did in the posted-price market. In order to compare the posted price with the dynamic update feature and a sequential ascending auction with automatic reservation price execution, the same goods have been sold for different subject groups.

To understand the effectiveness of different market mechanisms, we will test the propositions, $| P_P - P_e | > | P_A - P_e |$, where P_e is the competitive equilibrium price, P_P is the average price of a posted-price market with dynamic price updates, and P_A is the average price of an auction market.

Hypothesis 1: The average market price of a posted-price market with dynamic price updates is higher than that of an auction institution for digital goods.

H_0: $| P_A - P_e | - | P_P - P_e | \le 0$;
H_1: $| P_A - P_e | - | P_P - P_e | > 0$;
where
P_P: The average market price of a posted-price market with dynamic price updates;
P_A : The average market price of a discriminatory-price ascending-bid auction;
P_e: Competitive market equilibrium price.

P statistic with binomial distribution in the following is used to test this null hypothesis:

$P = nCr\ p^r (1-p)^{n-r}$, where

n: the number of trials of an experiment;
r: the number of cases that comply with the null hypothesis;
p: the chance that prices in a posted-price market are higher than those in auctions, ½.

Five out of five trials of the experiment, we observe that the prices in the posted-price market are higher than the prices in auctions. That is, the *P statistic* shows that the probability of obtaining exactly the same result (three out of three trials) is 0.03125[9], when the prices in the posted-price market are the same as those of auctions. Thus, the null hypothesis that the average price in a posted-price market is higher than the price in an auction cannot be rejected with the significant level, α, equals to 0.05. More trials of this experiment would lower this statistic and confirm the null hypothesis with a higher confidence level.

The three major reasons that the prices in a posted-price institution are higher than the prices in an auction are (1) sellers' market power in a posted-price institution, (2) the collusion among the buyers in an auction, and (3) transaction costs for buyers. First, as Plott and others (1978, 1989) addressed earlier, sellers can exercise market power, because sellers post an initial price for each product and buyers respond to this price in a posted-price market. Even if sellers have the power to update price dynamically, they are often reluctant to lower prices, compared to raising

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[9] $P = {}_5C_5\left(\frac{1}{2}\right)^5\left(\frac{1}{2}\right)^0 = \frac{1}{32} = 0.03125$

prices. This advantage of setting initial prices provides sellers the market power that they can maintain prices higher than the competitive prices in this market. Second, buyers who participate in auctions can collude with each other. There are buyers who are often hesitant to bid when their bid makes other bids drop from the winning list. Some others post messages which discourage others from bidding on the same auction and make others wait for other auctions, rather than bidding on the same auction. This activity can reduce the competition among the buyers for a certain type of products and eventually lower the prices for auctions, because the bids and prices in auctions are heavily dependent on the number of bids while this discriminatory-price ascending-bid auction is open. Third, the transaction costs for buyers who purchase products through an auction are substantially high, due to the high discomfort level with this market mechanism. Thus, if we adjust the demand curve to reflect the transaction costs, this demand curve might shift to the left. That is, because the high transaction costs in an auction discourage buyers from shopping through an auction, the low demand leads to lower prices in auctions.

Hypothesis 2: Transaction costs for the buyers using auctions on the Internet are higher than the costs of using posted-price markets.

The results of a user survey, which was administered in spring 1999, show that using auctions rather than using a posted-price market is more inconvenient for buyers when all other conditions are equal. The survey shows that students' active participation and usage ratio of E-Market and E-Auction are also different. That is, about 40 percent of participants actively used the posted-price market in contrast to just 23 percent of students among auction assigned students.

For a certain type of information that is time-critical, discomfort or cost of transactions using an auction increases. For instance, buyers who are very likely to win auctions also have to wait until these auctions are closed and winners of an auction are officially declared. Unlike the case in a posted-price market, in an auction the bidder has to wait until this auction is closed and winners and prices are settled, in order to claim the product. If a product is mission-critical or the duration of an auction is substantially long[10], this can be a big issue.

This nature of auction mechanisms and the fact that consumers are not familiar with auction institutions increase the costs of transactions for buyers; in turn, these factors discourage consumers from using the auctions. This is the reason why we observe lower numbers of transactions executed in an auction than in the posted-price market throughout this experiment.

10 The average duration of auctions on these experiments is about twenty-four hours. On the Internet auctions for physical goods, the duration often extends to a week.

Hypothesis 3: Transaction costs for sellers to sell products on the Internet using auctions are higher than the costs in posted-price markets.

Due to the short-life of an auction, compared to a posting in a posted-price market, sellers have to spend more time and effort to post and maintain products in an auction mechanism, even if the intermediary[11] provides all the necessary tools and technologies necessary to use auctions.

Using the seller survey, we analyzed the reasons and factors which raise the transaction costs of using an auction institution for sellers. During the spring semester of 1999, we observed that the number of products and advertisements posted on the auctions is substantially lower than the one on the posted-price markets. Even if sellers can register or publish product information through a posted-price market and auctions without spending any additional input, sellers often ignore auctions. For instance, only 134 products were registered in E-Auction, in contrast to 748 products in E-Market in the spring of 1999, and 204 products in E-Auction and 345 products in E-Market in the fall of 1998. In addition, just 16 advertisements were posted in E-Auction, while E-Market was flooded with 463 advertisements for the last two months in the spring of 1999.

For a seller to post a product in an auction, he has to decide on important factors like an initial price, quantity to sell, auction starting time, auction duration, and closing time. In addition, this seller might have to post the same product multiple times, based on expected customers' shopping terms unlike the posted-price market, where a seller posts a product with a fixed quantity available and buyers visit the market and purchase the product at their convenience. All these features of an auction raise transaction costs (selling costs) of a product through an auction.

These hypotheses 3 and 4 suggest that the costs of selling products through a auction like E-Auction for sellers and buyers are higher than those of selling products through a posted-price market, E-Market, unless auction mechanisms lure a new group of potential buyers to the market places.

Hypothesis 4: Sellers in a digital market can extract all the consumers' surplus.

One of the important issues that concern consumers in the electronic market places or a digital economy is that sellers can have plenty of information on consumers' characteristics and demand, in order to practice monopolistic power or to price products judiciously with respect to the consumers' willingness to pay. As a result, sellers may end up getting the whole surplus generated in the market because the sellers have more tools and measures to understand consumer

[11] The EDE mall provides functions as an intermediary, such as auctioneer service, electronic banking, electronic storage, and transaction clearing service.

surplus and exercise perfect price discrimination in the digital economy.

However, as we see in Figure 2, sellers or suppliers of digital goods failed to extract the entire net surplus that the market generated. Thus, we reject the hypothesis that sellers can extract all the consumers' surplus that the market has generated. This implies that sellers cannot exercise a monopoly, even though electronic market mechanisms provide powerful means of understanding and measuring consumer characteristics including willingness-to-pay and other demographics. Major factors that keep sellers from a monopoly are the competition among the sellers who produce substitutes and the relatively low search costs for consumers. The low search and switching costs allow consumers to switch from one seller to the other swiftly, based on products and services available in the market. Moreover, the competition among the sellers keeps the prices in the market low. On the other hand, the customization of information and services in a digital economy is the key for the sellers to keep their customers.

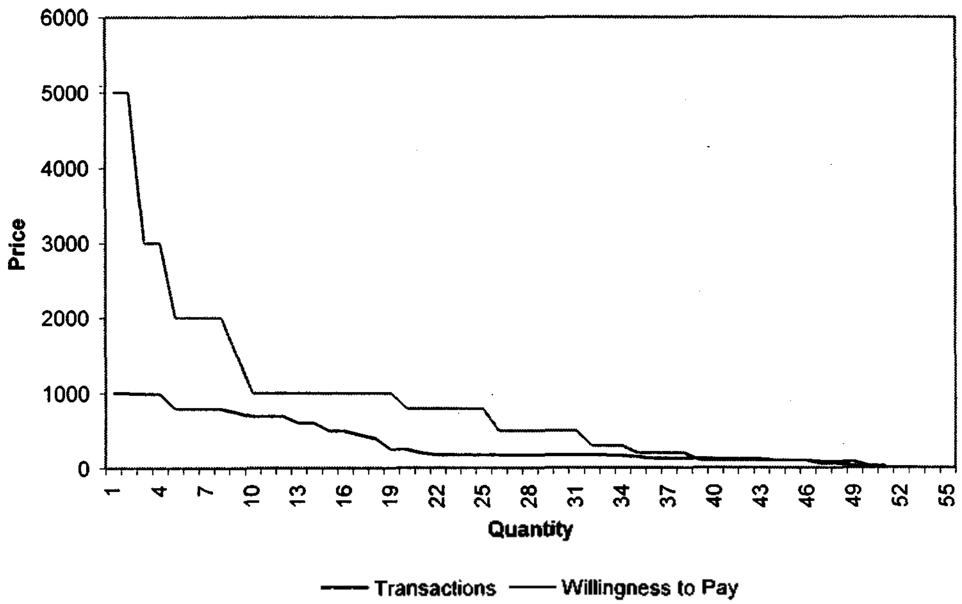

Figure 2 Consumers' Net Surplus

5. NetMarket Field Study on Posted-Price Markets and Discriminatory-Price Ascending-Bid Auctions

Having studied market mechanisms in a digital economy, using virtual field experiments, we also find that field research can complement virtual field experiments done on market mechanisms, and the field research can possibly show whether the results from the virtual field experiments still hold under different market environments. Thus, using the NetMarket dataset, which has been collected from the Internet for over five months (http://www.netmarket.com), we compare a posted-price market with a discriminatory price ascending-bid auction for various goods sold on the NetMarket site.

The Cendant Corporation, a $5.3 billion consumer goods and services company, sells over one million products and services on its Web site, from cars to electronics and cameras, books, appliances, luggage, perfume, flowers and gifts, computer hardware and software, video games and a variety of other goods and services. For an annual membership fee of $69, Cendant claims that its NetMarket Web site satisfies 20 percent of the average family's shopping needs. Because the company's business model relies almost entirely on membership fees, Cendant reports that it sells products to retail customers at, or near, wholesale prices. In 1997, Cendant facilitated the sale of more than $1.2 billion worth of products and services over the Internet. Before the decade comes to a close, the company will have offered a product selection which covers 95 percent of the products a typical household would buy (Henry et al. 1998). NetMarket maintains an auction site as one of its special features, like a haggle zone[12], or a flea market[13].

Using this dataset, we test the following hypothesis that the average market price of a posted-price market is higher than the price of an ascending-bid auction:

H_0: $P_A - P_P \leq 0$;
H_1: $P_A - P_P > 0$,
where
$\alpha = 0.01$;
P_P : The average market price of a posted-price market;
P_A : The average market price of an ascending-bid auction.

That is, the results from a virtual field experiment as we discussed in the previous section are also tested in the analysis of data collected in real businesses. The dataset collected from NetMarket on the Internet, which is one of the largest and successful Internet shopping malls where consumers can purchase physical products using various market mechanisms like EDE, is also used to test the hypothesis that the average prices in the posted-price market are higher than

[12] In a haggle zone, consumers can negotiate the price for a product with agents on NetMarket.
[13] Through a flea market, closeouts and refurbished products are sold at discount prices, compared to the ordinary market places.

the prices in auctions. The analysis of this dataset also confirms the results from this virtual field experiment.

We have analyzed the dataset from the NetMarket two times, one with the sample size of 48 in April 1999, and another with the sample size of 414 in July 1999. With the smaller sample, we use t value and test the normality assumption. Because we have enough data for the analysis done in July 1999, we use p value[14] to test the hypothesis.

First, the analysis with the first dataset is summarized in the following fashion:

The t value[15] for this dataset is 4.4899, where the critical value of t with a 0.005 level of significance with 47 degrees of freedom, is 2.6846. Thus, we cannot reject the null hypothesis, because $t_{47} = 4.4899 > 2.6846$. That is, prices in a posted-price market are higher than the prices in ascending-bid auctions.

To use this t statistic, we have to show that the population from which this dataset is collected is normally distributed. To test normality, we use the statistics as in Figure 3.

With the smaller sample, the Shapiro-Wilk statistic, W, is computed to check whether the sample data values are a random sample from a normal distribution. The W statistic is the ratio of the best estimator of the variance (based on the square of a linear combination of the order statistics) to the usual corrected sum of squares estimator of the variance. W must be greater than zero and less than or equal to one, with small values of W leading to rejection of the null hypothesis that the sample data come from a normal distribution (SAS 1985). This test shows that W is 0.835426; thus, we fail to reject the null hypothesis and can use the t statistic to test a hypothesis on market mechanisms without any problem.

Figure 3 A Set of Statistics from the First Analysis of NetMarket Data

N	48	Sum Wgts	48
Mean	10.89417	Sum	522.92
Std Dev	16.81045	Variance	282.5913
Skewness	1.619481	Kurtosis	2.690114
USS	18978.57	CSS	13281.79
CV	154.3069	Std Mean	2.42638
T:Mean=0	4.489885	Pr>|T|	0.0001
Num ^= 0	48	Num > 0	38
M(Sign)	14	Pr>=|M|	0.0001
Sgn Rank	423.5	Pr>=|S|	0.0001
W:Normal	0.835426	Pr<W	0.0001

[14] The p *value* is the probability of obtaining a test statistic equal to or more extreme than the result observed, given that the null hypothesis, H_0, is true. This p value is often referred to as the observed level of significance, the smallest level at which H_0 can be rejected for a given set of data. If the p value is greater than or equal to α, the null hypothesis is not rejected; if the p value is smaller than α, the null hypothesis is rejected (Berenson and Levine 1989).

[15] $t_{n-1} = \dfrac{\bar{X} - \mu_x}{\dfrac{S}{\sqrt{n}}}$, where $S = \sqrt{\dfrac{n\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2}{n(n-1)}}$

Second, the analysis with a larger sample is summarized as follows:

From the statistics in Figure 4, we found the test-statistic *p-value*, 0.0001, which is smaller than 0.01. We fail to reject the null hypothesis that the prices in a posted-price market are higher than those in the auctions. Thus, we can conclude that the average price in a posted-price market is higher than the price in an auction for physical products in NetMarket.

Because the sample size is greater than fifty in the later study, as in Figure 4, the data are tested against a normal distribution with mean and variance equal to the sample mean and variance. The usual Kolomogorov D statistic is computed and it suggests that we cannot reject the null hypothesis that the sample data come from a normal distribution. In addition, the test statistic W, 0.867745, is quite close to 1. Thus, this testing process is legitimate.

Figure 4 A Set of Statistics from the Second Analysis of NetMarket Data

N	414	Sum Wgts	414
Mean	10.92519	Sum	4523.03
Std Dev	18.16447	Variance	329.9479
Skewness	1.613878	Kurtosis	3.634561
USS	185683.5	CSS	136268.5
CV	166.2622	Std Mean	0.892735
T:Mean=0	12.23789	Pr>|T|	0.0001
Num ^= 0	409	Num > 0	304
M(Sign)	99.5	Pr>=|M|	0.0001
Sgn Rank	27442.5	Pr>=|S|	0.0001
W:Normal	0.869612	Pr<W	0.0001

The results in Figures 3 and 4 are consistent. These two analyses — one with the sample size of 48, which was done in April 1999, and the other with the sample of 414, which ran in July 1999 — show the same result that the average price of ascending auctions is substantially lower than that of posted-price markets for physical goods.

In addition to these analyses, we also found interesting anecdotes on the selection of products, prices, and discounts for auctions. The average discount that consumers of these auctions got from purchasing these products was about 10.82 percent. That is, the auction winners paid about 11 percent lower prices than in the posted-price market. Moreover, on average, consumers of products in auctions paid about $10.92 less, compared to the average prices paid through regular posted-price markets. This is a substantial discount, considering the fact those prices in a posted-price market run from $3.99 through $399.00, and the mode of prices in this market is only $19.99.

Another interesting fact we found is that the selection of products for the auctions varies over time, but many products are sold repeatedly through auctions for a given period of time. For example, TIGR A70-800 has been auctioned ten times and other products like SONY, BOSS B-8201, CLER CL1015, AT&T, BISS 1672S, CNON ES190, FRNZ WA6DW, STWD, TVLC 18303-EX, and UNID EXAI918RB have been auctioned at least five times during a two-month period. Considering that each auction is advertised or pre-announced several days before it is actually carried out and each auction lasts from two to ten days, we can easily tell that these popular items were constantly available to the buyers through these repetitive auctions. That is, NetMarket posted popular products among the buyers over a very extensive period of time, in order to increase the sales through auctions by selling best-selling products over and over again. This strategy also led buyers to bid low or stop bidding if the winning bid got too high, because some of the buyers knew that these products would be available again.

6. Strategic Implications

It is true that auctions on the Internet draw the attention of many consumers, specifically, the consumers that are adventurous in shopping and are looking for bargains (Baptna et al. 1999 also address this issue). In addition, the transaction costs in auctions are still high, even if the costs have been lowered substantially, compared to a traditional physical auction that takes place in an auction house. These high transaction costs for consumers often lead them to use a posted-price market if a competitive one to an auction is available.

Due to these reasons, we expect that a discriminatory-price ascending-bid auction as a market mechanism will be successful for certain types of products and businesses which meet the following criteria: (1) Products that appeal to risk seekers or bargain hunters. Currently a substantial number of consumers who shop through an auction on the Internet are looking for bargains or new products. Thus, products that might appeal to this group of consumers have a high chance to succeed. (2) Products that are not sold in a posted-price market. Due to the low transaction costs of posted-price markets, it is unlikely to help sellers if they sell products through both channels. Thus, it is wise to focus on a market place rather than sell a good through both mechanisms unless consumers in both markets are different. (3) Products that are hard to price, such as out-dated information, old-version software, closeouts, or refurbished items. Sellers often want to get rid of these products in a short period of time rather than putting efforts into marketing and advertising these goods. The auction is a good way of liquidating products without a given period of time. (4) New or test products for which the seller does not have much information on the buyers' needs. Through an auction, sellers can collect a rich set of information on bidders' willingness-to-pay. Using this information, sellers can predict the size and potential of a market for a good at substantially low costs. That is, by running auctions for new products for which sellers do not have much information about the market, sellers can set up pricing or sales strategies economically. Moreover, due to the heavy advertisement, marketing, and public relations (PR) on auctions on the Internet in the late '90's, consumers nowadays show more interest in this type of market place. Thus, auctions can lure quite a number of customers to a seller's Web-site and, in turn, the seller can direct these customers' attention to other products on sale at the same venue. That is, an auction can be a good advertising tool, or play a role that is comparable to the predatory pricing in a typical marketing paradigm.

7. Conclusion

In recent years, many retail businesses like Amazon.com, eBay, FirstAuction, NetMarket, OnSale, UBid, etc., jumped on the Internet auction bandwagon [16]. As a result, these companies paid substantially high fees to learn and develop proper business strategies for this new environment[17]. Unlike what most businesses in the real world presume, this research shows that discriminatory-price ascending-bid auctions in a digital economy might be not very beneficial for the sellers on the Internet, if sellers sell the identical digital products through both a typical posted-price market and an auction.

We found that a discriminatory-price ascending-bid auction, which is the most popular auction mechanism on the Internet, serves consumers better than it does the sellers or producers in the digital economy. That is, the average prices for digital goods in auctions are substantially lower than the prices in a posted-price market. In addition, transaction costs of using auctions are higher than in posted-price markets. These results indicate that it is not so wise to jump on the bandwagon of Internet auctions, if there is a market place with posted-price mechanisms which sells comparable items, or if a seller does not have special advantages or strategies in this new market institution.

This research also provides some strategic guidelines for sellers or producers of digital products. It is true that auctions on the Internet draw the attention of many consumers, specifically, the consumer group that is adventurous in terms of shopping. In addition, the transaction costs in auctions are still high, even if the costs have been lowered substantially, compared to physical auctions that take place in an auction house. Due to these factors, we expect that auctions as a market mechanism will be successful for certain type of products which meet the following criteria: first, products that appeal to risk seekers or bargain hunters; second, products that are not sold in a posted-price market; third, products that are hard to price, such

[16] Kim et al. (1996) discuss the details on business strategies and their implications, including the *bandwagon* or *snowball* effect. This unforeseen surge of auctions on the Internet might be an example of *excess momentum*, where businesses adopt a technology or a business model too early, when maintaining or slowly adopting the new business model provides the maximum industry payoff.

[17] These auction sites show substantial business strategy changes after their initial offering of auctions on the Internet. That is, due to the lack of understanding of this new economy and lack of experience, the selection of products, business policies, and models for each auction site have been substantially updated. Onsale.com, for instance, used a $1 minimum price for its products extensively in its introduction, and later used higher minimum prices for auctions and limits $1 minimum bids to selected products.

as out-dated information, old-version software, closeouts, or refurbished items; fourth, new or test products for which the seller does not have much information on the buyers' needs.

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Appendix: Summary of Analysis (NetMarket)

Variable=MARKET Prices in Posted-Price Market

Moments

N	414	Sum Wgts	414
Mean	76.22713	Sum	31558.03
Std Dev	81.44603	Variance	6633.456
Skewness	2.26615	Kurtosis	5.088503
USS	5145195	CSS	2739617
CV	106.8465	Std Mean	4.002854
T:Mean=0	19.04319	Pr>|T|	0.0001
Num ^= 0	414	Num > 0	414
M(Sign)	207	Pr>=|M|	0.0001
Sgn Rank	42952.5	Pr>=|S|	0.0001
W:Normal	0.707367	Pr<W	0.0001

Quantiles(Def=5)

100% Max	399	99%	395.75
75% Q3	89.99	95%	299
50% Med	49	90%	159
25% Q1	25	10%	14.99
0% Min	4.99	5%	10
		1%	4.99
Range	394.01		
Q3-Q1	64.99		
Mode	99		

Variable=AUCTION Prices in an English Auction

Moments

N	414	Sum Wgts	414
Mean	65.30193	Sum	27035
Std Dev	71.06804	Variance	5050.666
Skewness	2.399712	Kurtosis	5.643364
USS	3851363	CSS	2085925
CV	108.8299	Std Mean	3.492804
T:Mean=0	18.69614	Pr>|T|	0.0001
Num ^= 0	414	Num > 0	414
M(Sign)	207	Pr>=|M|	0.0001
Sgn Rank	42952.5	Pr>=|S|	0.0001
W:Normal	0.687021	Pr<W	0.0001

Quantiles(Def=5)

100% Max	361	99%	341
75% Q3	73	95%	261
50% Med	43	90%	151
25% Q1	23	10%	12
0% Min	4	5%	8
		1%	5
Range	357		
Q3-Q1	50		
Mode	29		

Variable=QUANTITY

Moments

N	414	Sum Wgts	414
Mean	1.335749	Sum	553
Std Dev	0.737003	Variance	0.543174
Skewness	2.402996	Kurtosis	5.596583
USS	963	CSS	224.3309
CV	55.17531	Std Mean	0.036222
T:Mean=0	36.87699	Pr>|T|	0.0001
Num ^= 0	414	Num > 0	414
M(Sign)	207	Pr>=|M|	0.0001
Sgn Rank	42952.5	Pr>=|S|	0.0001
W:Normal	0.519079	Pr<W	0.0001

Quantiles(Def=5)

100% Max	5	99%	4
75% Q3	1	95%	3
50% Med	1	90%	2
25% Q1	1	10%	1
0% Min	1	5%	1
		1%	1
Range	4		
Q3-Q1	0		
Mode	1		

```
Variable=DIFF          Price Difference

                       Normal Probability Plot
    92.5+                                                  *
        |                                                  *
        |                                                 *
        |                                                *
        |
    67.5+                                              **
        |                                             **
        |                                           **     +
        |                                           *   +++
        |                                         ** +++
    42.5+                                       ***++
        |                                      **++
        |                                    ***
        |                                 +***
        |                              +++**
    17.5+                            ++ ***
        |                         +++****
        |                      ++*****
        |                  *******
        |             ******
    -7.5+        ******+++
        |     ****  +++
        |** **   +++
        |*     ++
        |   +++
   -32.5+*++
        +----+----+----+----+----+----+----+----+----+----+
            -2        -1         0        +1        +2
```

저자소개

김범수

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