

Product Attribute as an Important Dimension in Developing Online Auction Strategy for Businesses

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Submitted to the Engineering Systems Division
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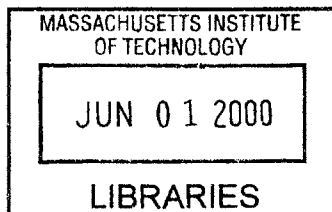
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ABSTRACT

Online auctions represent one of the most interesting developments in electronic commerce. On the one hand, it presents great opportunities – enabling businesses to reach large group of buyers, liquidate products at market-driven prices, and lower transaction costs. On the other hand, it makes sellers much more vulnerable because they have to compete with other vendors in a transparent and level trading environment. Therefore, it greatly undermines sellers' traditional source of competitive advantage based on channel power, brand reputation, and customer loyalty. Moreover, online auction puts tremendous pressure on product prices, which is likely to offset sellers' gain from increased reach and lower transaction costs. As a result, businesses must carefully evaluate the pros and cons of online auction before investing in it.

The goal of our research is to develop a framework which companies can use to determine whether online auction is an appropriate strategy for them by analyzing their products. Our analysis focused on two dimensions of the product characteristics: commodity-specialty and tangible-intangible attributes. We want to examine what attributes appeal most to the bidders in a highly competitive auction environment and what auction formats are most effective for product with certain attributes.

For this study, we conducted a laboratory experiment where we auctioned specific products whose attributes represent different scales along the commodity-specialty, tangible-intangible spectrum. Here is a summary of our findings:

- 1) In commodity market, the competitiveness of the auction format and high buyer sophistication put tremendous pressure on product price, cutting the sellers' already-razor-thin profit margin. On the other hand, sellers of specialty products are more likely to leverage the market dynamics and benefit from the broad reach and flexible pricing.
- 2) In online auction, tangible attributes play a much more important role in bidders' determination of the product prices. Tangible attributes provide an easy measure for bidders to assess the value of the products.

- 3) As bidders become savvier about the bidding process, they tend to collude with each other to drive down the price collaboratively. The transparent trading environment provided by online auction enables bidder to explore and speculate on others' intention and use this information to adjust their own bidding strategy. As a result, the bids they submitted reflect more of their perception of how much other would pay for the product rather than their own valuation of it.
- 4) Different auction formats indeed have different impacts on the auction results. For example, some auction formats encourage bidders to reveal their true valuation of the product early in the bidding process and other foster speculation and collusion among bidders. By carefully designing their implementation strategy, sellers can leverage the difference of the auction formats and maximize their benefits.

The structure of this paper follows a top-down approach. Chapter 1 presents an overview of the competitive landscape of business-to-business electronic commerce. It defines three emerging eMarketplace models – aggregator, auction, and exchange – and provides an in-depth analysis of their impacts on a company's supply chain strategy. Chapter 2 focused on the most popular of the three eMarketplace models – online auction. It examined the driving force behind the proliferation of business online auction, the variety of auction markets, and the economics of different auction formats. The second half of the paper concentrates on our research. Chapter 3 outlines our research questions and methodology. Chapter 4 layouts the experiment results and our analysis. Finally, Chapter 5 summarizes our findings and discusses their implications in the supply chain management.

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CHAPTER 1. INTRODUCTION

Business-to-business electronic commerce in the United States is moving into the mainstream economy at full speed. Forrester projects that online business will hit \$2.7 trillion in 2004. While Internet trade between individual partners will continue to flourish, electronic marketplace will fuel most of the growth - reaching 53% of all online business trade in five years.

This chapter describes the different eMarketplace models, analyzes their impacts on the supply chain management, and provides some guidelines on how company should choose their e-business strategies.

1.1. New E-Commerce Market Model

The initial wave of business-to-business e-commerce has been focusing on automating off-line processes. Transaction-oriented extranets allow companies to increase customer value and build deeper connections with channel partners. For example, using Cisco Systems' web site, buyers can configure their own routers, check lead times, prices, and order and shipping status, and confer with technical experts. The site generates \$3 billion in sales a year - about 40 percent of the company's total.

But these point-to-point connections are being replaced by a new business venue – eMarketplaces – in which dynamic many-to-many interactions supplant stagnant one-to-one relationship in the trade. Three eMarketplace models are changing the shape and flow of business trade: aggregator, exchange, and auction. Each model attacks different inefficiencies

and opportunities in the supply chain, such as reducing dispersion, facilitating liquidation, and creating industry-wide dynamic pricing.

Aggregator helps streamline the supply chain by reducing market fragmentation and empowering small players. It combines the purchases of several companies to increase their collective buying power. By pooling suppliers and concentrating demands, aggregator simplifies the purchasing process, builds a critical mass for the sellers, and lowers trading costs across the board.

Exchange creates an industry spot market for commodity-like products by matching many buyers with many sellers in real time. Like stock exchanges on-line exchanges provide vetted players with a trading venue defined by clear rules, industry-wide pricing, and open market information.

Auction is a buyer-driven model where the price of the product is determined through the competitive bidding process among potential buyers. Auction appeals to both expansion-minded sellers and bargain-minded buyers. Increasingly, companies are using online auction to liquidate excess inventory or test the price points of their new products.

The benefits of eMarketplace can be split three ways: sellers will reach more customers, gather better information about them, target them more effectively, and serve them better.

Intermediaries that organize those marketplaces benefit by earning transaction commissions and fees for value-added services such as information capture and analysis, order and payment processing, the integration of buyers' and sellers' IT systems, and consulting services. However, the best rewards go to buyers – eMarketplace brings together suppliers around the world to the

buyer's fingertip. The transparent nature of the eMarketplace gives buyers more power in product comparison, supplier selection, and price negotiation.

All three models have one thing in common: they connect disparate trading parties in a fragmented market and enable greater choice for buyers and expanded reach for sellers. The result is structure change in supply chain which will link trading partners more directly and provide them information that was previously unavailable. Next we will explain what is supply chain management and how companies can leverage the Internet to support their supply chain strategies.

1.2. Supply Chain Management

In their book "Fundamentals of Logistics Management," Lambert, Stock, and Ellram defined supply chain management as "the integration of business processes from end user through original suppliers that provides products, services, and information that add value for customers."

This definition illustrates two important characteristics of the supply chain management.

Flow of Products, Information, and Services. Too often people refer to supply chain as the channel of material flow and ignore its role in facilitating the flow of information and services. For example, as companies trade products, they exchange information about demand forecasting, product design, pricing, etc. They also provide services to each other, such as procurement, technical support, and transportation. This indicates that the performance of the supply chain management should not be measured solely on the effectiveness of the product flow, e.g. inventory turnover, but also on the efficiency of the information and service flow.

Integration. Supply chain connects all the parties that add value to a product's lifecycle: the material suppliers, manufacturers, distributors, shippers, and customers. Each player performs different functions within the chain, and has different, sometimes conflicting, objectives. Too often this becomes an obstacle impeding the flow of product and information along the chain.

E-Commerce brings new velocity to supply chain management. It breaks down barriers between trading partners, provides information visibility throughout the channel, and optimizes seller/buyer relationships based on market dynamics.

In the past, each step in the supply chain had a lock on its own information, making the barriers between the trading partners more defensible but the chain as a whole less efficient. The eMarketplace provides an open environment which takes away with much of the privileged access to information. As a result, it undermines this traditional source of advantage based on asymmetric information between trading partners. For example, suppliers can no longer count on advertising or customer ignorance to sell their products

As companies move to the eMarketplace, there has seen a fundamental shift of the focus of the supply chain from physical assets to intellectual asset. For example, traditionally, purchasing decisions were based on internal demand forecasts which are at best guesswork. The eMarketplace provides great information visibility where everyone within the supply chain is able to see what is going on both upstream and downstream. Companies are able to collect and analyze trade information such as sales and prices in real time. As a result, they can more accurately gauge the needs of the markets and better plan their manufacturing and replenishment process.

eMarketplace is also driving structural changes in a company's supply chain. Building on Internet's open platform, companies will be able to reach beyond their immediate customers and supplier and establish close relationships further up and down the supply chain. As firms moving in that direction, existing supply chain relationships will get blown apart. In place of today's vertical industry connections, the exploding number of interconnections will create a new network-like market structure in which partners can switch allegiances without cost and information and market feedback flow in real time. Companies will be able to move away from long-term contracts in favor of more flexible agreements - buying exactly what they need when they need it at the market-driven price.

The speed with which a company moves into the eMarketplace will depend on the following factors:

Transaction efficiency of existing supply chain. eMarketplaces will permeate most deeply in supply chains with severe inefficiencies such as poor information flow, complex or multi-tiered distribution channels, high degree of fragmentation, and highly cyclical or unpredictable supply or demand.

As mentioned earlier, eMarketplace helps companies achieve cost savings through greater process efficiency. Therefore, companies should conduct a detailed analysis of their supply chain to discover how much can be saved and where. For example, many steps in a traditional procurement process can be streamlined. From material sourcing, price negotiation, and vendor management, to lot sizing, transportation planning, and order and shipment tracking, eMarketplaces can make a tremendous impact.

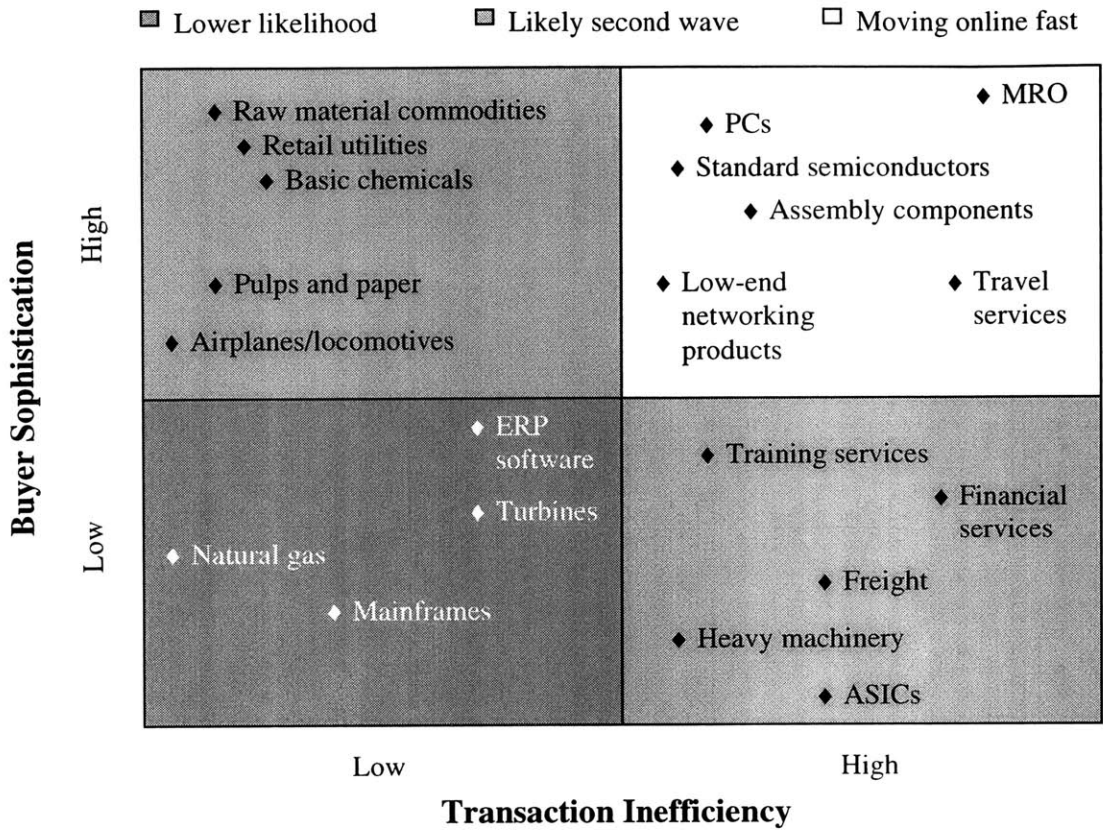
How much of an impact depends on how lean the existing supply chain already is. For example, At Dell, many process costs had already been taken out via direct sales and earlier efforts to automate and streamline the supply chain. Moving to the Web has created additional savings, but those savings have been small compared to what most companies could expect

Market power. The market power a company has in the supply chain will determine which marketplace model will be more effective. If its product stands out from competitors and is strongly branded, the company might not want to move it to the auction market where it is likely to be commoditized. Instead, it should consider selling it from the company's own Web site, like what Cisco and Dell are doing. On the other hand, if the seller has a weak market position, he should try to enter an aggregator model in order to broaden its reach.

Companies can also use their market power to drive their trading partners to the eMarketplace of their choice. For example, GM launched TradeXchange this year to buy and sell a wide array of products, raw materials, parts and services over the Internet. The exchange will enable GM to automate and streamline its purchasing process with more than 40,000 suppliers and dealers.

Product. Another important aspect in choosing the right e-business strategy is to analyze the company's key product line. Not all goods are equally suited for eMarketplaces. In a research conducted by McKinsey & Company, Berryman *et. al.* studied different product categories and concluded that products with inefficient transaction processes and sophisticated buyers are more likely to be brought to electronic marketplaces (see Figure 1).

Figure 1: Opportunities for eMarketplaces



In their study, buyer sophistication was measured by buyers' ability to define clear product specifications, their understanding of the differences between vendors, and how comfortable they are about buying a product without seeing it. The less sophisticated the buyers are the more bargaining power the supplier has in terms of pricing and product lifecycle. For example, products like ERP software, PBX, and mainframe computer are highly specialized and differentiated products and will less likely to be moved into the eMarketplace any time soon.

On the other hand, buyers of commodity or fast-moving products, such as raw materials, utilities, basic chemicals, paper, etc., are highly sophisticated. As a result, they are capable of driving their businesses to the eMarketplaces where they can achieve significant benefit through demand consolidation and volume discount. Suppliers of those product categories must act fast to establish their Web presence in order to prevent market share erosion, preempt competitors, and delay the development of a buyer-controlled marketplace.

Next we will take a closer look at the most popular of the three eMarketplace models – auction. We will analyze the driving force behind the proliferation of business online auction, the variety of auction markets, and the economics of different auction formats.

CHAPTER 2. BUSINESS ONLINE AUCTION

Over the past several years, online auctions have built themselves into one of the most successful e-commerce phenomena. Currently, online auctions trade billions of dollars' worth of goods per year, and are growing at a rate of more than 10% per month.

Of the online auction trend, the most visible are the consumer-to-consumer auctions, such as Amazon and eBay. However, media coverage notwithstanding, in dollar terms business-to-business sales will dominate the online auction market, growing to an expected \$52.6 billion by 2002.

2.1. Driving Forces

Most companies use online auction as an efficient liquidation channel for some of its products which, for one reason or another, don't fit in the traditional channel, such as obsolete equipment, discontinued models, used or refurbished items, overstocks, and products that failed to find distribution. There are vast quantities of finished goods and materials molding away in companies' warehouses and storage bins, taking up significant amount of financial (cost of capitals) and physical (storage space) resources and becoming a burden for most businesses. In the United States, the market for liquidated inventory is upwards of \$300 billion. While liquidators and brokers typically will buy such stuff, they often don't pay enough to make it worth the seller's while.

Online auction provides a fast, easy, and cheap way for businesses to clean their warehouses. All parties benefit. Sellers get higher prices than they would through a traditional broker. Buyers

gain access to a wider range of goods at highly competitive prices. As a result, online auction helps businesses turn their idle assets into new profit centers. Comparing with other sales methods, online auction provides the following advantages:

Broader access. Online auction attracts buyers all over the world. Global reach and round-the-clock accessibility translate into high market participation and very competitive prices.

Convenience. Traditional auction requires synchronous bidding where all bidders participate at the same time, tying each bidder up for the entire length of the auction. Online auction, on the other hand, is asynchronous and lasts days or weeks, giving bidders much more flexibility about when to submit their bids.

Transparent trading environment. In the past, buyers and sellers had to invest time, money, and travel to obtain bid and offer information or chose to limit any downside by striking private, fixed price deals. As a result, off-line buyers typically pay various markups based on channel power, personal relationships, or historical volume. Online auction, on the other hand, provides a leveled trading environment, resulting in a more market-driven pricing.

Lower costs. With the help of the Internet, sellers and buyers can participate in multiple, real-time auctions simultaneously - without accruing physical-world search and travel costs. Self-service on-line transaction also reduces much of the labor cost associated with other sales processes, such as direct sales, catalogs, or off-line auctions. These lower on-line operating costs translate into smaller markups - under 20% rather than 50% to 70% for an off-line equivalent.

However, the potential of business online auction goes far beyond creating and serving a second-hand market. It can become a strategic weapon in companies' effort to streamline their supply chain.

Fine tune inventory levels. No company is 100 percent efficient. Forecast errors like overestimating demand, competitive acts like vertical acquisitions that lock up suppliers, or unpredictable factors like natural disasters force businesses to stock up to against uncertainty. Access to auctions allows companies to build excess inventory into their business plans and use auction to dynamically adjust their inventory level, buying additional supplies to fulfill last-minute needs or unload excess inventory quickly at the best prices.

Optimize distribution channel. Companies can go around supply chain partners using anonymous, independent auctions. They can sell product to customers or buy product from suppliers at prices different from those in traditional channels. Doing so enables companies to maintain the supply-demand equilibrium or reach new customers and suppliers and. For example, manufacturers and distributors can buy at auction to take their own surplus out of market circulation so that they can maintain a desired price point or buy market space for the newest versions of their products.

Provide new marketing tool. On-line auctions can also play a role in companies' marketing and promotional strategies. As companies are discovering, auctions can advance publicity, attract traffic to sellers' sites, and generate leads for upselling to failed bidders and cross-selling to successful ones. Since the record of bids compiled at each auction shows exactly how much buyers are willing to pay for the products, sellers can mine it for valuable marketing data. Auction results can also be used to help sellers define prices for goods sold in the off-line world.

Some manufacturers actually launch new products on auction sites to find out the fair market price. It is much cost-efficient compared with other pricing mechanisms such as posted-offer retailing, bilateral negotiations, etc.

Ease the burden of reverse logistics. Along with the surge of online e-commerce is the burden of high-volume burst of reverse logistics. Retailing trade groups reported that by the year 2002 \$11 billion dollar worth of goods purchased online will be returned, mounting to \$1.8 billion to \$2.5 billion in losses due to transaction costs and losses on liquidated merchandise. Online auction websites like the Return Exchange provides eVARs a cost-effective liquidation channel for their returned goods. Through its network of regional centers strategically located near the major distribution hubs around the country, the Return Exchange takes returns from the customers, restores them to re-sellable conditions, and auctions them online. Its service helps retailers handle returns quickly, minimize the risk of price erosion, and avoid jeopardizing their primary sales channels.

2.2. Business Auction Markets

The business online auction market can be divided into three segments: commodity auctions, independent auctions selling surplus and first-run goods, and private auctions serving existing dealer networks.

2.2.1 Commodity auction

Commodity auctions bring together buyers and sellers for spot needs. Companies use commodity auctioneers to maximize profit and balance demand in a highly volatile market. The most notable example is the wholesale energy market. Online auctioneers like Altra Energy provide a real-

time, anonymous electronic marketplace where customers can instantly measure market availability by viewing actual transactions and current listings of supply and demand. Through better information visibility, participants can clearly see where the opportunities and risks may lie and more accurately gauge the needs of the markets. By 2002, Forrester expects \$32.2 billion in commodities to be traded on-line, ranging from utilities, energy, radio spectrum, to products with a short shelf life like airline seats and freight capacity.

2.2.2 Independent auction

Independent auctioneers, like onsale.com, handle surplus and first-run manufacturing goods. They have become a new sales channel for manufacturers to dispose of old inventory, test price-volume relationship for new products, and access more buyers.

Independent auctions are sprouting fast largely because of its low barrier to entry. Most independent website operate on consignment. They require little cash or infrastructure to become operational. Most of those web sites outsource credit risk to banks and delivery to FedEx or UPS. Because of the inefficiencies in existing channel, there is a ready supply of surplus from fast-moving industries such as electronics and personal computer which render products obsolete in six months.

In addition to basic auction functions, most independent auctioneers also provide value added services, such as inspecting and rating goods for sale, arbitrating disputes between buyers and sellers, etc. However, for customers, the biggest attractiveness of independent auction is its anonymity. In a highly competitive industry, companies are concerned about giving competitors access to sensitive information. As a result, they prefer independent auction because it provides a completely level “playing field” for all buyers and sellers. Here, participants’ identities are

protected. For buyers, no one will know that it is your company that has an urgent need for certain products. In addition, no one can make assumptions about the prices you may be willing to pay based on the size of your company. For sellers, your need to move a large volume of surplus will never be publicized. Much of the success of FastParts, a leading business-to-business Internet trading exchange for the electronic parts, is based on the value of this anonymity to manufacturers, which do not want to reveal details of their production level or excess capacity to buyers and competitors.

But this growth will eventually create channel conflicts for sellers. Anonymous buyers at independent auction sites can sidestep their channel partners. The result is that end users compete directly with dealers, upsetting pricing tiers and stripping both profit and trust out of channel partnership (see Figure 2). This can't last long. As companies realize that they must protect their channel partners, they will redirect most goods from independent to private auctions.

2.2.3 Private auction

It is projected that \$14.9-billion worth of goods and services will be privately auctioned by 2002 (see Figure 3). Private auctions allow company to exert control over product offerings, minimize channel conflict, and protect brand name. In addition, in private auctions, companies can show their own ads, maintain total control over the data left by visitors, cross-sell accessories to successful bidders, upsell alternatives to failed bidders, and, of course, save on commissions that would normally go to the intermediaries.

Figure 2: Channel conflicts between traditional and online customers

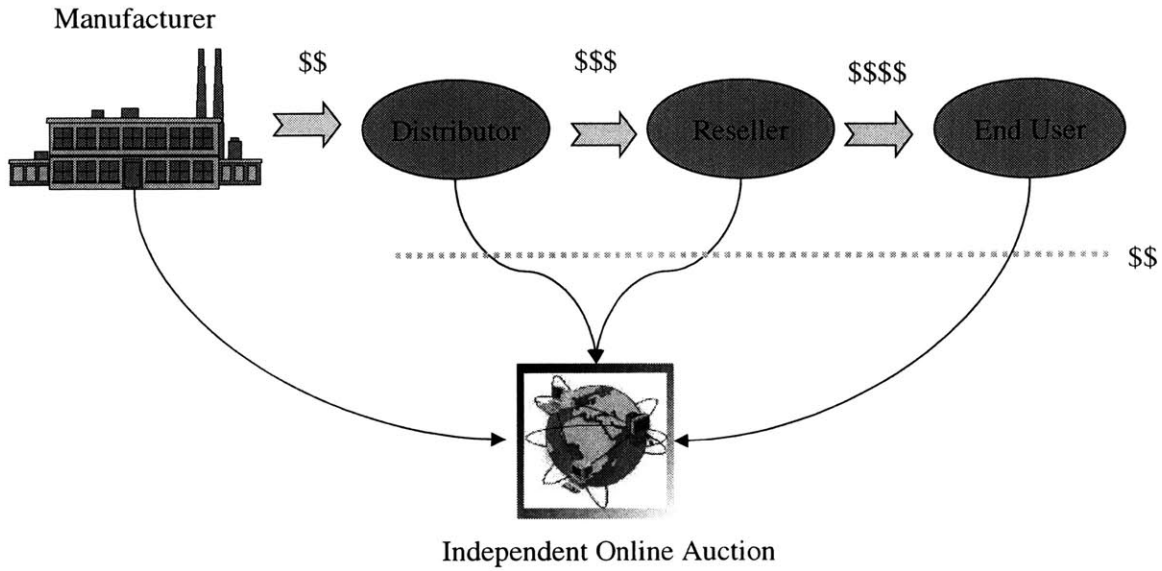
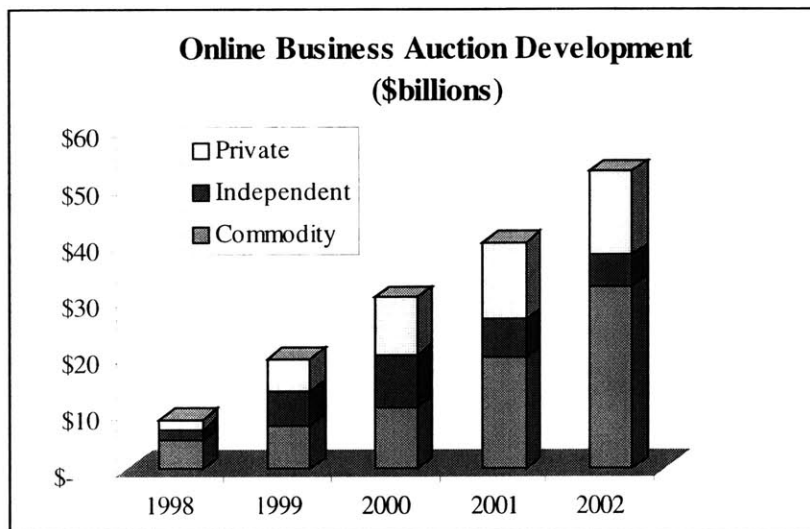


Figure 3: Online business auction development



2.3. Auction Format and Revenue Yield

Economists have long recognized that different auction formats generate important differences in revenue yields. This section discusses different auction formats in both the tradition venue and online environment.

2.3.1 *Traditional Auction Formats*

The four basic auction mechanisms outlined by Vickrey (1961) are English, Dutch, first-price sealed-bid, and second-price sealed-bid.

English Auction. English auction is probably the most popular auction format in which bidders compete against each other by raising the price of the product. The bidding process follows a “going, going, gone” mechanism where last remaining bidder wins the product and pays the amount of his final bid.

Dutch Auction. In a Dutch auction, the auctioneer starts the bidding process at some very high price point and decrease it until the first bidder finds the price low enough to respond it. The bidder will win the product and pay the amount at which the bid stops.

Sealed-bid Auctions. In a sealed-bid auction, auctioneer specifies a deadline. When it approaches, all bids are collected and the winner is determined. There are two variations of how the winning bid is determined. In a *first-price* auction, the winning bidder pays what he bids. In a *second-price* auction, the wining bidder pays the second highest bid plus one increment. In essence, sealed-bid is not a true auction in that it does not allow for reaction from the competitive market place.

Traditional auctions are expensive. In order to participate in the bidding process, all bidders must present in the same room at the same time. As a result, the bidding process must proceed promptly and end in a matter of seconds or minutes for each item.

Online auction, on the other hand, eliminates the location and time constraints so that bidders can participate in the auction from anywhere at anytime. Internet technology has lowered the costs of organizing and participating an auction which appears to be causing auctions to be used for more and more transactions over time. To attract the maximum participation, most online auctions open for a period of hours or days and use a hybrid of auction formats to improve the efficiency of the bidding process.

2.3.2 Online Auction Format

Sealed-bid. Similar to tradition sealed-bid auction, each bidder submits one confidential bid. First price is still the dominant format in determining the winning bid for a sealed-bid online auctions.

Incremental bid. Incremental bid is similar to the English auction. Before bidding, the bidders can view the current highest bid and decide whether to raise it or wait. If she raises the bid, she will become the highest bidder and the new highest bid can be viewed by everyone participating in the auction.

However, there is a slight difference in the bidding process. In a traditional English auction with all bidders present in the same room, the auctioneer closes the auction using the traditional "going... going... gone!" procedure. Online auctions are somewhat different, with geographically diverse bidders generally placing their bids over a period of days or weeks. Sellers normally set

the closing time and date 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 his or her 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 submitting a bid which just barely beats the highest bid and gives the rival bidder no time to respond. In this case, the game would become equivalent to a sealed-bid auction, with all the bids submitted at the very last minute. This destroys the English auction's attractive feature that encourage bidders 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. The first strategy is to implement a "proxy bidding" mechanism where each bidder is assigned a proxy agent, a computer program, by the auction software. Before bidding, the bidder tells the proxy agent the most he is willing to pay for particular item. During the bidding process, the agent will actively monitor the price and outbid other agents on the bidder's behalf until the maximum bid has been reached.

An alternative solution is to offer a short "extension period". If there is any bidding activity in the last five minutes of the auction, the auction's closing time will be extended by an additional five minutes. This process iterates if bidding continues, so the auction will not end until five minutes have passed without a new bid. Such an extension period effectively adds a "going, going, gone" rule and gives bidders the opportunity to protect themselves against "snipers." The disadvantage of this solution is that it prolongs the bidding process and obligates bidders to stay

with the auction until it is over. This removes the convenience of asynchronous bidding, which gives bidders the flexibility to enter their bids at any time.

Extended incremental bid. To restrain the length of the bidding process while protecting serious bidders against snipers, some online auction websites implement a “final round” approach. Here is how it works, after the deadline, instead of closing the auction, the auctioneer will announce a final round where all bidders must submit a sealed bid based on the current highest bid. The winning bid will be determined based on the result of the final round. However, there is a potential drawback of this approach too.

In above auction formats, we assume that all bids can be received and processed successfully. It may not be the case in online auction. For example, LabX, a member of the VerticalNet which specialized in laboratory equipment auction, warns bidders that “We are not responsible for Internet connectivity problems. We are not responsible for overloads on our server which could possibly occur if a large number of people tried to enter an auction at the same time. Our server, or even your computer, can potentially crash and go off line at any time, just like Internet connectivity.” In addition, there are unpredictable delays in the transmission of electronic information over the Internet. Bids may be lost, delayed, or discarded due to network congestion, especially during the final round of the extended incremental bidding process when everyone is trying to submit his or her bid at the same time. This may discount the advantage of the efficiency of the “final round” approach.

Reverse auction. Different from traditional auctions where sellers post products and buyers respond with bids, in reverse auction, buyers describe their needs and ask sellers to respond with products and prices.

Other auction formats. Other formats used in the online auction include double auction which allows sellers to continuously update their offers, multi-unit auction where multiple identical units of a good are auctioned individually, and package bidding where bidders bid on the combinations of related items.

In this chapter, we analyzed the reasons behind the booming of business auction on the Internet and the difference between online auction formats and traditional auction formats. Next chapter will detail our research questions, the contribution of our research, and the research methodology.

CHAPTER 3. OUR RESEARCH

As eMarketplaces populate industries, businesses must decide which e-business strategies to invest. Not all businesses are equally suited for a particular eMarketplace model. For example, in an auction or exchange market, suppliers become much more vulnerable because they will have to compete with other vendors in a transparent trading environment.

So how should companies decide which model suits them best, or, indeed, whether they should participate in the eMarketplace at all? Our research focuses on online auction model and tries to develop a framework to help companies determine whether online auction is an appropriate strategy for them by analyzing their products. The underlining hypothesis is that certain products lend themselves better to one type of market model versus others.

3.1. Research Questions

Our analysis follows two dimensions of the product attributes: commodity vs. specialty and tangible attributes vs. intangible attributes. We want to examine what attributes appeal most to bidders in a highly competitive auction environment and what auction formats are most effective for product with certain attributes. We hope to provide answers for the following questions:

- 1) *What products are best suited for auctions?*
- 2) *What auction format would yield the most revenue for a particular product type?*
- 3) *Will auctions change the importance of tangible and intangible attributes?*
- 4) *Will online auction change the relationship between the buyers and sellers?*

For this study, we conducted a laboratory experiment where we auctioned specific products whose attributes represent different scales along the commodity-specialty, tangible-intangible spectrum.

3.2. Product

Subject will bid on two products: personal computer and server computer. We choose these two products because 1) they belong to the same product category at both ends of the commodity-specialty scale (PCs are commodities, while server computers are highly specialize systems and differ significantly across vendors in term of functionality and performance.) 2) both products share a set of tangible and intangible attributes, and 3) subjects (college students) are fairly knowledgeable about these products and therefore able to make reasonable decisions.

Nine items are auctioned in each product category. All those items share the same configuration except four attributes: CPU speed, memory size, brand reputation, and expandability. Of the four attributes, the first two are tangible while the other two are intangible attributes. We specified the brand reputation ranging from unknown (never heard of it before), average, to excellent.

Expandability is defined as the ability for user to add additional functionality to the computer.

Some examples of expandability include whether the computer reserves empty I/O slots for extra hardware, how easy the operating system runs application from other vendors, etc. A product's expandability ranges from low, medium, to high in this study.

3.3. Auction Format

Economists have long recognized that different auction formats generate important differences in bidding result and bidders' behaviors. For example, the revenue-equivalent theory argues that in

second-price sealed-bid auction and English auction, bidders tend to bid up to their valuations. However, in the first-price sealed-bid auction and Dutch auction, bidders tend to bid strictly less than their valuation, in order to leave themselves some surplus when they win.

Others have observed that certain auction format yields higher revenue for bidders who are risk averse or risk-neutral. For example, risk-averse bidders benefit more from the first-price auction than the second-price auction. If bidders are risk-neutral but values are affiliated rather than independent, the first-price auction normally yields lower revenue than the second-price auction.

One of our goals is to test the impact of auction format on the efficiency of online auctions. We identified four auction formats that widely used by online auction web sites and ran the same experiment across all four of them to compare the results. The four auction formats are: sealed bid, incremental bid with extension period (“extension period”), incremental bid with final round (“final round”), and “final round” with reliability less than 1.

The first three auction formats have been explained in detail in Chapter 3. The fourth one, “final round with reliability less than one,” is chosen to simulate the scenario where the data was lost or delayed due to network congestion or server crash. This situation becomes even more serious during the final round of the extended incremental bidding process when everyone is trying to submit his or her bid. In the fourth format, we assigned a reliability factor p to the final round of extended incremental bid. For example, $p=50\%$ means that there is only a 50% chance that the bid will be received correctly. Knowing this fact may encourage the bidder to place his maximum bid early in the bidding process.

In all four formats, the winning bids will be determined using the second-price. We believe that second-price bidding is a more efficient action format. It encourages bidders to reveal their true valuation of the product early in the bidding process (they can sit on it safely without worrying about overpaying the seller).

Different from real-life auctions, in our experiment, the auction is conducted in a discrete-timing manner. Within each auction, the bidding process is sliced into a series of rounds and progression is done round by round rather than in continuous time. Doing so offers two advantages. First, it encourages bidders' participation – the auction will not proceed until everyone places his bid in this round. Second, it allows us to implement the extension mechanisms without specifying a deadline which would significantly slow down the bidding process. In our experiment, the auction will close or move to the final round when no one raise his bid for two consecutive rounds. Table 1 listed the detailed bidding procedure for each auction format.

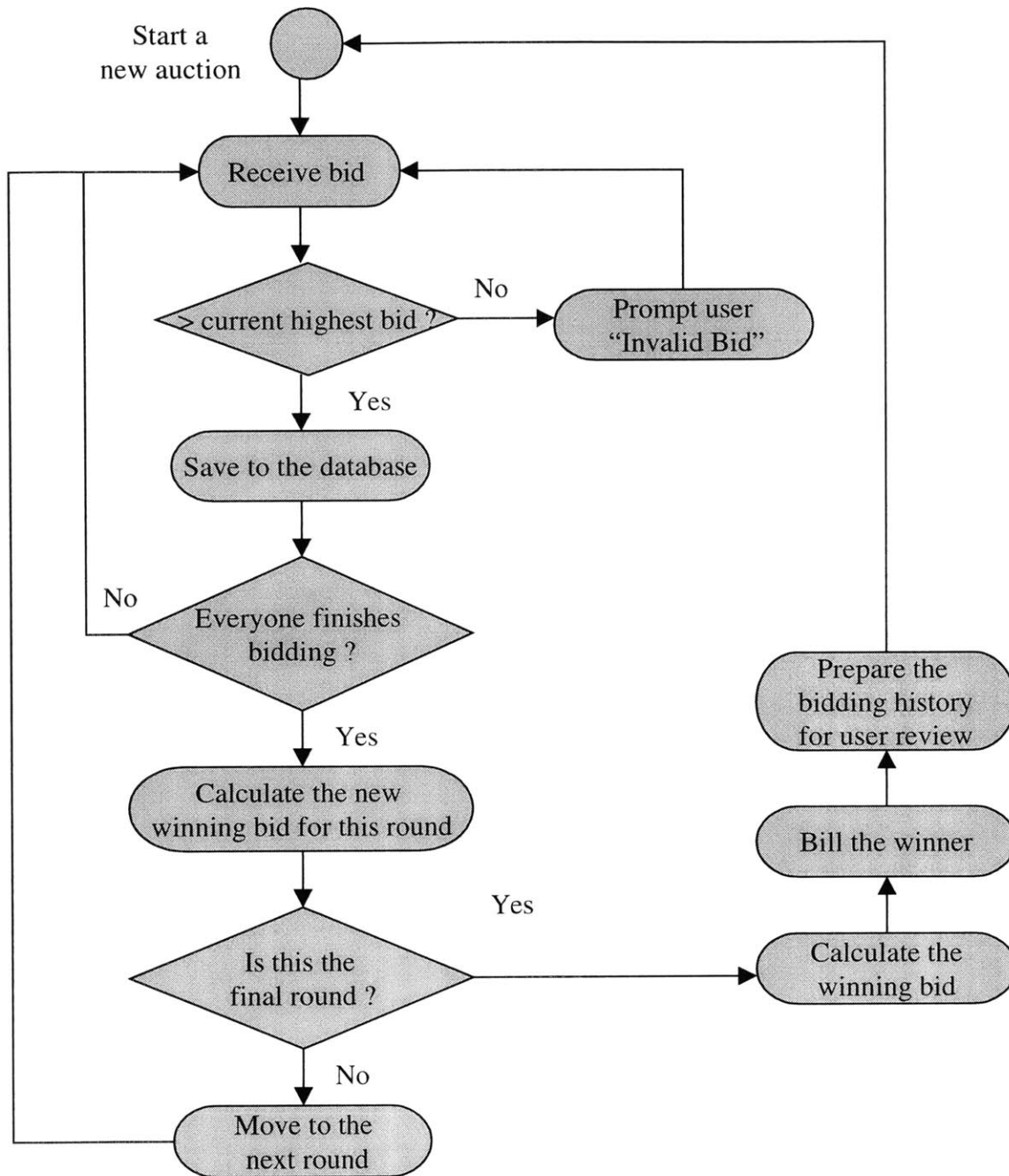
3.4. Auction Software

To gain flexibility in selecting the auction format and control the bidding process, we developed our own auction software for this experiment. The system includes three tiers: user interface, common gateway interface (CGI), and database. The user interface was designed using standard HTML and can be accessed from anywhere using a web browser. Both the CGI application, which was written in Perl, and the database server are running on the Linux platform. (See Figure 4 for the functionality and process flow of the auction software).

Table 1: Auction formats in the experiment

<i>Auction Format</i>	<i>Specification</i>
<i>Sealed bid</i>	Participant submits one confidential bid which is the most she is willing to pay for this product. The result will be determined immediately after all bids are received. The winner will pay one dollar over the second-highest bid received.
<i>“Extension period”</i>	Participant bids in multiple rounds. Each round starts from the winning bid of previous round. The bidder can either raise the bid by submitting a price higher than the current highest bid or keep his or her previous bid. After all bids are received, the winning bid will be determined and the auction moves to the next round. This process will iterate until everyone stops bidding. If no one raising bid within two consecutive rounds, the auction will be closed. The winning bid is the second-highest bid plus one dollar.
<i>“Final round”</i>	This format differs from the previous one in that after two consecutive idle rounds, instead of closing the auction, the auctioneer will announce a final round where all bidders submit a sealed bid against the current highest bid. The winning bid will be determined based on the result of the final round.
<i>“Final round” with $p=0.5$</i>	This format follows the same rule as the previous one except that not all bids will be successfully accepted in the final round. For example, for a reliability factor of 50%, roughly half of the bids submitted in the final round will be lost.

Figure 4: Auction software process flow



After logging in to the system, user can enter his or her bid. The data will be sent to the web server through HTTP connection. The CGI application resided on the web server extracts the bid from the HTTP command, formulate SQL queries, save/retrieve data from the database, and generate the HTML page to be displayed by user's browser.

As mentioned earlier, we sliced the bidding process into a series of rounds. Within each round, after everyone places his or her bid, the software calculates the winning bid, which will serve as the basis of the next round bidding. If the bidder chooses to raise the bid, he must submit a bid higher than the previous winning bid. Otherwise, an error message of "Invalid Bid" will be displayed and the bidder has to submit another bid.

If this is the final round, the software will calculate the winning bid, bill the winning bidder, and prepare a bidding history report for bidders to review. The report lists all bidders in the order of their final bids. However, the winner's final bid will not be revealed to protect his true valuation of the product. Instead, the winning bid is displayed.

3.5. Administration Tools

Other than providing the basic bidding functions, such as accepting bids, calculating winning bids, and moving the auction process forward, the system also provides tools for the administrator to:

- a) Load input data file to the server. The data file contains information about item name, seller name, seller reputation, bidder login, etc.
- b) Select auction format. The administrator can choose one of the four auction formats: sealed bid, "extension period", "final round", or "final round with reliability less than 1". For the

last one, the administrator can specify the value of the reliability factor between 1% and 100% (default is 50%).

- c) Monitor the bidding process. During the auction, the administrator will receive up-to-the-minute update about bidders' activities (who bids what at which round).
- d) Control the progress. The auction will automatically proceed from one round to the next and from one item to another. However, the administrator can choose to intervene by 1) moving the auction to the next round, 2) declaring the final round, or 3) terminating the current auction and starting the auction of the next item (see Figure 5).
- e) Collect the results. After the auction is over, the system will generate a log file detailing all the bidding activities by every bidder in every round. In this experiment, we will use that information for statistical analysis. In the real world, the data captured is of strategic importance to the auctioneers who can use it for cross-selling and up-selling to customers.

3.6. Experiment

For each experiment, we auctioned 18 items: nine PCs and nine servers (see Table 2 and 3 for detailed product configurations). Subjects were instructed to bid on each and every one of those items. The products were auctioned in sequence – only one item was auctioned at a time and a new item was auctioned after the previous auction had finished and its result had been reviewed by all bidders. Doing so allows subjects to learn from their previous experience and adjust their bidding strategy accordingly

Figure 5: Administrator interface

Dandy.com

Item Name: PC9

Seller: Dandy
 Bid Type: Extended Incremental Bid w/ p<1
 Highest Bid: 661
 Highest Bidder: user16
 Status: **Open (round 9)**

Next Round **Final Bid** **Finish**

History

User Name	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8	Round 9
user15	100 100	300 200	350 50	350 0	350 0	610 200	610 0	610 0	
user16	180 180	200 20	310 110	550 240	550 0	650 100	700 50	700 0	700 0
user17	100 100	200 100	500 300	500 0	600 100	600 0	620 20	620 0	620 0
user18	500 500	500 0	500 0	500 0	600 100	600 0	660 0	660 0	660 0

Table 2. Product catalog for personal computers

<i>Item</i>	<i>Speed (MHz)</i>	<i>Memory (MB)</i>	<i>Brand Reputation</i>	<i>Expandability</i>
PC1	800	256	Average	Low
PC2	800	64	Excellent	High
PC3	600	256	Unknown	High
PC4	400	256	Excellent	Medium
PC5	800	128	Unknown	Medium
PC6	600	128	Excellent	Low
PC7	400	128	Average	High
PC8	600	64	Average	Medium
PC9	400	64	Unknown	Low

Table 3. Product catalog for server computers

<i>Item</i>	<i>Speed (MHz)</i>	<i>Memory (MB)</i>	<i>Brand Reputation</i>	<i>Expandability</i>
Server 1	500	2,000	Average	Low
Server 2	500	512	Excellent	High
Server 3	400	1,000	Unknown	High
Server 4	300	2,000	Excellent	Medium
Server 5	500	1,000	Unknown	Medium
Server 6	400	1,000	Excellent	Low
Server 7	300	1,000	Average	High
Server 8	400	512	Average	Medium
Server 9	300	512	Unknown	Low

Each experiment involved four subjects, most of whom were MIT students. Before the experiment started, each subject receives a copy of the bidding rules and product catalog. The administrator also spent 10 minutes explaining the purpose of the experiment, the products to be auctioned, online auction in general, and the bidding process specific to this experiment.

Within each auction, the bidding process is sliced into a series of rounds and progression is done round by round rather than in continuous time. Subjects can either raise their bid or keep their previous bid. Meanwhile, they can see the following information from the screen (see Figure 6):

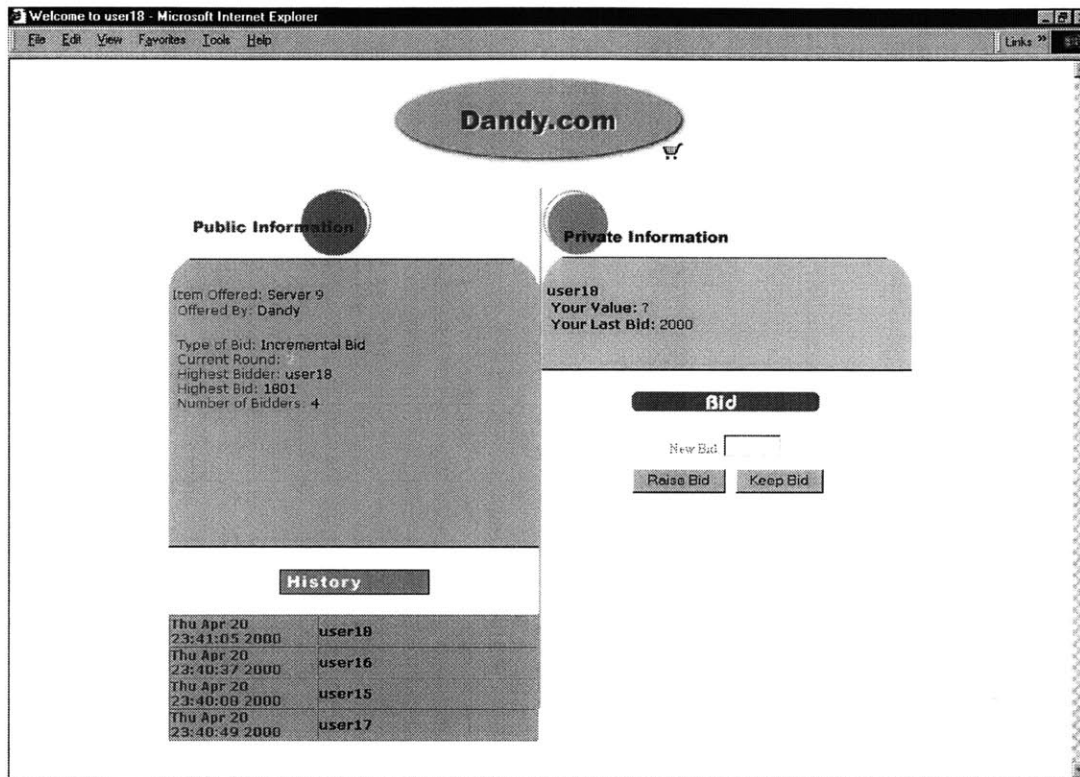
Item offered: the name of the item the subject is bidding on. Subject can refer to the product catalog for detailed product configuration.

Current highest bid and highest bidder. The winning bid of previous round and the bidder who placed the highest bid. The winning bid is the second highest bid plus \$1. If more than one bidders place the same bid, whoever comes first wins the bid.

Bidding history: The bidding history lists of all bidders in the order of the bids they placed in previous round. The higher the bid, the higher the bidder is on the list. From here, subject can learn about his position in the race comparing with other bidders. The list will be updated when a new round starts.

Last bid: the bid the subject placed in previous round. This information is only accessible by the subject himself.

Figure 6: User interface



In the beginning of each auction, the administrator announced the item name and remind subjects to check the product configuration from the catalog. During the bidding process, the administrator would monitor the progress and promptly announce the start of a new round when everyone finishes placing his or her bid. When the auction is over, the administrator would declare the winner and the winning bid. Meanwhile, bidders can check out the final bids of all bidders (except the highest bid). After everyone finishes reviewing the auction result, the administrator would announce the start of the next item auction.

For this project, we conducted a total of 12 experiments. Each experiment involved 4 subjects who bided on 18 items (9 PCs and 9 server computers). Each auction format was tested three times with the same products but in different orders. As a result, we had 3 sealed-bid auctions, 3 “extension period” auctions, 3 “final round” auctions, and 3 “final round with $p=0.5$ ” auctions.

CHAPTER 4. RESULTS AND ANALYSIS

This section will present the results of the experiment and our analysis.

4.1. Impacts of Auction Format on the Winning Bids

In the experiment, we identified four auction formats that widely used by online auction web sites and ran the same experiment across all four of them. The four formats are: sealed bid, “extension period,” “final round,” and “final round with $p=0.5$ ” (there is a 50% chance that the bid would be lost in the final round”). Figure 7 shows the comparison of winning bids among the four auction formats. As we can see from the chart:

- Sealed bid auction generates the most revenue yields for sellers, followed by the “final round” approach.
- The “extension period” approach is apparently the most effective auction format in terms of driving down the prices.
- The “extension period” approach and the “final round with $p=0.5$ ” approach have similar impact.

Since we auctioned two distinctive types of product, the above analysis does not give us enough information about whether this is the general pattern for the auction of all the products or there is a difference between PCs and servers. To answer this question, we separated the bidding result of PC from that of the server and conducted a similar analysis (see Figure 8). Here are the findings:

Figure 7: Comparison of winning bids (all products)

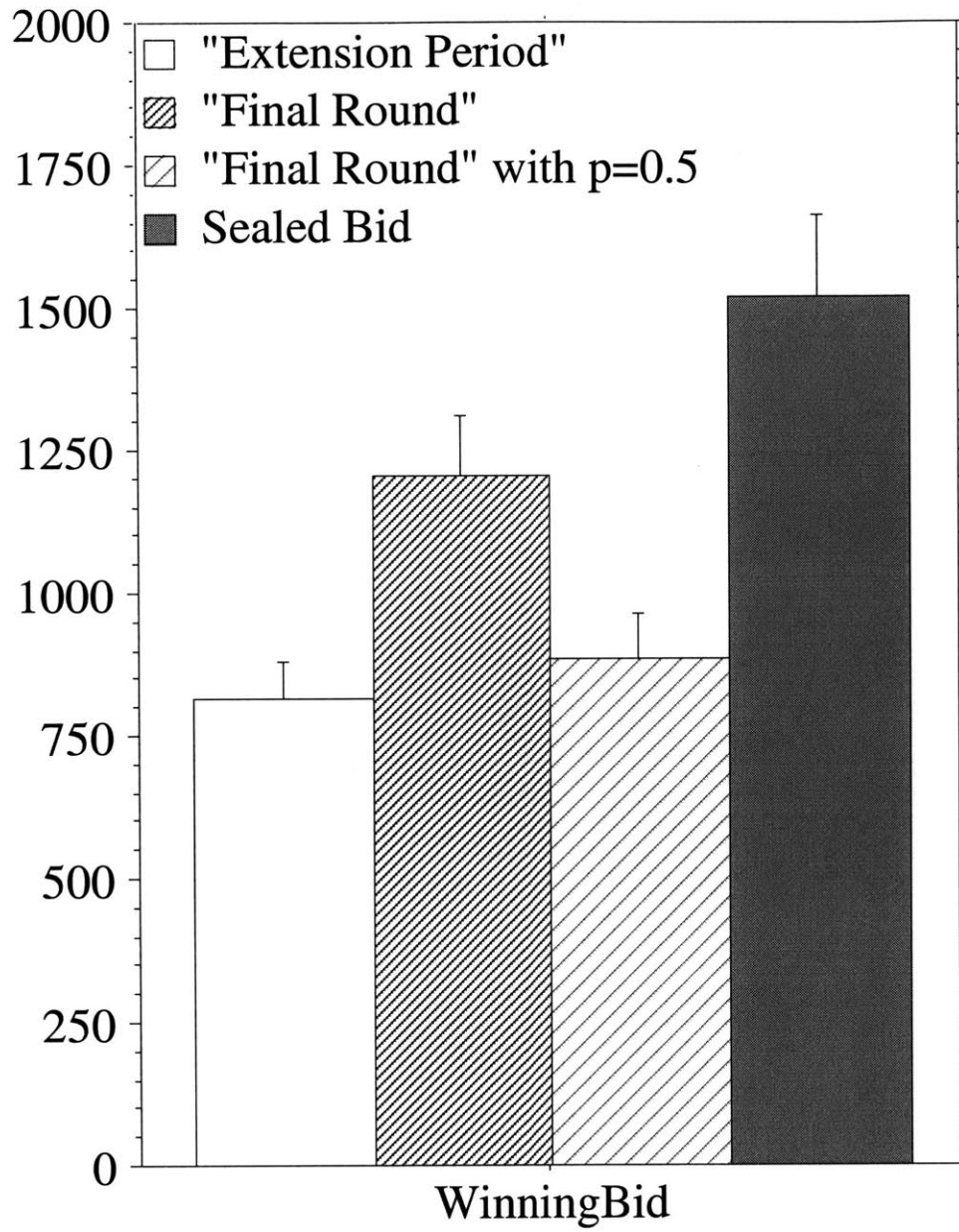
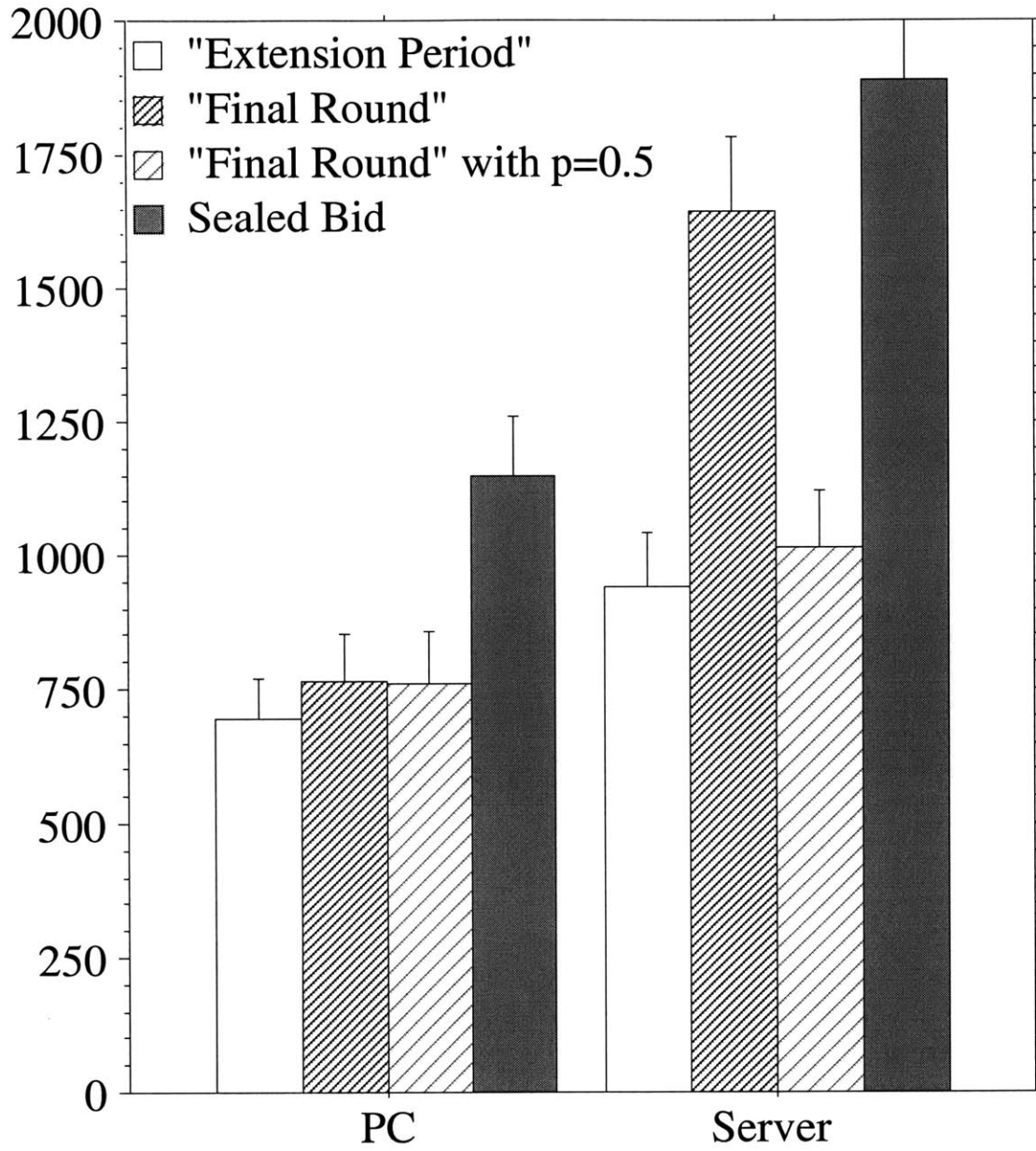


Figure 8: Comparison of winning bids (PCs and servers)



First, for both products, sealed bid yielded significant higher revenue than the others did. To explain this symptom, we need to go back to the basic economics theory of auction. As mentioned earlier, economists like Vickrey believed that in a second-price sealed-bid auction, bidders tend to bid up to their valuations of the products (the revenue-equivalent theory). So we believe that, in our experiment, the result of the sealed-bid auction reflects the bidders' initial valuation of the product, that is how much they would be willing to pay at an off-line market.

Using the sealed bid as a yardstick, we can see that other real-time auction formats ("extension period" and "final round") could create significantly saving for the bidders, especially in the commodity auction. For example, the average winning bid for PCs in real-time auctions is \$737, compared with that of the sealed-bid of \$1,150, resulting in a 36% saving.

Second, the results show some similarity between the auction of these two products. In both auctions, the "extension period" approach has the same impact on the auction prices as the "final round with $p=0.5$ " approach did. It is not hard to explain this equivalence. In the "final round with $p=0.5$ " approach, although bidders can reserve their true valuation for the final round, there is 50% chance that their bids would be lost. After bidders realize this fact, they tend to reach their valuation early in the process before the auction reaches the final round. The effect will be the same as that of the "extension period" approach.

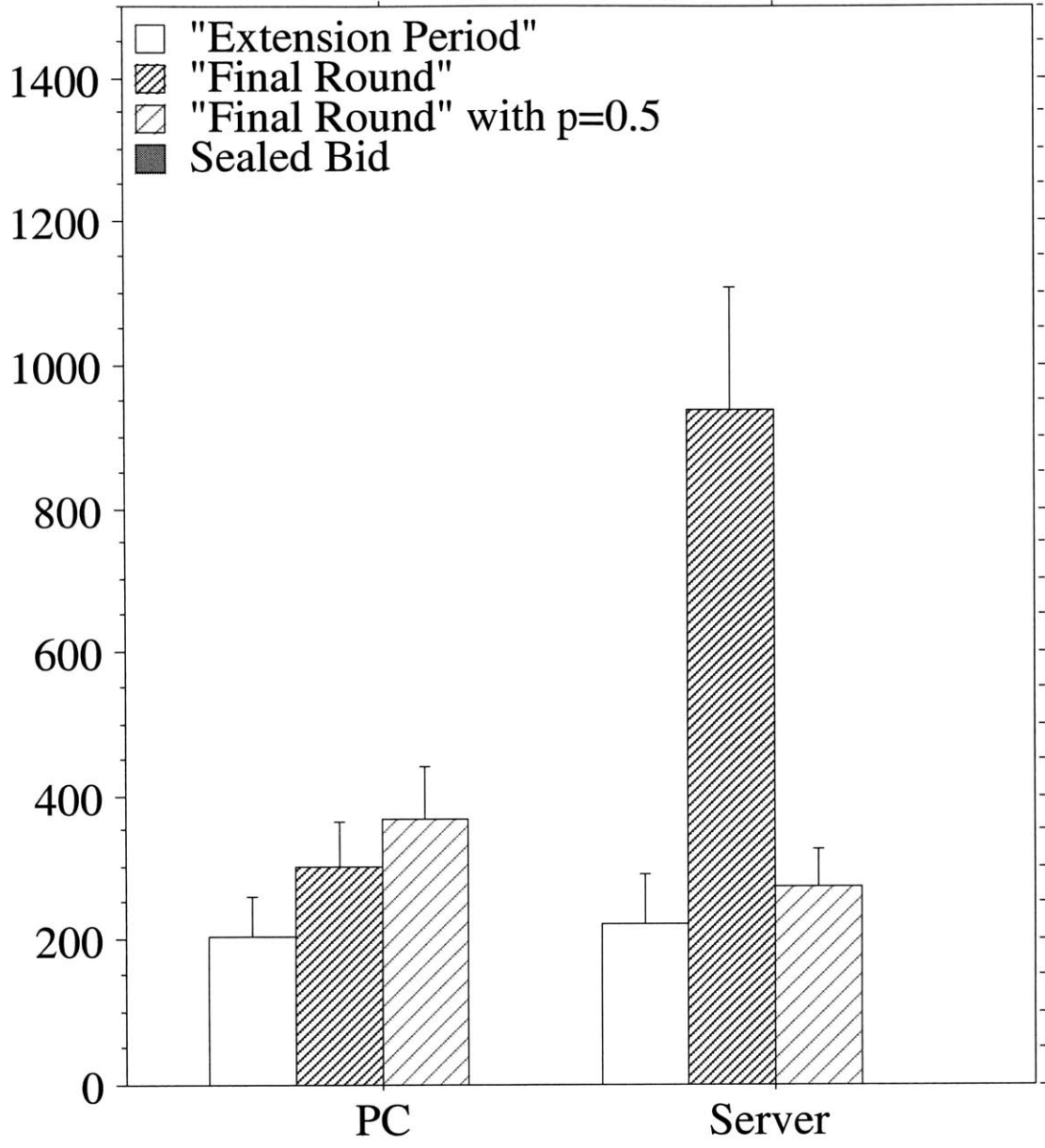
What's interesting is that we discovered that the "final round" approach behaved differently in the auction of the two products. We believe that this difference is caused by the characteristics of the product and the auction format. For commodities like personal computer, the products are standardized or non-differentiated and the supply is ample. It was fairly easy for bidders to determine the value of the products and they were not pressured to buy the products at this

particular auction (they can always get it from other channels or other auctions). As a result, they were more assertive on their prices and don't hesitate to reveal it early in the bidding process.

Different from PCs, server computers are highly specialized products. It is difficult for bidders to assess the true value of the product with the limited information they were given. Under this circumstance, they tend to speculate on the price. The "final round" approach fosters exactly this kind of attempt. Here bidders know that they don't have to reveal their cards early because the winning bid will be determined in the final round. So they tend to withhold their final price and use the initial rounds to explore others' intentions, hoping to beat others in the final round. As everyone is using this technique, the game becomes equivalent to a sealed-bid. That is why its yield is so close to that of the sealed-bid.

This theory is further supported by Figure 9, which shows the increases between bidders' initial bids and their final bids. From the chart we can see that in the "final round" auction, bidders tend to start their bids low and raise them significantly in the bidding process, especially for the auction of server computers where they are uncertain about the value of the products.

Figure 9: Comparison of bid increases (final bid – first bid)



4.2. Impacts of Auction Formats on the Max Bids and Final Bids

Lets first differentiate the final bid and max bid. The max bid is the highest bid the bidder submitted in the auction. The final bid is the last *valid* bid the bidders had placed, which is used to calculate the winning bid after the auction finishes. In an incremental bidding process, like “extension period” and “final round,” final bid and max bid should be the same. However, in the “final round with $p=0.5$ ” approach, there is a 50% chance that the last bid submitted by the bidder would be lost. So the max bids (what bidders submitted in the final round) may or may not be their final bids.

By looking at the max bid, we can study individual bidder’s true valuation of the product. This information was not presented in the analysis of the winning bid because the winning bid is calculated using the second-price. It doesn’t reflect the variation among the bidders. Studying the final bids, on the other hand, helps us understand the bidder’s reaction to the uncertainty of final round.

Figure 10 and 11 shows comparison of max bids and final bids across all four auction formats for PCs and servers. Both of them are very similar to that of the winning bids. It reinforces our previous analysis of bidders’ behaviors in both the commodity auction and specialty auction.

Figure 10: Comparison of max bids

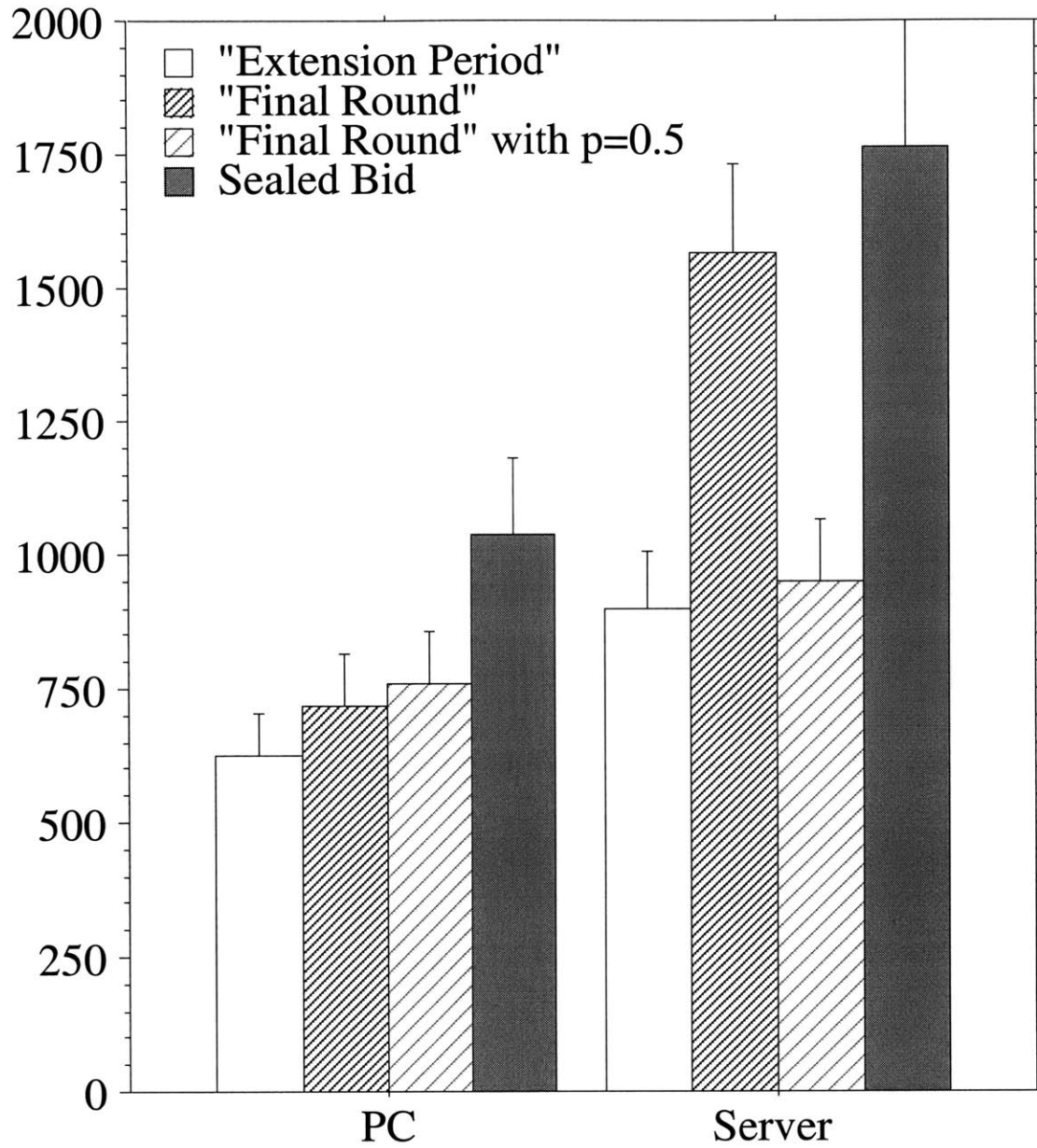
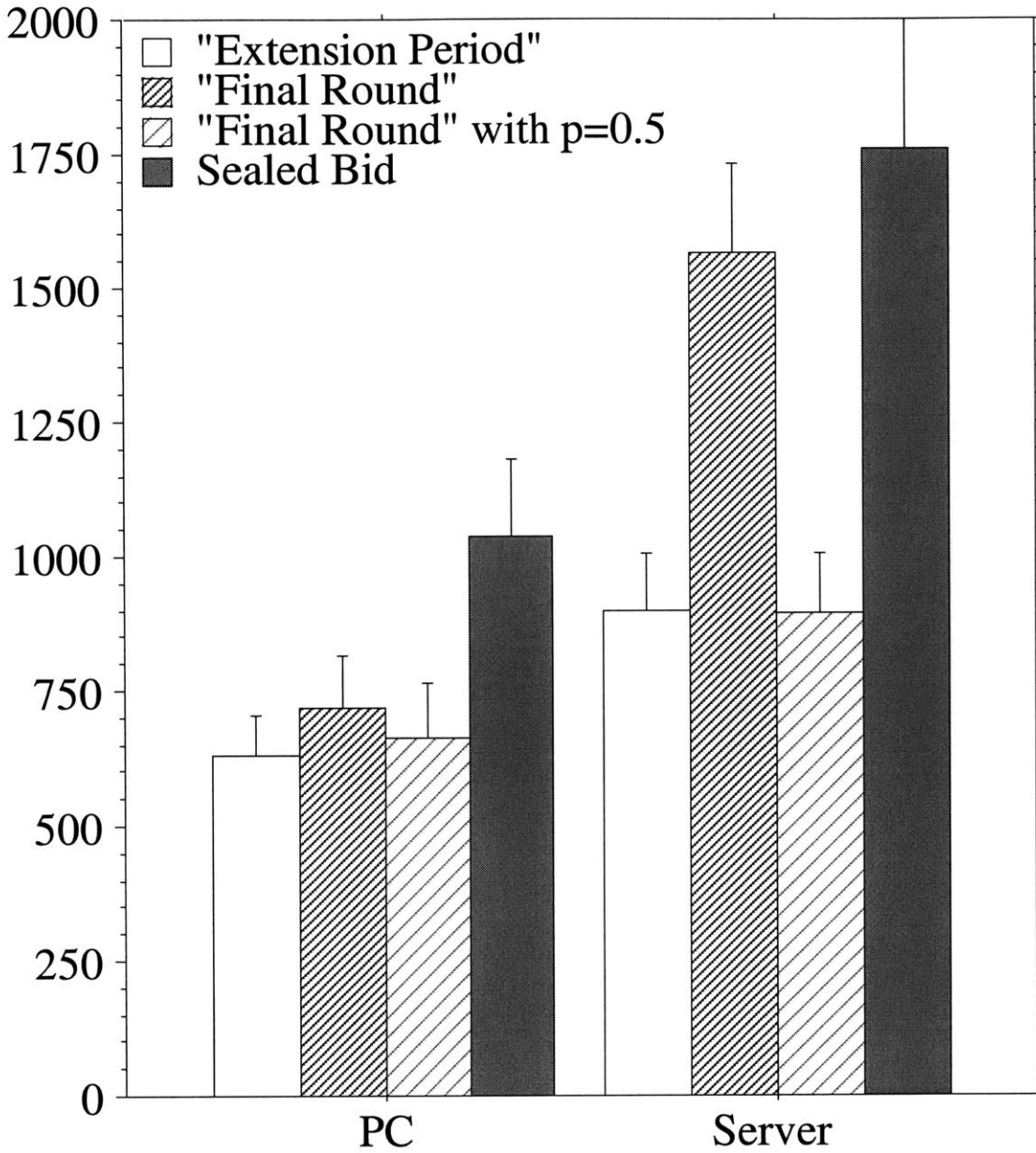


Figure 11: Comparison of final bids



Comparing the max bid analysis and the winning bid analysis, we see some slight differences, primarily in the PC auctions. For example, the winning bid analysis shows that all the three real time auction formats have almost the same impacts on the auction of PCs. However, the max bid analysis reveals that bidders actually bid higher in the “final round with $p=0.5$ ” approach and lower in the “extension period” approach with the “final round” approach in between. This result indicates the competitiveness of the three auction formats. The higher the max bid, the more competition the auction format promotes.

The final bid analysis also shows an interesting phenomenon – the three real-time auction formats actually have similar impacts on the PC auction as they do for the server auction. This fact further supports our analysis that bidders are more likely to speculate in the “final round” approach than in any other formats. Only in the PC auction there is less uncertainty involved, so the impact of speculation is much smaller than that of the specialty auction.

4.3. Collusion Effect

The goal of this analysis is to study bidders’ bidding pattern as they become more familiar with the auction process.

Within the experiment, we auctioned 18 different items, each with a unique set of attributes. Figure 12 shows the maximum bids the bidders placed for each item. As we can see from the chart, there is a general downward trend in their bids. In other words, as the auction proceeds, bidders tend to place lower and lower bids. One possible explanation is that the products offered in the end are less attractive to the bidders than those offered earlier. However, we have eliminated this possibility by deliberately designing our experiment. In the product catalog, the

order of the products was arranged randomly. Also, for the 12 experiments conducted, we switch the product order three times to make sure that it adds no complexity to the auction results.

We believe that as the auction proceeds, bidders become more savvy and they tend to collude with each other to drive down the auction price collaboratively.

In economics theory, collusion is defined as the secret activity undertaken by two or more people for the purpose of manipulating the prices of a product in an open trading environment. In its ideal form, no collusion should occur in an auction. Everyone would bid up to his or her true valuation of the products and the one that value the product most wins. However, we have seen that in many cases, the auction results were largely determined by the collusion among bidders within the group rather than their true valuations of the product.

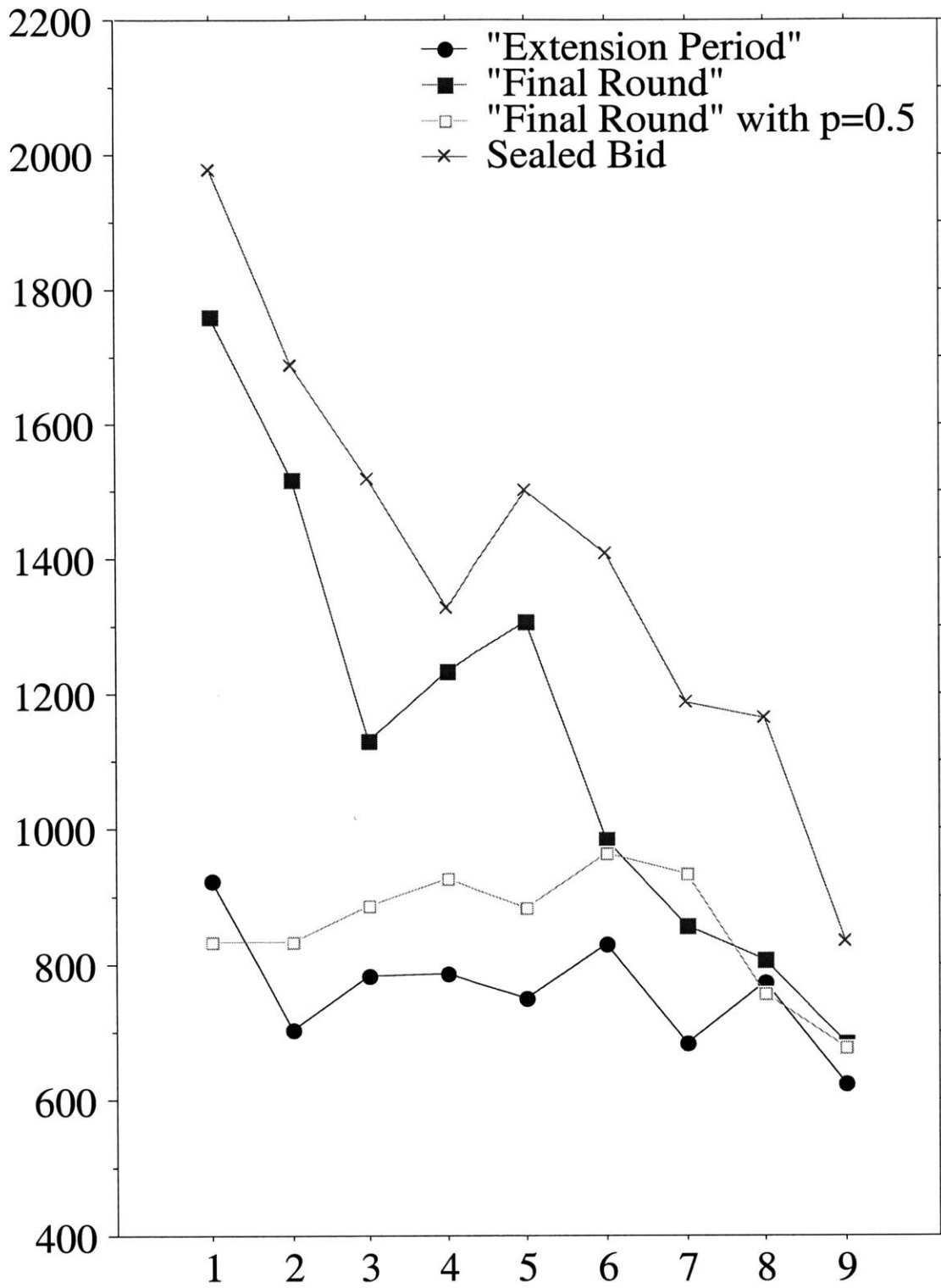
In our experiment, subjects were explicitly advised not to exchange information about their bids during the auction. However, they can still learn the intention of the others through the continuous bidding process – since similar items are auctioned one after the other, subjects were able to compare the results of previous auctions with their own valuation and adjust their bids accordingly. For example, one subject told us that her original valuation of one particular item was \$2000. However, after seeing that most bids were in the hundreds for several rounds, she changed her bid to \$1000.

This phenomenon reveals an important difference between online auction and the traditional trading channel. In the traditional trading environment, price is negotiated strictly between the buyers and sellers. The deciding factors are channel power, personal relationships, historical volume, etc. However, in online auction, the price is determined among the buyers themselves.

This would have a profound impact on the relationship among the buyers. The important question is: would online auction intensify the competition among buyers or encourage them to collude with one another and drive down the profit margin of the sellers collaboratively. The result of our experiment clearly supports the latter case.

Some auction formats foster this kind of collusion effect more than others do. As we can see from Figure 12, bidders are more likely to collude in sealed bid and “final round” auctions, because bidders in these two formats tend to withhold their true valuation of the product and the dominant strategy for bidders is speculation. The “extension period” and “final round with $p=0.5$ ” auctions, on the other hand, foster a competitive and transparent trading environment. In order to win, bidders have to reveal their true valuation of the products early in the bidding process.

Figure 12: Trend of the bidding process



4.4. Impact of Tangible and Intangible Attributes on the Auction Results

One of the goals of our research is to study the impacts of product attributes on the auction results. Specifically:

- what types of attributes would bidders value most in determining the values of the products: tangible or intangible?
- would they value certain attributes more in the commodity auction than in specialty auction?
- what roles, if there is any, the auction format plays in bidders' perception of the product attributes?

In the experiment, we auctioned two categories of product: PC and server computer. Within each product category there are 9 items. Those items differentiate by four attributes: CPU speed, memory size, brand reputation, and expandability. Of the four attributes, the first two are tangible attributes while the last two are intangible attributes.

Figure 13 and 14 show the relationship between auction results and the scale of the attributes for both PCs and server computers. From the charts, we can see that there is almost a linear relationship between the auction prices and the scale of the tangible attributes (CPU speed and memory size) – bidders tend to bid higher for products with more favorable tangible attributes. However, although bidders also tend to pay more for products with higher scale of intangible attributes, those intangible attributes have a much smaller impact on the auction results. For example, the price difference between product with high scale intangible attributes and low scale intangible attributes is much smaller than that of tangible attributes.

Figure 13: Impact of attributes on auction results (PC)

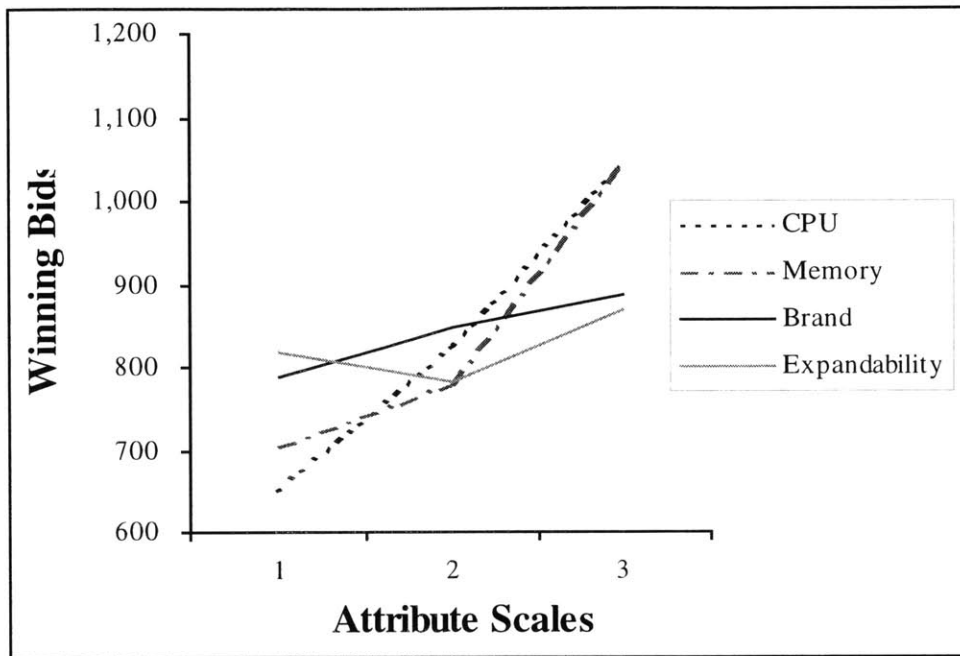
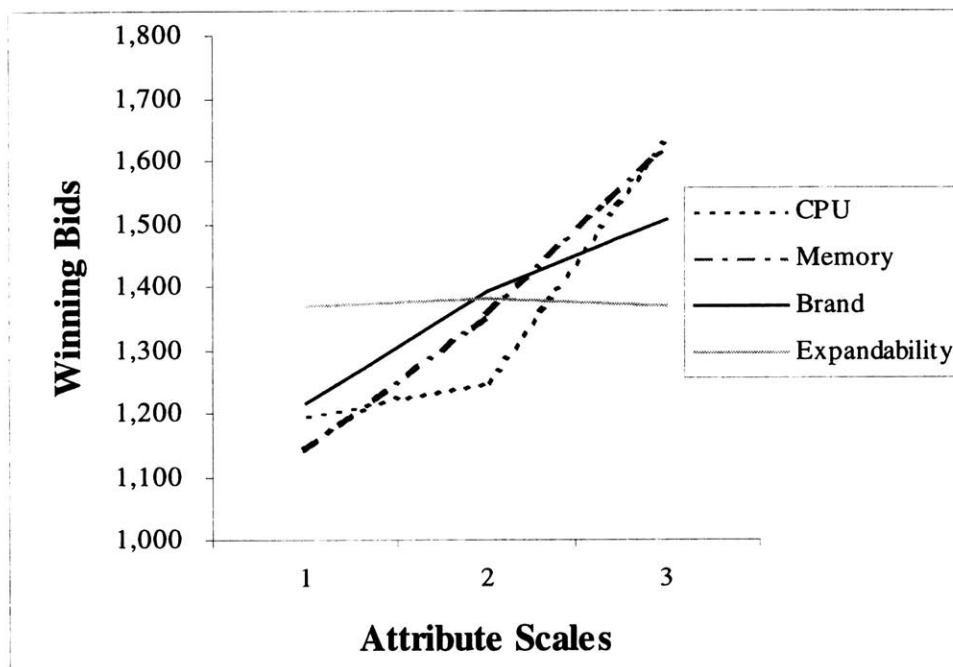


Figure 14: Impact of attributes on auction results (Server)



The argument is further supported by Figure 15, which shows the coefficient of the four attributes. As we can see from the chart, the two tangible attributes have much higher coefficients than those of the intangible attributes, indicating that in a highly competitive online auction environment, the tangible attributes play a more important role in bidders' valuation of the products.

The above analysis is for the auction of all products. Next, we will analyze whether there is difference between the two product types. In other words, would tangible and intangible attributes affect the auction result of PCs differently from what they do for the servers? Moreover, does the auction formats matter? For example, would certain auction format help bidders focus more on the tangible/intangible attributes than others do?

Figure 16 shows the coefficient of the four attributes for both the auctions of PC and server. The most interesting observation of the chart is that brand reputation has a much higher coefficient in the auction of server than it does for PCs, meaning that bidders tend to pay more for server computer with high brand reputation than they would do for PCs. This fact indicates that when bidders are uncertain about the value of a product, as in the case of server computer, they would choose one with a better brand reputation and pay more for it. However, in commodity auction, bidders are less concerned about the brand but more focused on the tangibles attributes.

Figure 15: Coefficient of the four product attributes (for all product)

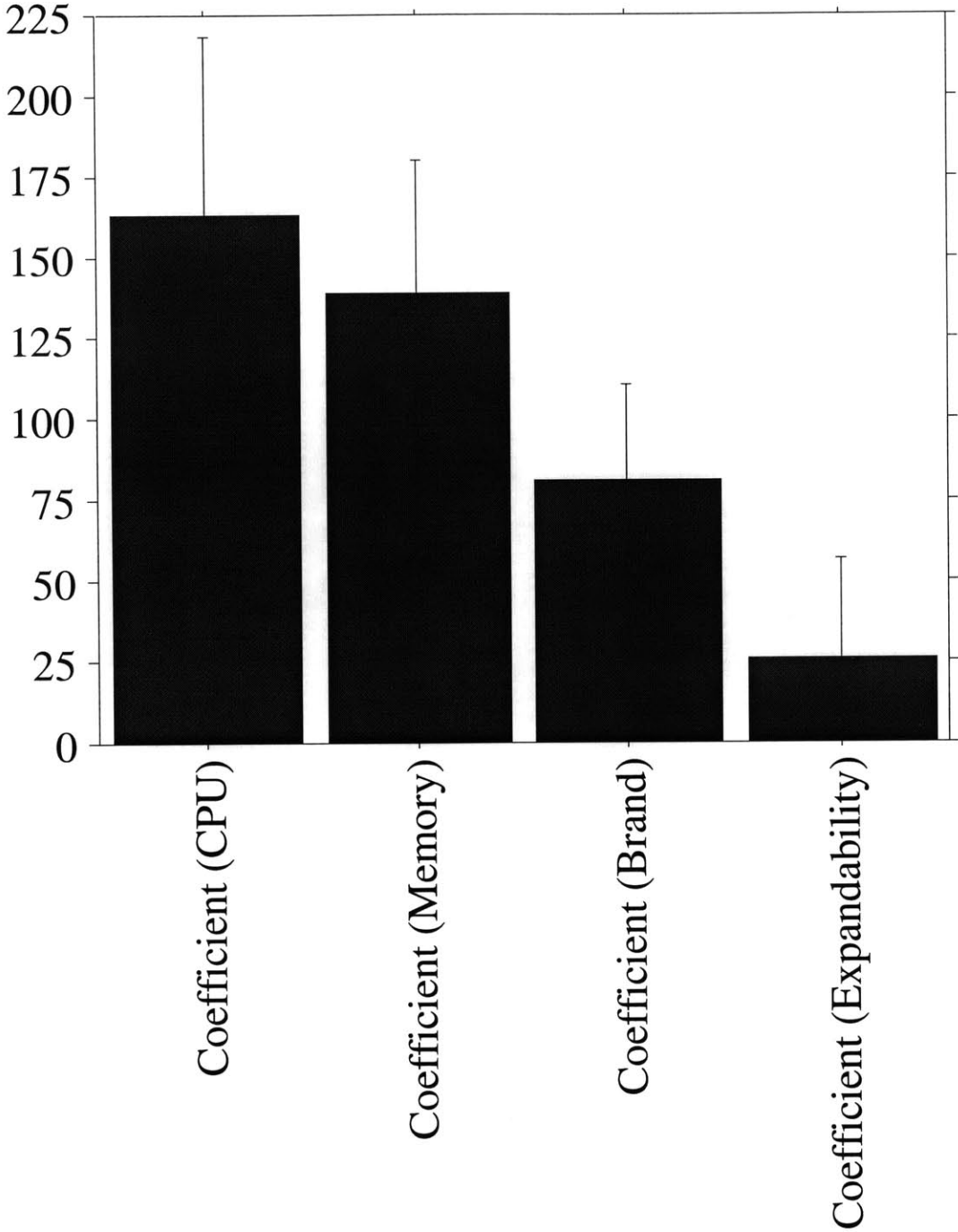


Figure 16: Coefficient of the four product attributes (for PCs and servers)

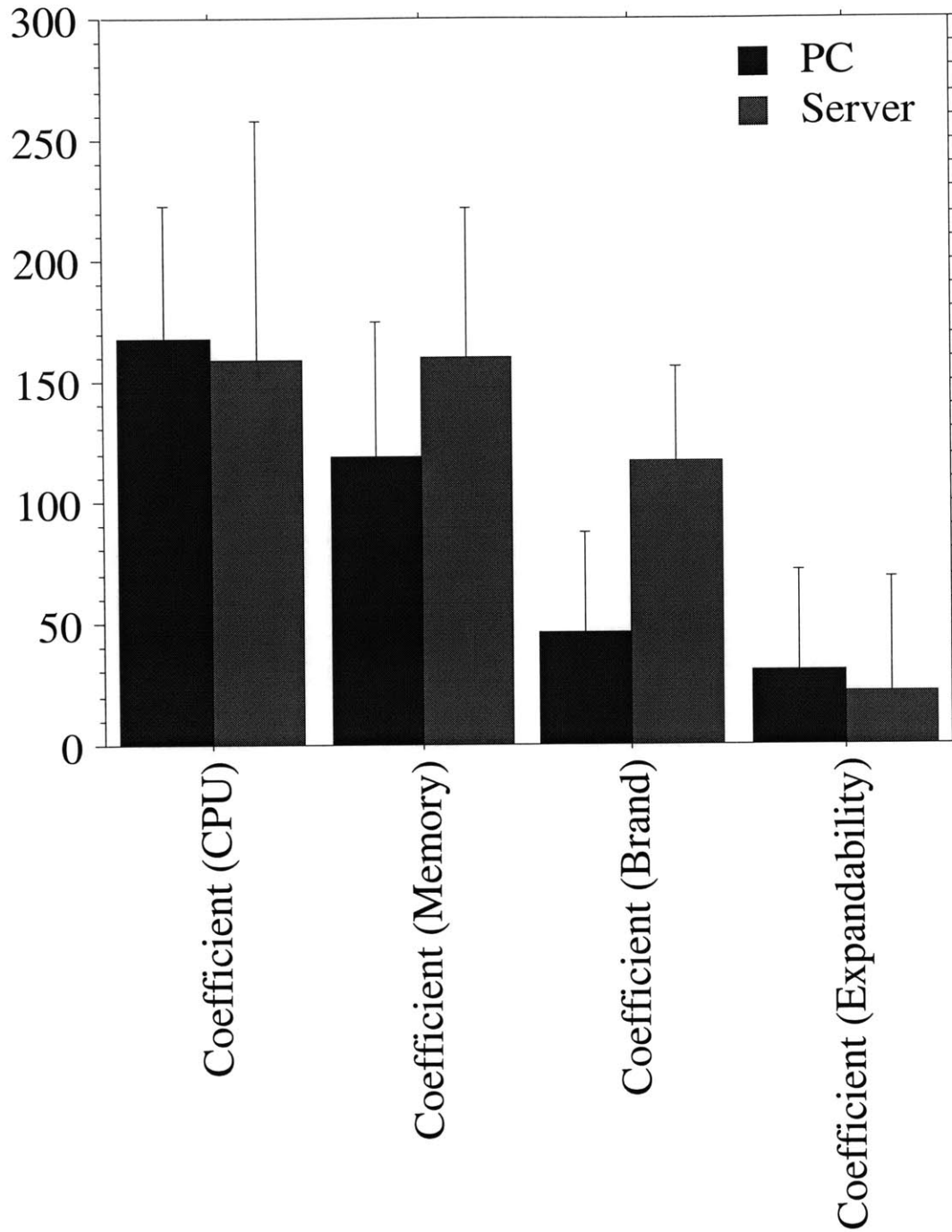
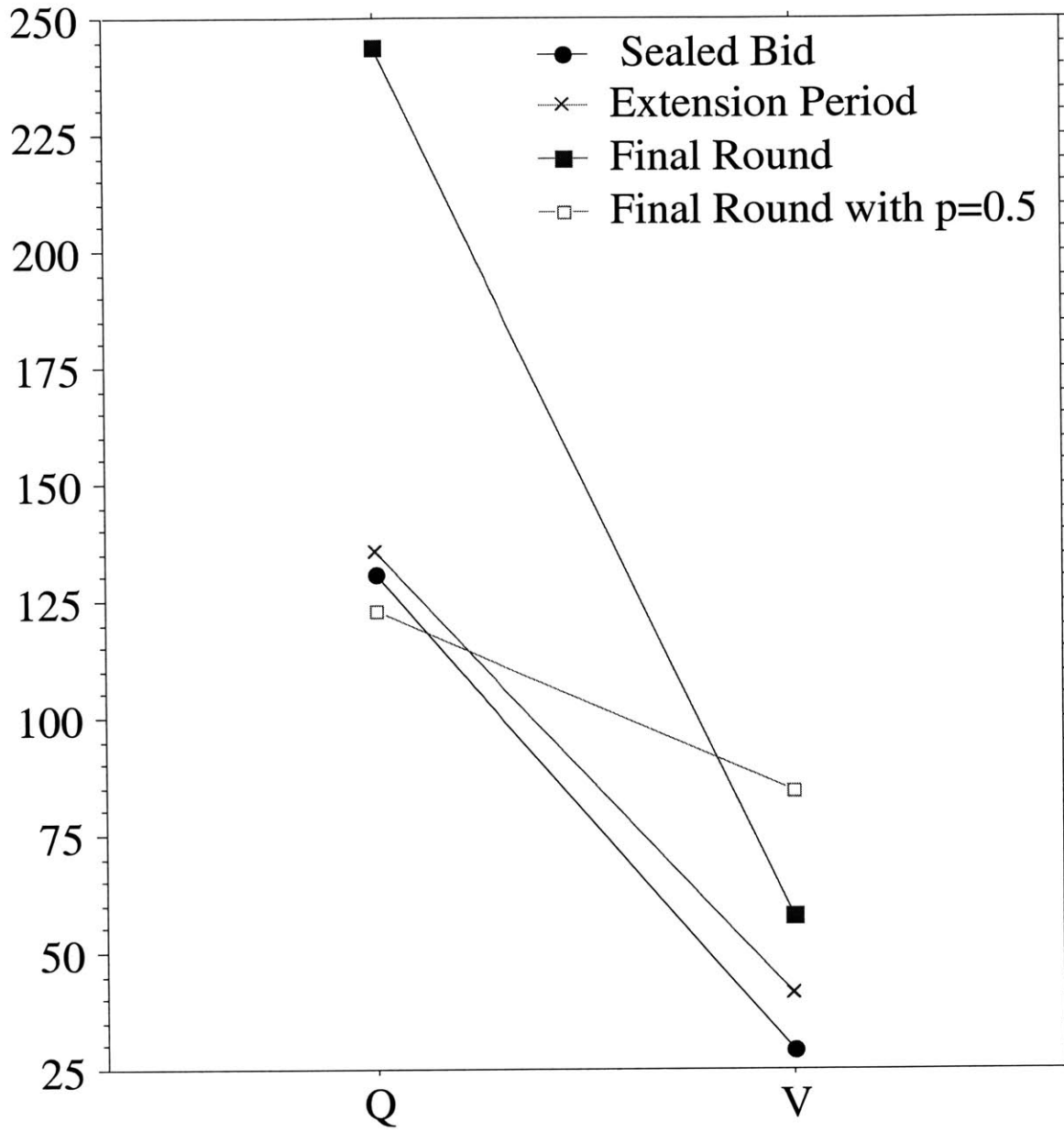


Figure 17 compares the coefficient of tangible and intangible attributes across all four auction formats. To simplify our analysis, we group the two tangible attributes into one variable called “Q” and the two intangible attributes into another variable called “V.” The most noticeable observation of this chart is that the tangible attributes have a much higher coefficient in the “final round” approach than they do in any other formats. This is an interesting phenomenon.

Of the four auction formats, the “final round” approach is the trickiest one. Here, bidders were not eager to reveal their true valuation of the product early in the bidding process because they knew that the results would be determined by the final round. So they tend to use the initial rounds to explore others’ intentions, even trick others by starting their bids significantly low (see Figure 9). The bid they placed in the final round were actually a combination of their valuation of the product and their speculation of how much the others would pay. Our result shows that in this bidding strategy, the bidders rely highly on the tangible attributes to determine their bids.

Figure 17: Coefficient of tangible and intangible attributes across all four auction formats



CHAPTER 5. DISCUSSIONS AND CONCLUSIONS

Online auctions represent one of the most interesting developments in electronic commerce. On the one hand, it presents a promising opportunity – providing a fast, convenient, and low cost way for sellers to reach large group of buyers, liquidate products at market-driven prices, and lower transaction costs. On the other hand, it makes sellers much more vulnerable because they have to compete with other vendors in a level and transparent trading environment. Therefore, it greatly undermines sellers’ traditional source of competitive advantage based on channel power, brand reputation, and customer loyalty. Moreover, online auction puts tremendous pressure on product prices, which is likely to offset sellers’ gain from increased reach and lower transaction costs. As a result, businesses must carefully evaluate the pros and cons of the online auction model before investing in it.

In this section, we will reiterate our research question, summarize our findings, and discuss their implications in the supply chain management.

5.1. Answers to Our Research Questions

In chapter 3, we formulated our research questions as follows:

1) What auction format would yield the most revenue for particular product type

We identified four auction formats that widely used by online auction web sites and name them as: sealed bid, “extension period,” “final round,” and “final round with $p=0.5$.” Our research shows that different auction formats indeed have different impacts on the auction results:

- Sealed bid auction yields significantly higher revenue than the other three real-time auction formats did. We believe that sealed bids reflect bidders' initial valuation of the product, that is how much they would be willing to pay in an off-line market.
- Using the result of sealed bid auction as a yardstick, we found that real-time online auctions could significantly drive down the product prices, as much as 36%.
- The “final round with $p=0.5$ ” and “extension period” auctions have almost the same impact on the auction results. As bidders realize that their bids in the final rounds might be lost, they tend to raise their bids early in the bidding process.
- In commodity auction, the “final round” approach has the same impacts on the auction result as the “extension period” and “final round with $p=0.5$ ” formats did. However, in the specialty auction, it yields significantly higher. This difference is caused by the speculative nature of the auction format and the uncertainty involved in the valuation of the products.

2) *Will online auction change the relationship between the buyers and sellers*

Online auctions are transforming the cherished notions about price in a capitalist economy. Here buyers will determine how much the products worth to them instead of paying the seller-set prices. This will have a profound impact on the relationship between seller and buyer and among buyers themselves.

Our research discovers that as bidders become more savvy about the bidding process, they tend to collude with each other to drive down the price collaboratively. The transparent trading

environment provided by online auction enables bidder to explore and speculate on others' intention and use this information to adjust their own bidding strategy. As a result, the bids they submitted reflect more of their perception of how much other would pay for the product rather than their own valuation of it.

We also found that some auction formats foster this kind of collusion effect more than others do. For example, bidders are more likely to collude in sealed bid and "final round" auctions because of the speculative nature of the two auction formats.

3) What products are best suited for online auction and will auctions change the importance of tangible and intangible attributes

As eMarketplaces populate industries, businesses must decide which e-business strategies to invest. Our research tries to develop a framework to help companies determine whether online auction is an appropriate strategy for them by analyzing their products. We believe that certain products lend themselves better to one type of market model versus other.

In our experiment, we auctioned specific products whose attributes represent different scales along the commodity-specialty, tangible-intangible spectrum. Our goal is to examine what attributes appeal most to the bidders in a highly competitive auction environment and what auction formats are most effective for product with certain attributes. We discovered that:

- In online auction, bidders pay more attention to the tangible attributes than they do to intangible attributes. Tangible attributes provide an easy measure for bidders to assess the value of the products.

- The “final round” approach is the most effective auction format for products with high value of tangible attributes. Here, bidders rely highly on tangible attributes to determine the value of the products.
- In the specialty auction, bidders are uncertain about the value of the products. As a result, they tend to pay more for products with a higher brand reputation. However, in commodity auction, buyer sophistication is fairly high. Therefore, they are less concerned about the brand but more focused on the tangible attributes.

In summary, our research provides a practical framework for companies who are thinking about moving their businesses to the eMarketplace. It can help them determine what products are better suited for online auction and what products should remain in the traditional market. Moreover, how they could manipulate the difference of the auction formats to maximize their benefits. In the next section, we will discuss the implications of our findings on the supply chain management.

5.2. Implication to Supply Chain Management

Based on the results of our research, we recommend the following strategies for companies who are looking forward to moving their businesses into the online auction marketplace.

5.2.1 Differentiate Product Offering

Commodities are easy targets for online auction. They are always in demand and traded in large volume. So it is easy for sellers to attract a critical mass of buyers and achieve significant savings from the improvement of transaction efficiency. However, sellers of commodities are also the ones who are most vulnerable. By definition, commodities are standardized or non-differentiated

products with ample supply. The buyers' sophistication is pretty high – they can easily determine the value of the product and compare it across multiple vendors. Whenever buyers compare apples with apples, they choose the cheapest one. Therefore, online auction puts tremendous pressure on price, cutting the sellers' already-razor-thin profit margin.

On the other hand, sellers of specialty products are more likely to leverage the market dynamics and benefit from the broad reach and flexible pricing. The unique characteristics of the specialty products make it harder for buyers to compare across multiple vendors. As a result, they are less price-sensitive. The challenge for sellers, therefore, is to differentiate their product offering and present it as a specialty.

One strategy is to complicate the product offering – combining multitude of SKUs and auction it as a complete package. For example, instead of auctioning individual computer, the seller could let buyers bid on a complete home office system, which consist of computer, printer, monitor, scanner, and application software. Doing so will allow sellers to: 1) differentiate their product offering, 2) provide one-stop shopping for buyers, 3) allure manufacturers of the complementary products into their web sites and establish strategic partnership.

Another strategy is to bundle commodity products with value-added services. Many researches have predicted that logistics is going to be the next big "domain" in the B2B e-commerce. Sellers who are able to provide prompt delivery, streamlined procurement, and just-in-time inventory management will be the winners of the eMarketplace. In this case, they have extended their roles from material suppliers to solution providers.

Companies can also differentiate their products by establishing a strong brand. Many firms fear that online auction will commoditize their offerings. However, our research shows that, like in the traditional market, buyers are willing to pay more for brand name products, especially in the specialty auction. Nevertheless, companies must consider the potential cannibalization effects the auction market may have on their existing distribution channels. One possible solution is to create a separate brand specifically for products to be auctioned on the Internet.

5.2.2 Leverage the Difference in Auction Formats

Our research indicates that different auction formats have different impacts on the auction results. In general, the “extension period” approach provides a more competitive and transparent trading environment and encourages bidders to reveal their true valuation early in the bidding process. (We consider “final round with $p=0.5$ ” is equivalent to the “extension period”). The “final round” approach, on the other hand, fosters speculation and trickiness among bidders. Here, bidders are more likely to withhold their true valuation of the product until the final round. They tend to use the initial rounds to explore others’ intentions and trick others by starting their own bids significantly low. The bid they placed in the final round were actually a combination of their valuation of the product and their speculation of how much the others would pay.

What this means to businesses is that they could actually influence the results of the auction to their benefits by carefully selecting an appropriate auction format. For example, under the circumstances where the benefits of a flexible, market-determined price are likely to be greatest, sellers may prefer to auction their products using the “extension period” approach. However, if there is a lot of uncertainty involved in the product characteristics and the buyers’ sophistication

is pretty low, the sellers may choose the “final round” or sealed-bid auctions and benefit from the speculative activities of the buyers.

5.2.3 Select the Right Products

Our research shows that in a highly competitive auction environment, tangible attributes play a more important role in bidder’s valuation of the products than intangible attributes do. Bidders tend to pay more for products with high scale of tangible attributes than they would do for products with high scale of intangible attributes. Knowing this fact will help companies determine what types of product should be moved to the auction market and which should remain in the off-line channel. For example, the ideal candidates are products with a lot of tangible attributes and can measure up against their competitors in those attributes. If the value of the products is difficult for customers to understand and measure, the sellers may want to sell them through other channels such as direct sale, brick-and-mortar store, etc.

5.3. Future Work

Overall, we consider the experiment successful. It was well designed and well executed. The results are solid and reveal some interesting facts that have practical implication on supply chain management. However, because of the time constraint, we couldn’t further explore some of our findings. For example what would be the long-term impacts on the buyer/seller relationship after they move their business to the auction market? would the results still uphold if we auction multiple items simultaneously? and whether the “seller reserved prices” have any bearing on the efficiency of different auction formats. In addition, some of the phenomena we discovered, such as the collusion effect and the impact of the “final round” approach on bidders’ bidding pattern, many need to be further analyzed.

There are some limitations in our experiment setup. For example, only four bidders were involved in each auction. It would be interesting to see what would happen to the collusion effects if we increase the number of bidders. Also, our experiment was conducted in controlled lab environment and the subjects were college students. It is necessary to verify our findings in a real online business auction environment. For future work, we could identify some products whose attributes spread along the commodity-specialty, tangible-intangible spectrum, track their auctions for a period of time, and compare the results with those of ours.

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