TIME AND ONLINE AUCTIONS

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ABSTRACT

Online auctions differ from traditional auctions in several ways, but perhaps one of the most significant is the amount of time that bidders interact with the auction mechanism. This paper examines past findings in online auctions and discusses three psychological mechanisms through which bidders may increase their valuations of an item through interaction with the auction mechanism over time. In doing so, this paper provides a theoretical lens through which previous empirical studies of online auctions can be interpreted and serves as a guide for future research.

Keywords: Behavioral economics, prospect theory, online auctions, sniping, auction equivalence

1. Introduction

With the rapid growth of the Internet, online auctions have become a popular and efficient way for both businesses and consumers to exchange goods while allowing businesses to reinvent the way that they manage their relationships with trading partners [Smith et al. 2000]. Consumers have been quick to adopt online auctions for the purchase and sale of everything from collectibles to automobiles. While these online auctions are typically structured around well-studied auction types, past research comparing online and offline auctions has yielded mixed findings [Lee 1998; Overby & Jap 2009]. As a result, numerous researchers have called for an examination of the theoretical and empirical impacts of moving auctions to the online environment [Klein & O'Keefe 1999; Pinker et al. 2003; Van Heck & Vervest 1998].

The increased use of information technology for both online and offline auctions has enabled empirical researchers new opportunities to analyze data on auction outcomes [Bajari & Hortacsu 2003; Katkar & Reiley 2006; Kuruzovich et al. 2010; Lee 1998; Lucking-Reiley et al. 2007] and conduct field experiments [Lucking-Reiley 1999]. These efforts have yielded a greater understanding of mechanism design and the behavior of bidders and sellers—providing empirical tests of auction theory and examining the impact of features unique to online auctions. These studies have presented three particularly intriguing findings not predicted by traditional auction theory. First, Lee [1998] found that an electronic implementation of a wholesale auction resulted in higher overall prices than in the earlier offline market. Second, Lucking-Reiley [1999] found a lack of equivalence between Dutch and first-price sealed bid auctions in an online field experiment—findings which differed both from theoretical predictions and prior offline experiments. Finally, several studies have observed the prevalence of bid "sniping," in which the majority of the bids arrive in the final minutes or seconds of the auction [e.g., Bapna 2003; Ely & Hossain 2009; Glasner 2002; Ockenfels & Roth 2002].

A key difference between the online auctions and the traditional "live" auctions is *the length of time over which the auction occurs*, and this paper suggests that this is important to understanding differences between online and offline auctions. Empirical studies of auctions have reported the significance of the amount of time in the determination of final price for items being auctioned [Lucking-Reiley et al. 2007]. The mechanism proposed to justify the higher revenues of longer auctions has been the arrival of bidders with higher valuation. This paper discusses alternative causal mechanisms through which the extended time of Internet auctions can influence bidder valuation and explain prior empirical studies. In order to help understand how consumers interact with auction mechanisms over time, this paper will draw upon the extensive research on individual decision-making originating in prospect theory [Kahneman & Tversky 1979] and the theory of mental accounting [Thaler 1980], in which individuals are found to make decisions in ways which differ from traditional utility theory.

Over the past 25 years, prospect theory has been recognized as a modification of traditional economic theory that in some cases more accurately explains how individuals actually make decisions. Some examples where prospect theory has been applied include: the labor decision of New York City cab drivers [Camerer et al. 1997], the

reluctance of investors to realize losses [Odean 1998], public policy decisions [Quattrone & Tversky 1988], and consumer purchase behavior [Thaler 1980]. While the endowment effect and decision framing have been discussed in the context of online auctions [Ariely & Simonson 2003; Heyman et al. 2004; Wolf et al. 2009], this paper provides a more thorough discussion of the role of time in framing of online auctions and examines the insights that can be gained from previous studies on individual decision-making. In doing so, this paper both integrates empirical findings from past research and highlights potentially significant areas for future investigation.

This paper makes several contributions to the literature. First, it examines the importance of time as an embedded design component of online auctions. Though online auctions take place over a much longer period of time than traditional offline auctions, the implications of this for bidder valuation processes has not been critically examined. Second, it uses findings from the behavioral economics literature to make specific predictions (propositions) regarding how bidder valuations can be expected to vary with time in the interaction with online marketplaces. These predictions can be utilized as a guide for future research in the empirical and experimental study of online auction outcomes. Finally, this research shows how time and findings from the area of behavioral economics can be used to explain a variety of related empirical findings from online auctions, including areas of auction design, comparisons between online and offline auctions, and patterns of bid sniping.

In §2, short overviews of the valuation model of traditional auction theory and prospect theory are given, along with an overview of how online auctions and behavioral economics has been used to explain auction outcomes. In §3 the impact of the bidder decision frame is examined and the mechanisms through which valuations are impacted by time are presented. Section 4 discusses the implications of this work, with specific emphasis on how it can explain prior empirical findings in online auctions. Finally, §5 indicates directions for future research and concludes the paper.

2. Theoretical Background

2.1. Rational Choice Model of Auctions

In the normative model of rational choice, upon which auction theory is based, individuals make decisions in order to maximize utility. Auction outcome is a function of auction format, the distribution of the bidder valuations, and the amount of information that bidders have about the valuation of others participating in the auction. The study of auctions is often segregated into two types: those with private valuations and those with common valuations. In the *private valuation* model, individuals have a reservation price (V) at which they value an item. In the case of the *common valuation* model, an item has a value (V), and each individual has an estimate of that value. The value individuals attach to an item changes as the individuals receive signals (t) from others about their valuation. If all private signals were available to the bidder i, in an auction with n bidders the bidder would have a valuation equal to $V_i(t_1,..,t_n)$. In the bidding process, the bidder attempts to maximize her utility by obtaining the item at the lowest price possible, with the criteria that the item price (p) is less than the bidder's reservation price. Following this rule, the utility provided by the item (purchased at a price less than the reservation price plus the remaining assets) is always preferable to the original asset position.

The normative model of rational choice attributes bidder decision-making to the initial estimate of valuation and increases or decreases resulting from signals that are received from other bidders. It is assumed that the model provides not only a theoretical way of investigating the normative behavior of completely rational agents, but also a way to describe the actual choices of individuals [Arrow 1982; Friedman & Savage 1948]. However, a significant line of research has questioned the normative model of rational decision-making in the prediction of the behavior of individuals [e.g. Kahneman & Tversky 1979; Kahneman & Tversky 1982; Tversky & Kahneman 1981; Tversky & Kahneman 1992]. Prospect theory and the research that has grown from it have repeatedly shown the importance of decision frame in bridging the gap between the normative models of decision-making and actual empirical results. This extensive research provides a theoretical guide for understanding the actual decisions of bidders in the context of the auction.

2.2. Prospect Theory and Framing Effects

Prospect theory [Kahneman & Tversky 1979] has provided an extension to standard utility theory that has been very successful in explaining empirically observed exceptions to the standard utility model. The theory separates the decision-making process into two steps: (1) the framing of the decision and (2) the valuation of the item being auctioned.

The term *framing* has been used in the prospect theory literature to explain both the formulation of the question outside of the individual and the internal formulation that the individual develops when making a decision. By utilizing the term *framing* to refer to both actions, however, this terminology has "blurred the important distinction between what decision makers do and what is done to them: the activities of editing and mental accounting on one

hand and the susceptibility to framing effects on the other" [Kahneman & Tversky 2000, p. xiv]. As these two framing issues are quite distinct in how they relate to online auctions, different terms are used.

The term *external-framing* refers to how problems are phrased external to the individual making the decision. Research indicates that even when presented with equivalent problems, decisions will be strongly influenced by how the problems are phrased. This specifically contradicts the property of *invariance*, in which the equivalent formulation of choices should result in the same preference order [Arrow 1982], that is a part of the rational model of decision-making. The term *internal-framing* is used to refer to how decision makers formulate their view of a situation. Research supports the concept that an individual's decisions do not always maximize overall assets. Rather, individuals form an internal reference point and then make decisions in terms of gains and losses from that reference point. Changes in reference point can result in changes of decision.

In the valuation phase of the decision-making process, individuals have been shown to obey an s-shaped valuation curve that is concave for gains and convex for losses [Kahneman & Tversky 1979]. The curve is also much steeper for gains than for losses, implying that individuals experience more pain from a loss than the pleasure they experience from an equivalent gain. An example of both framing and valuation was presented in Kahneman and Tversky's [1982] work on prospect theory:

> *"Imagine that you are about to purchase a jacket for $125 and a calculator for $15. The calculator salesman informs you that the calculator you wish to buy is on sale for $10 at the other branch of the store, located a 20 minute drive away. Would you make a trip to the other store?"*

For the question above, 68% of the respondents were willing to drive to the other store in order to save the $5 on the $15 calculator. However, when the values of the calculator and the jacket were switched ($125 for the calculator and $15 for the jacket), only 29% of the subjects were willing to make the trip to save $5 on the $125 calculator. In this case, external-framing refers to how the problem was phrased by the researcher. The internal-framing of the individual views the $5 savings with respect to each individual purchase, rather than the combination of purchases. In other words, both expenditures are assigned a topical account in the individual's internal-frame. Decisions are made relative to the gains and losses from the account, when compared with the item price [Kahneman & Tversky 1982; Thaler 1985]. Saving $5 on a $15 purchase is worth traveling to another store for, but $5 on a $125 purchase is not. Both external-framings of the question, however, lead to the same overall asset position.

2.3. Online Auctions

Auctions, depending on the type, consist of one or more decisions that bidders make regarding the valuation of an item. Bidders first need to decide whether to place a bid, and if they decide to place a bid, they must specify the amount. Nearly all auction websites utilize a variant of the English auction [Lucking-Reiley 2000], referred to as the second-price, sealed-bid auction. In these auctions, individuals enter their maximum bid, or a "proxy bid," and the auction mechanisms automate the bidding process to ensure that the person with the highest proxy bid is in the lead of the auction. The highest bidder wins the auction but pays the second highest bid plus a small increment. Individuals can enter a proxy bid at any point up until the end of the auction. The ending rule of the auction—i.e., whether an auction has a fixed or flexible ending time—has been found to be important in influencing bidder strategy in online auctions [Ariely & Simonson 2003].

Researchers have utilized empirical and theoretical work on online auctions as a way to examine the influence of auction features such as feedback mechanisms [Ba & Pavlou 2002; Livingston 2005; Resnick & Zeckhauser 2002] and buy-it-now options [Anderson et al. 2008; Mathews 2004; Onur & Tomak 2009; Standifird et al. 2004]. In addition, other researchers have examined issues of auction characteristics [Bland et al. 2007; Gilkeson & Reynolds 2003], bidder heterogeneity [Bapna et al. 2004], multiunit auctions [Bapna et al. 2001], auction dynamics [Dass 2011; Wang et al. 2007], and channel selection [Walczak et al. 2006]. Overall, this work has been able to develop theory and use data from online auctions to obtain a greater understanding of both mechanism design and behavior of bidders and sellers.

Experiments using online auctions have further enabled researchers to examine how and when theoretical models of auctions fail to predict outcomes. Lucking-Reiley found a lack of auction equivalence when comparing a variety of auction types [Lucking-Reiley 1999]. Ariely and Simonson [2003] found that individuals often overpay in auction channels relative to lower-priced options from fixed-price channels. Heyman and colleagues [2004] identified an endowment-like effect driving bidder valuation higher from being in the lead of auctions. By using experiments, this work has been able to directly link mechanism design with auction outcomes.

2.4. Online Auctions and Multiple Proxy Bids

If individuals experience some type of transaction cost when placing a bid, the most efficient bidding strategy would be to enter a single proxy bid at the reserve price. For items in which the individual has a private valuation,

entering a single proxy bid at that valuation would minimize the transaction cost associated with entering bids. However, an examination of real bidder data shows that this is rarely the case. There are several potential explanations for this behavior.

According to standard economic theory, the decision to increase a proxy bid from one point to another would only result from signals that the item has a higher value than originally predicted. For items in which there is no known valuation, this is a likely explanation. However, for items such as new electronic goods—where reference prices from online fixed-price channels such as Amazon.com can easily be found—it is unlikely that bidders will obtain more information about the product's value through other bidders' signals. Kauffman and Wood [2004] have suggested that the increase in valuation may result from a "herd mentality" or "bandwagon effect," in which individuals increase their valuation because others increase their valuation.

One reason some individuals may place more than one bid is that they have a positive utility for participating in the auction. A previous study of business-to-consumer auctions found that a certain category of bidders (participators) experienced a small positive utility from bidding in online auctions [Bapna et al. 2003]. They enter more than one bid, usually just enough to put them in the lead. They then monitor the auction and always enter a minimum bid. In the online B2C auctions examined, however, individuals do not have the advantage of the same proxy mechanism as bidders in the eBay-style auction. Bidders trying to obtain an object at the lowest price have an economic incentive to increase their bid by the minimum increment, as otherwise some bidders may pay more than others and receive the same product, a situation that may undoubtedly cause dissatisfaction among some consumers.

The reasons for multiple proxy bids discussed above can be placed in two categories: (1) increase in the valuation of a good or (2) execution of a bidder strategy. Though it is clear that in some cases, multiple proxy bids may result from an increase in valuation from signaling or execution of a bidder strategy, this paper presents an alternative explanation of why individuals increase their valuation of an item and therefore enter more than one proxy bid. This research suggests that a bidder may increase their valuation for an object through their interactions with the auction mechanism over time, making time a very relevant component of auction design.

The bidder's interaction with the auction mechanism determines their exact decision frame. Prospect theory supports the claim that the decision frame must be considered as an integral part of how individuals actually make decisions [Kahneman & Tversky 1979]. Though the research growing from prospect theory addresses the types of situations faced by bidders, namely decision-making under uncertainty, auction researchers have largely ignored prospect theory. There are several psychological processes found in the individual decision-making literature that have important consequences for the outcomes of auctions, particularly in the online domain. These psychological processes are particularly important in the online domain because of the length of time that the bidders interact with the auction mechanism. In order to understand the consequences of framing in online auctions, one must first consider the decision frame faced by bidders in a typical online auction. These mechanisms are also similar to the endowment effect identified as relevant to understanding bidder valuation [Heyman et al. 2004; Wolf et al. 2009].

3. Time and Bidder Valuation

There are several components of the online auction that make up the internal frame of the bidder when entering a bid. These include whether or not previous bids were entered, whether the previous bids placed the individual in the lead of the auction, the amount of time the individual spent in the lead, the amount of time that has passed since the previous bid, the amount of time remaining in the auction, the amount necessary in order to give the individual a chance to win the auction relative to the overall previous bid. Unlike live auctions, which take place in one time period, online auctions take place over multiple time periods. The bidders in a typical online auction have multiple chances to make a decision regarding their highest valuation and place a bid. In order to fully understand the framing of the bidding decision, the various components of the decision frame must be analyzed in the context of previous decision-making literature.

3.1. Bidder Endowment

During the online bidding process, individuals may possess the lead for extended periods of time. The endowment effect [Knetsch 1989; Knetsch & Sinden 1984; Thaler 1980] indicates that possessing an item, even for a short period of time, may lead to a valuation much higher than would be expected. Individuals who have an item removed from their possession (endowment) view it as loss [Thaler 1980]. In Knetsch [1989], when students in an experiment were given either a mug or a piece of candy, an overwhelming majority (90%) decided to keep the item that they were given rather than trade it for the other item, even though a group of students not given an item indicated that about half would prefer a candy and half would prefer a mug. Studies of the online auctions have further indicated that bidders appear to experience the endowment effect, such that interacting with the auction over time leads to higher prices [Heyman et al. 2004; Wolf et al. 2009].

Individuals participating in an auction may have an expectation or hope of winning an item. Though they do not actually physically possess the item during the auction, they do possess the lead of the auction and may experience a similar increase in valuation resulting from being in the lead. When being outbid, individuals may feel a sense of loss as if something they had nearly possessed had been taken away. Because, according to prospect theory, losses are more highly valued than gains [Kahneman & Tversky 1979], the perceived valuation resulting from the loss of the item to another bidder $-V(p_{i+1})$ may be greater than the original proxy bid $V(p_i)$. This series of mental transactions, $V(p_i) - V(p_{i+1})$ would lead the bidder to increase their valuation of the item above the original valuation.

P1: The amount of time in the lead of an auction will influence an individual's willingness to increase her final valuation for an item.

P2: The number of times a bidder gains the lead of an auction will influence that individual's willingness to increase her final valuation.

3.2. Hedonic Framing and the Weber-Fechner Law of Psychophysics

In the bidding process, the initial bid expenditure and the subsequent bid increments are made at different points in time. There are two important findings in the decision-making literature that indicates that the timing of expenditures may have a significant influence on the valuation of items: hedonic framing, and the Weber-Fechner law of psycho-physics.

The principles of hedonic framing [Thaler 1985] address the implications from prospect theory that expenditures occurring at different times are in some cases not valued as strictly additive. For example, in some cases the valuation of two payments may be different from that of a single payment. In other words, for two prospects x and y, $V(x+y) <> V(x) + V(y)$. This can be used as a guide to when individuals would prefer a single gain or loss compared with multiple gains or losses.

Hedonic framing predicts that, when possible, individuals will combine a small loss with a larger gain [Thaler 1985]. In the case of auctions, separating the bid *b* and increment *i* into different bidding periods may affect valuation, as the valuation V(b) + V(i) may be perceived as less than a single bid equal to *b* + *i*. If a bidder adjusts their reference frame to the current proxy bid amount, they may see the possibility to combine a small loss, the incremental bid, with the pleasure of obtaining an item. This principle, in auctions, leads to the observation that individuals may be more accepting of small expenditures made over time. This would result in higher valuations for items in which individuals are able to make small bid increments over time.

The Weber-Fechner law of psychophysics is an additional mental accounting mechanism that may result in an increase in bidder valuation over time. This law states that noticeable difference of a stimulus is proportional to the stimulus [Stigler 1965; Thaler 1980]. Thaler [1980] applied this to predict that individuals are indifferent regarding an amount of money (P_{Indif}) that is a certain percentage (K) of an overall purchase (P_{Total}), where $K = P_{Indif}/P_{Total}$. This could cause an individual to increase a bid by P_{Indif} if they perceived that this would give them an opportunity to win the item. If, after each bid, the bid frame adjusted to the current bid position, this could result in a bidding war of very small increments, each less than or equal to P_{Indif}. The small increments would lead to higher auction revenues than would be predicted otherwise.

Because of impact of the principles of hedonic framing and the Weber-Fechner Law of Psychophysics discussed above, it is expected that:

P3: The amount of time a bidder interacts with an auction will influence that individual's willingness to increase their final valuation.

4. Discussion

The Internet and the increased use of information technology have enabled tremendous growth in the number of empirical studies on online auctions. This paper suggests that behavioral economics can provide an explanation of the theoretical mechanisms driving empirical findings from past research on online auctions. While the empirical findings are extremely important, connecting and reinterpreting findings through different theoretical lenses can provide both important insights and directions for future research.

This research suggests that time may be playing an important role in the decision-making process of individuals using online auctions, driving differences between theoretical predictions and reality. Although online auctions take place over a much different time horizon than traditional auctions, this difference has been discussed little in past work examining online auctions. Specifically, in applying a lens of behavioral economics, this paper further explores how the mechanism discussed here can help explain past research examining: (1) differences between online and offline auctions, (2) differences in mechanism design, and (3) the phenomena of late bidding or sniping.

4.1. Comparison of Online and Offline Auctions

Lee [1998] examined the implementation of an online auction for used automobiles in Japan and asked the

question, "Do electronic marketplaces lower the price of goods?" In the study, price data for items were analyzed both before and after the implementation of an electronic auction marketplace. The surprising results showed that prices were actually higher for the online auction than for the offline auction. There are several possible explanations for the observed increase in prices associated with the transition from offline to online auctions. First, the online market included a quality rating system that the offline version did not have. This may have provided direct value to auction participants. Second, low-quality cars may have been screened out of the auction altogether, such that less quality uncertainty [Akerlof 1970] associated with the cars in the auction leads to a higher price. Similar findings by Overby and Jap [2009] indicate that when given an option between two markets, sellers will utilize online markets for goods with lower quality uncertainty, supporting the second mechanism as justification for at least part of the difference in prices.

Interpretation of the analysis presented here provided several other possible psychological mechanisms that could cause prices for an online marketplace to be higher than an offline marketplace. In a typical ascending-price offline auction, individuals possess the lead for only a very short period of time, possibly only seconds. There is very little time for an individual to be in the lead and for the endowment effect to have an impact on valuation. Rather than having an expectation of possessing an item for an extended period of time, the bidder is engaged in a short transaction in which there is little time to interact with the auction mechanism.

Bidding during a typical online auction, however, takes place over an extended period of time. Because of this, it is expected that the bidder's decision frame may be different at the beginning of the auction than at the end of the auction. As the auction progresses, the bidder's internal-frame shifts from the starting bid amount to the current bid amount. This could enable the mechanisms involving hedonic framing or the Weber-Fechner law of psychophysics to initiate bidder responses that increase the resulting final sale price for the auction.

4.2. Auction Equivalence

Lucking-Reiley [2006], in a pioneering field experiment, empirically compared Dutch auctions with first-price auctions and English auctions with second-price auctions in an online environment. The surprising results (listed in Table 1) contradict traditional auction equivalence theory and previous lab experiments. Theoretical predictions based on the rational model of consumer choice predicts the equivalence of Dutch, first-price, second-price, and English auctions for risk-neutral bidders [Vickrey 1961], as the dominant strategy in each format is to bid one's valuation. Previous lab experiments on auctions, however, resulted in significant differences from the rational model. Dutch formats for auctions have experimentally yielded lower revenues than first-price auctions [Coppinger et al. 1980; Cox et al. 1982; Cox et al. 1983]. Lab experiments involving English auctions have indicated lower revenues for English auctions [Coppinger et al. 1980; Kagel et al. 1987], in which bidders bid their valuation, than for second-price auctions, in which bidders bid more than their valuation [Kagel et al. 1987; Kagel & Levin 1993].

Lucking-Reiley [2006] found that the Dutch auction produced a 30% higher valuation than the first-price auction format. In addition, he found that English auctions produced approximately the same valuation as second-price auctions, though specific bidder comparisons indicated that bidders, when bidding in each auction, typically bid higher in the English auction than in the second-price auction. In examining the real world experiments compared with the previous lab experiments, a key additional insight can be gained by examining the lengths of the auctions and the opportunity for the bidder to interact with the auction mechanism over time.

In first and second price auctions, bidders must calculate a valuation and enter a single bid at a single point in time. Both the initial valuation of the item and the bidding occur during the same time period. Thus, the bidders cannot interact with the auction over time and the online and offline versions of the auctions occur over the same time period. The English and Dutch auctions in Lucking-Reiley's experiment, however, lasted several days. As a result, there was an opportunity for the individuals to increase their valuation of items through the interaction with the auction mechanism over time. This is a significant difference from previous lab experiments, in which individuals take part in a series of auctions over one session.

Reinterpreting Lucking-Reiley's experiment shows significant support for the theoretical mechanisms described here. Both Dutch and English auctions were significantly higher in revenue when compared with first-price and second-price auctions, respectively, in the online experiment than would have been predicted by previous lab experiments. Lucking-Reiley referred to the physiological anchoring effect of the Dutch clock as a potential cause of the increased revenue of Dutch auction when compared with first-price auctions [Engelbrecht-Wiggans et al. 2006]. The examination of the role of time in this paper expands on this observation and incorporates prospect theory and the theory of mental accounting. Evidence from other contexts provides information on the importance of external framing on bidder decision-making. External framing in this case refers to how the decision problem is presented to the bidder. By beginning with a high valuation, the individual is given a mental reference point. This anchoring effect, when allowed to influence the bidder over time, may lead to valuations consistent with the starting prices of

the auctions—i.e., Dutch auctions would be anchored high while English auctions would be anchored low, consistent with the findings reported in Table 1.

4.3. Late Bidding or Sniping

Numerous researchers have noted the prevalence of late bidding, or "sniping" in online auctions. Bajari and Hortacsu [2003] note that in their survey of eBay coin auctions the median winning bid occurs after 98.3% of the total auction has been completed. Roth and Ockenfels [2000] suggest that the late bidding strategy results from the private information model. They suggest that bidders are uncertain of the value of items, for sale and resale, in online auctions. Bidders are therefore unwilling to give others information about their valuation of a good by early bidding. Bidding early would give other individuals a better idea of the actual value of the item, as the average of multiple private valuations is a more accurate valuation than just a single valuation. They further suggest two possible equilibrium states. In the first, an agent bids their valuation early and in the second bidding occurs at the last minutes of the auction. The last minute bidding further suggests that bidding late represents a type of bidder collusion, in which "price wars" are avoided and all bidders benefit.

The Roth and Ockenfels model, however, has been challenged on several counts. First, Nawar [2003] shows that the "last-minute bidding" is not in fact an equilibrium. Bajari and Hortacsu [2002] suggest that the actual reason is more complicated, as last-minute bidding has been observed in auctions with private valuations, in which individuals do not change their valuation for an item even if they know others' valuation for the item. This is likely to be the case for items such as new electronics, in which reference values of the items are available, and each bidder should know their private valuation.

Interpretation of bid sniping in the context of the theoretical mechanisms described here suggests an alternate explanation. If individuals do, in fact, increase their valuation for an item through the interaction with the auction mechanism as presented here, bid sniping would be a rational strategic response to the mechanisms on two levels. First, individuals who practice bid sniping are not allowing the individuals who do not practice bid sniping a chance to increase their valuation though mechanisms of the endowment effect, hedonic framing, or Weber-Fechner law of psychophysics. Individuals are in fact behaving strategically by bidding at the last minute to obtain an item for a lower price than they would have otherwise by bidding early in the auctions. By not allowing the other individuals to interact with additional higher bids, they are giving themselves the chance to obtain the item at a lower price than they would have otherwise. Allowing other bidders additional time periods to make a decision regarding their valuation for an item would only result in an increase in the overall price.

A second possible reason for late bidding not previously examined is that individuals may know that they will interact with the auction mechanism in the ways presented here, therefore increasing their valuation and increasing the chance they will experience "winners' curse." There is significant evidence that individuals selectively utilize specific mechanisms in order to maintain self-control with regard to purchases. Strotz [1955] first introduced the concept of *precommitment* through a quote from the Odyssey: "…but you must bind me hard and fast, so that I cannot stir from the spot where you will stand me….and if I beg you to release me you must tighten and add to my bonds." He further defined precommitment as a way that individuals deal with changing preferences. By identifying areas in which preferences are expected to change and making a precommitment to a particular decision, individuals are able to act consistently from one period to another.

Thaler [1980] further examined this as a problem of self-control, modeling an individual as a *planner* and a series of *doers*. The planner acts in the first time period and the doers act in subsequent time periods [Thaler 1980]. By creating a control in the first time period, the planner is able to exert control over subsequent doers. Examples of this type of self-control device include Christmas clubs, drug abuse centers, diet clubs, and smoking clinics [Thaler 1980]. Through late bidding, individuals are able to exert a measure of self-control in the bidding process, acting rationally by limiting themselves to one bidding transaction. Placing a bid at the last minute does not allow any potential increase in valuation resulting from the interaction with the auction mechanism through the processes presented here. Placing a bid at the last minute does not allow the individual to actually possess the lead for an extended period of time. They, therefore, shield themselves from any type of loss associated with the endowment effect. This may allow them to both avoid the sense of loss associated with losing something in their endowment and prevents them from acting irrationally and bidding up the item past their original valuation. By bidding in the final seconds of the auction, they are able to ensure that they will not be tempted into a bidding war with others participating in the auction. The *planner* ensures that his rational maximum bid is executed by acting in the same time period as the *doer*. Future *doers* do not have time to interact with the auction and increase their valuation.

5. Conclusion

As noted, this research makes a contribution to the understanding of time as an embedded but infrequently discussed component of online auctions. Online auctions provide bidders and sellers with a much longer period of

time to interact with the auction mechanism. Research from the area of behavioral economics provides the theoretical foundation for understanding the implications of time for bidder strategy.

An additional contribution of this work is to provide a series of related propositions that can be utilized as an important area of future empirical and experimental work. This research suggests the need for specific experimental comparison of different auctions using different time periods while controlling for the population of bidders able to view an item. As the process of bidder arrival happens throughout the online auction, it is necessary to separately evaluate the physiological mechanisms and associated impacts of interacting with auctions over time.

Finally, this research provides an integrated interpretation of three related empirical findings from past research—including the implications of auctions moving online, comparison of different auction mechanisms in an online context, and late bidding or "sniping." There may be a variety of complex phenomena that are driving these behaviors, but by showing the relevance of time and past work in behavioral economics in interpreting past empirical results this work provide greater understanding as to how individuals actually make decisions in the use of online auctions.

Table 1: Empirical Findings of Auction Models

Empirical Findings	**Overall**	**Pairwise**
Previous Lab Experiments [Coppinger et al. 1980; Cox et al. 1982; Cox et al. 1983]	D < F	
Lucking-Reiley [2006]	D > F	D > F
Previous Lab Experiments [Coppinger et al. 1980; Kagel et al. 1987]	S > E	
Lucking-Reiley [2006]	S = E	S < E

Notes:

a. Abbreviations:

D = Dutch auction revenue
F = First-price sealed-bid auction revenue
S = Second-price sealed bid auction revenue
E = English auction revenue

b. D = F = S = E in theoretical models of risk neutral bidders.

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