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The Effects of Business-to-Business E-Commerce on Transaction Costs: Description, Examples, and Implications

by

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Abstract

In this paper, we study the changes in transaction costs from the introduction of the Internet in transactions between firms (i.e., business-to-business (B2B) e-commerce). We begin with a conceptual framework to organize the changes in transaction costs that are likely to result when a transaction is transferred from a physical marketplace to an Internet-based one. Following Milgrom and Roberts (1992), we differentiate between the impact on coordination costs and motivation costs. We argue that it is likely that B2B e-commerce reduces coordination costs / increase efficiency. We classify these efficiencies into three broad categories – (1) process improvements; (2) marketplace benefits; and (3) indirect improvements. At the same time, B2B e-commerce affects motivation costs. In particular, we discuss the impact of the introduction of e-commerce on informational asymmetries. Second, we present some early examples of such effects from three companies from which we have been able to obtain data. We measure the process improvements for all three companies. We measure marketplace benefits for one company. We then attempt to measure motivation costs for one company by comparing the performance of an Internet marketplace to a physical marketplace. We are able to document potentially large process improvements. We document one example of large marketplace benefits. We find mixed evidence of motivation costs.

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I. Introduction.

By separating the physical and information flows connected with each transaction, the Internet has provided radically new ways to trade goods. The choice between an Internet-based marketplace and a physical one depends on the transaction costs of each of these two alternatives. More precisely, this choice depends on which of the two marketplaces, physical or electronic, better “economize[s] on bounded rationality while simultaneously safeguarding them against the hazards of opportunism.”¹

In this paper, we make an early attempt at studying the changes in transaction costs from the introduction of the Internet in transactions between firms. These transactions are more commonly known as business-to-business (B2B) electronic commerce. We begin with a conceptual framework to organize the transaction costs gains and losses that are likely to result when a transaction is transferred from a physical marketplace to an Internet-based one. Following Milgrom and Roberts (1992), we differentiate between the impact on coordination costs and motivation costs. Concerning coordination costs, we suggest e-commerce produces efficiencies into three broad categories – (1) process improvements; (2) marketplace benefits; and (3) indirect improvements. Concerning motivation costs, we discuss the impact of the introduction of e-commerce on informational asymmetries.

We then discuss how alternative B2B marketplace structures economize differently on transaction costs, and discuss when each model is likely to be most appropriate as a function of the characteristics of the transaction. We also provide some

¹ See Williamson (1985), p. 32.

early examples of gains derived from the introduction of B2B in three companies for which we have data.

In studying how alternative organizational forms solve the problem of economizing on the costs of transacting, this paper is a descendant of Coase (1939). Our paper, however, takes a substantially different tack from previous empirical literature within this tradition. Previous work has largely been concerned with studying when the “the market” should be preferred to “the firm,” or occasionally, when each of these should be preferred to different types of long run arrangements. Little work exists, to our knowledge, on the transactions costs of alternative spot market arrangements.

A second, important difference with previous transaction costs literature concerns the types of transaction costs that we study. Since Joskow’s (1987) econometric study of the duration of contracts, the relation between asset specificity and organizational form has been the main concern of empirical work on transaction costs.² We take a broader approach here, studying both incentive or motivation-related transaction costs and those related to coordination problems in different spot market arrangements.

Our approach is also new in its focus on B2B electronic commerce (or e-commerce). Given its recent emergence, there is very little (if any) extant empirical work that studies B2B e-commerce, i.e. commerce in which one business buys from or trades with another business. Most of the early press and academic work on electronic

² See e.g. Crocker and Masten (1993), for natural gas, and Goldberg and Erikson (1987) in petroleum coke, and Lyonss (1994) study of subcontracting in the engineering industry. These papers findings are consistent with the prediction that more specific transactions require longer, more formal contracts. The Lafontaine (1992), Lafontaine and Slade (1997,1998) studies on franchising, on the other hand, have found that specific investments are not very important for franchising, and have studied the determination of royalty rates in these contracts. Finally, Homstrom and Milgrom (1991) find that previous work on the importance of non-selling activities by Anderson (1995) and Anderson and Schmittelein (1994) suggest that *measurement costs* are a key determinant of the extent to which incentive issues matter.

commerce centered on business-to-consumer (B2C) companies like Amazon, AOL, and others. It seems likely, however, that the Internet will have a larger impact on B2B e-commerce. In particular, B2B e-commerce has the potential to generate substantial efficiencies.³

The paper proceeds as follows. We begin by providing a simple framework to analyze the ways in which B2B e-commerce affects transaction costs. Second, we discuss how alternative B2B e-commerce models (as classified by Kaplan and Sawhney [2000]) economize on transaction costs. Third, we present some early examples of such efficiencies from three companies from which we have been able to obtain data. We estimate the process improvements for both companies. We then attempt to compare the performance of an Internet marketplace to a physical marketplace for two of these companies. We hope to increase the number of examples in a subsequent draft.

II. A framework for analyzing changes in efficiency due to B2B e-commerce

As mentioned above, B2B e-commerce has the potential to substantially reduce transaction costs in inter-firm trade. Following Milgrom and Roberts (1992), we classify transaction costs in two categories: costs associated with the problem of *coordination* and costs associated with the problem of *motivation*. Shifting a transaction from a physical environment to the Internet has the potential to affect both types of transaction costs.

³ E.g., see Sawhney and Kaplan (1999).

A. *Coordination costs*

Coordination costs are “related to the need to determine prices and other details of the transaction, to make the existence and location of potential buyers and sellers known to one another, and to bring the buyers and sellers together to transact.”⁴ We find it useful to classify the effects of the Internet on coordination costs into two general categories: process improvements and marketplace benefits. Below, we describe the potential Internet-based improvements in these coordination costs. It is important to recognize (and we then discuss) that reductions in transactions costs are likely to lead to additional direct and indirect benefits. We use this framework in later sections to study the gains attained in some examples.

1. *Process improvements*

B2B e-commerce can improve efficiencies by reducing the costs involved in an existing business process. Such an improvement may take place in two basic forms. First, it may simply reduce the cost of an activity already being conducted, as when a transaction that is currently conducted by phone or fax is automated. In other instances, the Internet provides an opportunity to redesign the existing process.⁵

The methodology we use to measure or estimate the value of process improvements is straightforward. First, we describe and measure the costs of the activities involved in the existing process in detail. Second, we describe and measure the costs of the process using B2B e-commerce. The difference, if any, is the value of the process improvement.

⁴ Milgrom and Roberts (1992), p. 28.

2. *Marketplace benefits*

We classify the second way in which B2B e-commerce can reduce coordination costs as marketplace benefits (or direct information improvements). These benefits come in some of the following forms.⁶ The Internet potentially reduces a buyer's cost of finding suppliers because it is less expensive to search for products and compare prices over the Internet than it is to read catalogs and make phone calls. Conversely, sellers can reach more potential customers at lower cost. As a result, buyers will find sellers they might not have otherwise found. EBay is an example of this on the consumer side. (eBay is C2C – consumer-to-consumer.)

Second, the Internet potentially provides buyers with better information about product characteristics (including prices and availability) because it is less expensive to obtain.

Third, the Internet potentially provides better information about buyers and sellers. This is particularly relevant in the area of credit, which we study in our examples.

On the other hand, conducting the transaction over the Internet may also increase these transaction costs, due to the buyers inability to physically inspect the merchandise object of the exchange. This may be the case when buyers need to match their needs for objects based precisely on a characteristic that requires physical inspection. For example, consider the second hand car example that we explore in depth later. Suppose that dealers in a particular location sell cars to a lower income, older consumer who takes good care

⁵ See Kaplan and Sawhney (2000). They also provide a summary description of Autodaq.com which we describe in more detail below.

⁶ Also, see Phillips and Meeker (2000).

of the cars, while dealers in another location cater to lower income handy-men. Holding all the observable characteristics constant, dealers in the first location will be looking for cars in perfect condition; while dealers in the second location will be looking for cars in bad, but repairable condition. If the condition of the car is hard to communicate without hearing the motor and looking at the car, it will be difficult to distinguish between these cars in an Internet auction. As a consequence, the matching of cars with buyers may be worsened. It is important to note that this effect takes place regardless of the fact that the composition of supply of cars is unchanged (no adverse selection).

Estimating these costs and benefits is appreciably more difficult than estimating the process improvement benefits. One place to look – and one for which we have data – is at the prices buyers pay. Lower prices for buyers are a likely result of lower search costs and better matching. Unfortunately, lower prices are not proof of marketplace efficiencies because it is possible that lower prices represent (1) reductions in seller processing costs; or (2) a reallocation of the surplus of the transaction.

Other places to look include the amount of trade and prices sellers receive. If B2B e-commerce delivers marketplace benefits, trade should increase. Ebay is a clear example of this in that trade occurs that would not occur otherwise. Higher prices for sellers would represent better matching. Again, it is likely that lower customer acquisition costs would reduce prices.

3. *Direct and indirect effects of coordination costs reductions*

Clearly, any reduction in coordination costs results in direct economic gains through a reduction in the cost of undertaking these transactions. It is possible, however,

that other indirect benefit also will arise. As the costs of undertaking spot market transactions decreases, participants in these transactions may adjust their behavior and realize further efficiency gains. These are particularly likely to come from two sources: better information processing, and changes in organizational form.

Better information about future demand through B2B e-commerce may allow a seller to improve its demand forecasts, and use that information to change its production decisions to better match demand. Conversely, a buyer might obtain better information about existing (and future supply), and use that information to change its inventory decisions.

Second, make or buy decisions are likely to be affected. If the Internet is able to produce important decreases in the costs of carrying out transactions in the market, the transaction costs economizing paradigm (Coase [1939] and Williamson [1985]) leads us to predict that fewer transactions will be undertaken inside firms and more will be undertaken in the market.

Again, these effects are difficult to measure.

B. Motivation costs

Milgrom and Roberts (1992) distinguish two types of motivation-related transaction costs: those associated with informational incompleteness and asymmetries, and those associated with imperfect commitment.

1. *Informational incompleteness and asymmetries*

These type of transaction costs are present “when the parties to the transaction do not have all the relevant information needed to determine whether the terms of an agreement are acceptable and whether they are actually being met.”⁷ To the extent that physically observing the merchandise to evaluate its condition is valuable to the buyer, some of that information is lost through the conduct of the transaction through an electronic format.

This loss of information about the object of the exchange may translate into an efficiency loss if adverse selection worsens in virtual auctions. Consider, for example, the original lemons issue in second hand automobile markets (Akerlof, 1970), which will later be our example. Holding observable characteristics constant, sellers might try to sell cars with strange sounding motors exclusively thorough the Internet.⁸ If sellers offer this type of object more frequently over the Internet, buyers willingness to pay for the average object decreases, leading sellers of higher (unobserved) quality to withdraw from the market.

2. *Transaction costs that arise from imperfect commitment*

Milgrom and Roberts (1992) define these costs as deriving from “the inability of parties to bind themselves to follow through on threats and promises that they would like to make but which, having made, they would like to renounce.”

B2B e-commerce has the potential to both increase or decrease these costs. First, by standardizing processes and by leaving an electronic trail, the Internet has the potential

⁷ Milgrom and Roberts (1992).

⁸ Thrid-party inspections can eliminate this problem.

to reduce the costs of imperfect commitment. Alternatively, a buyer may avoid intermediary fees by viewing the product over the Internet, but contacting the seller directly.

III. Alternative B2B e-commerce hubs and transactions costs

B2B e-commerce and B2B intermediaries are structured in a number of different ways. These different intermediary and transaction structures, in turn, have different transaction costs. Again, as with the choice between physical and electronic marketplaces, the choice of electronic marketplace structure is likely to depend on the attributes of the transactions. In what follows, we refer to marketplaces as hubs because they perform functions other than just pure marketplace functions.

In terms of their effect on transactions costs, hubs can be classified⁹ by (1) the nature of prices and terms; and (2) the bias of the marketmaker. We discuss the effect of these different structures on transactions costs, and which structure likely to be superior in different circumstances.

A. Nature of prices and terms

Prices and terms of transactions in B2B hubs are of two basic types.¹⁰ In the first type, prices and terms are fixed. This may also be referred to as an aggregation mechanism. This essentially is an on-line version of a catalog. The value in this is that the Internet aggregates a large number of buyers and sellers under one roof, and reduces transaction costs by “one-stop shopping.” For instance, Chemdex.com allows

⁹ In this section, we rely on and expand on Kaplan and Sawhney (2000).

¹⁰ It is important to point out that a particular marketplace may undertake both types of transactions.

laboratories or hospitals to issue a single purchase order for hundreds of life science products, and Chemdex.com sources these products from a diverse set of suppliers. The aggregation mechanism is static in nature, because prices are pre-negotiated. The aggregation mechanism (also called the “catalog mechanism”) is likely to work best for small or low value transactions where negotiation is cost prohibitive. This can occur for a number of reasons such as a very high number of SKUs (Stock Keeping Units), a highly fragmented supplier universe, a high cost of processing a purchase order relative to the cost of items procured.

In the second type of transaction, prices and terms are not fixed. The hub uses a matching mechanism that creates value by bringing buyers and sellers together to negotiate prices and terms on a dynamic and real-time basis. For example, Autodaq.com brings buyers and sellers of used cars together; Altra Energy makes a market in energy and electricity. The source of value creation in the matching mechanism is improved matching due to improved marketplace liquidity. While catalogs benefit only from the aggregation mechanism, exchanges benefit from both aggregation and matching. The matching mechanism tends to work best for when the value of the transaction is high and negotiation cost is not prohibitive. This is more likely when products can be fully and reliably described on-line and traded sight-unseen.

B. Biased versus neutral hubs

Another dimension that is important in describing a B2B hub is its bias. B2B hubs can be either neutral or biased. Neutral hubs do not favor buyers over sellers or vice versa. Biased ones, in contrast, favor either buyers or sellers. As a result, neutral hubs

are faced with a “chicken-and-egg” problem, in that they need to get buyers as well as suppliers into their system, without compromising their neutrality. They need to be careful in taking equity investments from large buyers as well as from large suppliers, because they can be perceived as biased. The benefit that neutral hubs have is that they are true “market-makers”, because they bring both buyers and sellers together.

Some hubs are one-sided and biased by design. These biased hubs work either for the sellers or the buyers, and help them to negotiate better terms or streamline the buying/selling process. Biased hubs (like neutral hubs) can operate both as aggregators and as matchers. When they favor sellers, biased hubs act as forward aggregators or forward auctioneers. When they favor buyers, biased hubs act as reverse aggregators or reverse auctioneers.

Neutral hubs and biased hubs differ in at least one important way. Neutral hubs are most likely to succeed and add value in markets that are fragmented on both the buyer and seller sides. In such markets, neutral hubs add value both by aggregating and improving matching. If one side of the market is concentrated, these benefits are small or non-existent to the concentrated side of the market. Biased hubs, in contrast, can succeed as long as one side of the transaction is fragmented.

IV. Sample companies

In this version of the paper, we analyze data provided by three B2B e-commerce companies – Autodaq, CapitalThinking, and NutraBid. Therefore, the inputs to our analysis are potentially biased. In addition, one of the authors is an advisor to all of these companies.

Autodaq operates in the used car auction market for large volume sellers – such as rental companies, lease finance companies and manufacturers. The buyers in this market are automobile dealers, not individuals. Rental companies buy new cars, rent them for several years, and then sell them. Lease finance companies lease new cars for several year terms. At the end of the lease term, roughly half of the cars are either purchased by the lessee or by the original dealer. The lease finance company must sell the cars that are not purchased by the lessee or the dealer.

CapitalThinking is a marketplace or hub for the sale and purchase of commercial real estate mortgages. Its goal is to develop an exchange market in which technology matches buyers and sellers with property- and loan-level data and analytics. Its core objective is to increase “the efficiency, depth, and ultimately, the liquidity, of commercial real estate financial markets.”

NutraBid provides technology infrastructure and eCommerce services to the nutraceutical industry. The nutraceutical industry consists of dietary supplements (vitamins, minerals, etc.), functional / medical foods, and natural / organic food and personal care.

Autodaq and CapitalThinking are unbiased hubs where the terms and prices are not fixed, but are determined dynamically. NutraBid is a neutral hub that has performed a number of services including acting as a biased reverse auctioneer – for manufacturers buying from suppliers – and as an unbiased aggregator – for retailers buying from distributors and manufacturers. For NutraBid, we have data on their reverse auctioneer functionality.

We have information on direct process improvements from all three companies. While this information was provided by the companies and may be biased, we believe that the qualitative nature of the information is robust. We have transaction data from two of the companies. These data are not biased in any way of which we are aware or can think of.

In future drafts, we hope to increase the number of examples.

V. Changes in coordination costs: Examples

In this section, we describe and attempt to estimate coordination cost changes for our sample B2B e-commerce companies.

A. Process improvements

1. Autodaq.com

We compare the time and economic costs involved in the Autodaq / Internet process with those in the physical auction process.

In the physical world, when a large volume seller needs to dispose of a car, the seller stores the car, then has it transported to a physical auction site. At the physical auction site, the car is described and inspected. The car also may be reconditioned by the auction site operator. Reconditioning involves repairing minor flaws in the car's exterior – dents, scratches, cracked windows, etc. Dealers travel to the physical auction site and bid on the car. After the auction, the dealers go home and the car is transported again to the winning dealer. The winning dealer performs any necessary maintenance or repairs on the car and any necessary additional reconditioning.

In the Autodaq / Internet system, Autodaq contracts with an inspector who inspects, describes, and photographs the car. For cars coming off lease, this occurs at the dealer from whom the lessee leased the car. For cars coming from fleets, this occurs at the fleet holding lot. The car is then put up for sale in an online auction. Dealers bid on the car over the Internet from their computers. The car is transported to the winning dealer. The winning dealer performs any necessary maintenance or repairs on the car and any necessary reconditioning. If the car does not sell over the Internet, the seller can decide to engage the physical auction process.¹¹

Unlike in the physical auctions which are exclusively run as ascending oral auction, the Autodaq auctions employ a variant of a second price auction in the form of a “proxy bidding” mechanism, in which dealers submit the highest price they would be willing to pay, and Autodaq automatically increases their bid in the presence of other bids by just enough to become the leading bid. The auction format also allows dealers to directly purchase the car by accepting the ask price given by the seller.

In this section, we estimate the value of the process improvement / reduction in transaction costs. In the next section, we attempt to estimate the marketplace benefits.

Table A.1 compares the physical auction process to the Autodaq Internet process, both in terms of time and money. The comparison is made for a typical car coming off lease or from a rental fleet. The table measures time from the day the car comes off lease or is retired by the rental car company to the day the car arrives at the buying dealer. The

¹¹ This process is not unique to Autodaq. Several competitors exist. In particular, the largest operator of physical auctions, Manheim, has an Internet based subsidiary – Manheim Online. Manheim Online differs from Autodaq in that it uses the Internet to list the cars that it has for sale at its physical auction site. In its current incarnation, therefore, Manheim Online, potentially reduces buyer transaction costs, but does not change seller transaction costs.

table measures costs as the economic costs of the process. It does not measure the benefits to a seller from moving from a physical process to the Internet process.

Table A.1 indicates that the Internet process can reduce average total time from 44 days to 6 days. The savings in time come in several areas. First, it typically takes 15 days before lessors and fleet owners ship cars to the physical auction site. Part of the reason for the delay is that the physical auction company does not pick the car up immediately. The other reason is that the seller may attempt to sell the car to the original dealer, but must take some time attempting to determine the appropriate price.

Second, it typically takes 25 days from the time a car arrives at a physical auction site until it is sold. One reason for the delay is that the car generally waits some time before it is reconditioned and reconditioning takes some time. The most important reason, however, is that the physical auction sites try to make each individual auction somewhat homogeneous in terms of the cars available. In other words, sell largely Fords in one auction; largely Toyotas in the next. This makes sense because dealers typically are looking for particular types of cars. As a result, the physical auctions will wait until they have a critical mass of a particular car type before holding an auction.

The “Dollars” columns in table A.1 attempt to value the economic costs of the two processes. The most important costs are the costs of capital and of depreciation. The cost of capital is relatively straightforward. The typical car (in our sample) sells for \$13,483. Each day the car is not sold, the seller is not able to deploy that capital elsewhere. We assume a cost of capital of 8%. This is essentially a debt cost of capital which may understate the true cost of capital for a seller.

The cost of depreciation is based on the fact that sale prices for used cars depreciate with the age of the car. Autodaq estimates that the sales price depreciates by 12% each year.

Autodaq estimates that a dealer travels one hour each way to the auction and buys four cars at the auction. This translates to one-half hour of travel time per car. Conservatively valuing the dealer's time at \$40 per hour, this translates into \$20 per car. Autodaq assumes that the dealer spends five hours at the physical auction. We assume, conservatively, that the dealer does not waste any of these five hours at the auction.

Finally, we assume that reconditioning costs are the same for the physical auction as for the Internet auction. This also is likely to be conservative in that cars bought in a physical auction are usually reconditioned again by the buyer after they are bought. To account for this, we have not added any extra time to the Internet process for reconditioning.

Based on these assumptions, we estimate that the physical auction process has an economic cost of \$450 per car (not including reconditioning). The Autodaq / Internet process has an analogous economic cost of only \$165 per car – a \$285 reduction.

2. *CapitalThinking*

As mentioned earlier, CapitalThinking is a marketplace or hub for the sale and purchase of commercial real estate mortgages. When a commercial purchaser buys a building, the purchaser generally takes out a mortgage to finance the purchase. In the physical world, the purchaser will often hire a mortgage broker who will help the purchaser obtain a loan. In the CapitalThinking / Internet world, CapitalThinking

performs many of the broker functions. CapitalThinking can work directly with borrowers to find loans, and it can work with brokers to make the brokers more efficient. In this case, therefore, the Internet process and the physical process have similar steps. The Internet has the potential to shorten those steps.

CapitalThinking describes five stages of the commercial mortgage process: (1) creating the loan request, selecting a lender, and applying; (2) evaluating term sheets; (3) post-term sheet due diligence; (4) creating and sending a loan commitment; and (5) post-commitment to closing of the loan.

Overall, table A.2 shows that CapitalThinking reduces the time from seeking financing to closing on the loan from 98 days to 41 days. In our next version, we will discuss the reductions in time in more detail and put values on those reductions in time.

CapitalThinking did in fact close its first loan in 40 days. In future versions of this paper, we will have data on additional transactions. We also will obtain additional data on the time required in the existing physical process.

3. *NutraBid*

NutraBid provides technology infrastructure and eCommerce services to the nutraceutical industry. As we mentioned above, we have data on NutraBid's role as a biased reverse auctioneer for manufacturers buying from suppliers.

The procurement process for nutraceuticals consists of three phases both in the physical world and on the Internet. First, the buyer develops a request for proposals (RFP) to be sent to suppliers, mails the RFP to the suppliers, and receives responses from interested suppliers. Second, the buyer analyzes the RFPs and chooses the more

attractive suppliers with whom to negotiate. Finally, the buyer plans negotiations, schedules them, and conducts them.

Table A.3 reports the time involved in the physical and Internet processes. The physical process takes 84 days which the NutraBid / Internet process takes only 28 days. NutraBid attributes the time savings to the following factors. In the first, RFP development phase, NutraBid believes that RFP development time is reduced by customizing standardized RFPs, using web-based RFPs and emailing RFPs and responses. In the second, RFP analysis phase, NutraBid believes it simplifies the analysis by focusing primarily on quality and services while ignoring pricing analysis to the auction. Finally, in the negotiation phase, the electronic auction precludes multiple rounds of face-to-face negotiations. NutraBid believes that a 10 minute electronic auction achieves a result that is equivalent to 3 or 4 rounds of face-to-face negotiations. This represents the largest savings in time.

In future versions of this paper, we will have data on additional auctions. We also hope to obtain additional data on the time required in the existing physical process.

B. Marketplace Benefits

1. NutraBid

NutraBid provided us with detailed results of their first reverse auction. The buyer provided NutraBid with desired purchases of more than 10 raw materials and the prices that the buyer was currently paying and expected to continue paying for those raw materials. The buyer also indicated the suppliers it wished to source from. NutraBid

contacted those suppliers and then conducted a reverse auction for the desired amounts of the indicated raw materials.

Overall, the buyer obtained bids that were 14% lower in aggregate than the prices the buyer was currently paying. The buyer received lower bids on more than 80% of the individual raw materials offered.

This result is clearly consistent with substantial marketplace benefits. Those benefits are potentially a result of lower search costs and better matching. However, as we noted earlier, the results also are consistent with two other explanations. First, it is possible that the lower prices represent reductions in seller processing costs. This would be consistent with the reduced process time analyzed in the previous section. Second, lower prices may partially represent a reallocation of the surplus of the transaction. I.e., the buyer is appropriating some of the oligopoly or other rents of the suppliers. In a future version, we hope to be able to distinguish among these explanations.

VI. Changes in the costs of informational asymmetries and incompleteness

In this section, we explore changes in the costs of informational asymmetries and incompleteness using data provided by Autodaq. The data reflect the results of a pilot or beta test in which Autodaq listed 1752 cars and sold 689 cars on Autodaq's Internet-based system in the first several months of 2000.

A. Asymmetric Information in Physical and Internet Automobile Auctions

While in the physical auction a buyer has an extra independent indication of the condition of the car, in the form of his own evaluation, the Internet auction relies exclusively on hard, quantifiable data that can be observed in the database. The potential

informational loss is probably small, as information in physical auctions is usually very restricted. In a description of these physical auctions, Genosove (1993) points out the limited access to the cars enjoyed by the bidders:

“Prior to the bidding, the car is parked outside, where potential bidders can examine its exterior. They are prohibited from opening the doors or raising the hood. Mileage and options are chalked on the car’s windows. When the car’s turn approaches, it is driven into the appropriate lane and then, before bidding is concluded on the previous car, driven up to the auction block. Now the hood is raised and dealers are permitted to enter the car. There is time to check the odometer, to ensure that the air conditioner works (but, in the summer months at least, not the heater) and to take a look at the running motor. But there is no opportunity to test the brakes or any number of other things that a consumer might check out in a drive around the block (...)

On top of the auction block stands the auctioneer and, beside him, the seller, who under the rules of the auction must be present. The auctioneer announces any major defects in the car, of which the seller has informed him. Bidding is oral and ascending. When bidding will go no higher, the seller is asked to accept or reject the winning bid. About 60% of the time he accepts. The car will have been driven away before the bidding is concluded. From the time it arrived at the auction block until the time it is driven away, a minute and a half will have passed.”

The Internet-based auctions run by Autodaq, on the other hand, do not allow any physical inspection of the cars by the buyer.¹² The seller and the Autodaq inspection provides an extensive list of information on the car’s options and on all other measurable aspects of the car condition, such as its mileage, the damages suffered, age etc.

Autodaq auctions are also exclusively directed to business. A difference here, possibly attenuating adverse selection issues, is that individual used car dealers cannot post cars for sale in the Autodaq site. Sellers are only financial institutions, manufacturers and other fleet/lease/rental operators.

Importantly, Autodaq does not preclude buyers and sellers from participating in physical auctions. Moreover, cars unsold after 3 Internet auction cycles are returned to

¹² Both Autodaq and the physical auctions do inspect the cars and describe them for buyers. Autodaq argues (and we agree), that the information in electronic form is richer and more useful as it allows buyers to search more efficiently for their desired cars and options.

the seller. This raises the possibility of a seller offering only those cars that are in a relatively worse unobservable condition through this channel.

Adverse selection, therefore, would imply that cars with relatively bad unobservable characteristics would be sold on the Internet. Specifically, adverse selection between physical and virtual world auctions would imply a lower average price, conditional on observable characteristics, for cars sold over the Internet, and a lower conditional probability that the car would be sold at each price. High quality cars for each level of observable characteristics would not come to the market or, when they come, would have a very low probability of being sold given that the seller would demand high average prices for the average condition that buyers expect to find in the market. This will be particularly the case for cars whose condition is likely to have a high conditional variance, such as older cars, cars with higher mileage and those that were involved in accidents. In other words, bad cars will drive out good ones (pun intended).

Mitigating this effect is the fact that individual dealers are not allowed to sell cars on Autodaq. To the extent that such dealers are more likely to try to dump their lemons, it may actually be that the Autodaq market is more, rather than less, efficient than the physical auction market.

Second, as we argued earlier, even if the composition of the sample of cars is the same in a physical auction and in a Internet auction, the actual transactions may differ because of the smaller possibility of matching on the Internet when matching is based on physical inspection. The reduction in the value of matching is likely to matter most when the information derived from direct observation is more valuable. The value of

information will in turn be determined by the variance in the value of the car *conditional* on its observable characteristics.

We think it is reasonable to believe that this conditional variance increases with the age, mileage, and damages of the car. The conditional variance of the value of a new car is likely to be small, while an older car's condition may vary a lot depending on the care of the customer. To the extent that quality of care can be gauged from direct observation of the car, cars with the worse observable characteristics will not be matched as well on the Internet as at a physical auction.

B. Empirical Strategy

The focus of our analysis is to understand the efficiency of the Internet automobile market in itself and relative to the physical auction market. To do this, we study four quantities: the probability that a car is sold; the time it takes to sell a car; the price at auction relative to the book price; and the price attained by a car relative to the price that the same car would attain in a physical world auction.

The first of these variables, the probability that a car is sold, is an important determinant of the efficiency of the market. If there does not exist a price at which buyers and sellers can conduct the transaction, then the market is not performing efficiently. As discussed in the previous section, we expect that cars with good unobservable characteristics relative to their group will have more trouble selling so that the reserve price demanded by the seller to conduct the transaction will be too high relative to what the buyer is willing to pay. To the extent that the variance in unobservable characteristics is particularly important for cars that are older, have more

mileage, and have more damage, we would expect those cars to be the least likely to be sold. A similar hypothesis can be made concerning the time that a car takes to be sold.

The third variable in our study is the auction price to book price ratio. We would expect, if adverse selection exists, this price to be lower for cars whose condition is subject to a larger variance.

Finally, we study the ratio of the price the car on the Internet to the price a car with these characteristics would have attained in the physical world.

C. Data and Estimation

As discussed above, we use four primary dependent variables in our analyses. First, time to sale for each individual car is measured by the number of auction cycles a car is on the block. Each bidding cycle lasts one day, and there are 5 cycles per week. After 3 cycles, the car is returned to the seller as unsold.

Second, we use an indicator variable for whether the car is sold. This variable is 1 if the car was sold after three cycles and 0 if it was not.

Third, we analyze the Internet price relative to book price. The book price is the Kelly blue book price which is the retail book value of a reconditioned used car as estimated by a commonly used guide

Fourth, we measure the relationship of the Internet price to the physical auction price. We calculate this variable as the ratio of two variables in the data set – the price at which a car sold was actually sold, and the price at which an average car with similar observable characteristics was sold as derived by Autodaq from a data set of physical

auction sales. The algorithm takes into account, motorization, mileage etc. of the car sold in the Autodaq site, but *not* option data.

For each car auction, the following independent variables were available: number of miles; damages; age of the vehicle in 2000; Kelly blue book price; number of bidders in the auction; and options / characteristics of the car (availability in the car of 52 individual characteristics, as well as type of transmission, motorization etc).

Table B.1 provides summary statistics for our data. The table shows that 39.3% of the cars in the sample were sold over the period at an average sale price of \$13,483. The average Kelly blue book value for these cars was substantially higher. The roughly 10% discount is due to the fact that the blue book estimates value to a final buying consumer.

Estimated physical auction values for the cars were available for a subsample of 747 observations. The ratio of the Internet to physical auction value of the car was 1.02, indicating that the average car in an Internet auction attained a 2% higher price than it would have attained in a physical auction. This ratio, however, oscillated quite a lot, with a standard deviation of 8.9 percent points.

Table B.2. presents all the unconditional pairwise correlations between the variables in the sample and suggests some of the results we are going to study in what follows.

The main estimation issue¹³ is a consequence of the censored nature of the data: Both the number of cycles and the price variables are censored. The number of cycles

¹³ Most of the empirical literature on auctions takes the number of bidders as given (Paarsch, 1992, Laffont, Ossard and Vuong (1995), etc. As has been pointed out by Bajari and Hortacsu (2000), bidders' entry into auctions with more attractive rules may be endogenous. We follow the previous literature in not dealing with this possible endogeneity.

that the car was on sale is censored at 3. We use the information on unsold cars in a Tobit model to take into account this right censoring. Also, the price paid is censored at the reservation price. If the buyer wants to buy a car at a price that is lower than the reservation price, no transaction takes place, and a 0 price appears. We used a censored normal regression model, in which the price variable was taken to be left-hand censored at the reservation price.

D. Results

1. Probability of Sale and Time to Sale

Table B.3 presents the analysis of the probability that a sale actually takes place using a Probit model. The evidence for the adverse selection hypothesis is mixed. While damaged cars are significantly less likely to sell, neither older cars nor cars with more miles are less likely to sell. In fact, there is a significantly positive relation between the mileage of the car and its age on the probability of a sale.

Table B.4 reports the results on the time to sell in cycles. They are consistent with the evidence on the probability that a car is sold. Cars with more miles and older cars are significantly more likely to sell earlier, while damaged cars are insignificantly more likely to sell later.

The results in tables B.3 and B.4 suggest that the reservations prices for cars with high mileage and for older cars must be substantially lower (relative to book value). This is indeed the case, as Table B.5 shows. Surprisingly, on the other hand, more damaged cars do not have lower reservation prices.

The second piece of evidence available on the performance of Internet auctions concerns the transaction prices of the cars. We present this information in two forms: the transaction price relative to the book price; and the transaction price relative to the physical auction price. We present two tables on each of these prices: the first for each pair (tables B.6 and B.8) presents the evidence for the OLS estimates on those cars that are actually sold. This is clearly a biased estimate, since the willingness to pay of the buyers is censored by the reservation price, and we do not observe transaction prices for unsold cars. Tables B.7 and B.9 present censored normal regressions in which the reservation price is used as the censoring point. Because the results are similar for both specifications in both cases, we discuss them together.

In univariate regressions, the sale to book price ratio decreases significantly with both the age of the car and the number of miles it has been driven. In a multiple regression, however, this ratio decreases with mileage, but increases with age. This result is consistent, albeit not completely, with adverse selection. This could occur in physical auctions as well, so does not in itself indicate any worse performance by the Internet than physical auctions.

To get at the performance of the Internet relative to physical auctions, we analyze the ratio of the Internet price relative to the physical auction price. Consistent with adverse selection, cars with higher mileage are significantly more likely to sell at lower prices in the virtual world than in the physical world. However, older cars are significantly more likely to sell at higher prices – both in univariate and multiple regressions. We view this as mixed evidence toward to presence of adverse selection

problems in the Internet auction. Overall, it seems, that if adverse selection exists, the problem is not large.

V. *Conclusion*

In this paper, we have studied changes in transaction costs B2B e-commerce.

We began with a conceptual framework to organize the transaction costs gains and losses that are likely to result when a transaction is transferred from a physical marketplace to an Internet-based one. Following Milgrom and Roberts (1992), we differentiated between the impact on coordination costs and motivation costs. We argued that it is likely that B2B e-commerce reduces coordination costs / increase efficiency. We classified these efficiencies into three broad categories – (1) process improvements; (2) marketplace benefits; and (3) indirect improvements. At the same time, B2B e-commerce affects motivation costs. In particular, we discuss the impact of the introduction of e-commerce on informational asymmetries.

Second, we presented some early examples of such effects from three companies from which we have been able to obtain data. We measured the process improvements for all three companies. We measured marketplace benefits for one company. We then attempted to measure motivation costs for one company by comparing the performance of an Internet marketplace to a physical marketplace. We were able to document potentially large process improvements. We documented one example of large marketplace benefits. We found mixed evidence of motivation costs.

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TABLE A.1
PROCESS COST OF PHYSICAL AUCTION VERSUS INTERNET AUCTION PROCESS PER
CAR

	<i>Physical Auction</i>		<i>Autodaq / Internet</i>	
	TIME (DAYS)	DOLLARS	TIME (DAYS)	DOLLARS
Wait for pick-up	15		0	
Ship to auction	2		0	
Ready for sale	10		2	
Ready for sale until sale	15		2	
Ship to dealer	2		2	
Total Time	44		6	
Capital Cost of Time		\$130		\$18
Depreciation Cost of Time		\$195		\$27
Inspection Cost		\$ 5		\$60
Shipping Cost		\$100		\$60
Reconditioning Cost		X		X
Dealer Travel Cost	0.5 Hours	\$ 20		
Dealer Time Not Bidding	0 to 4 Hours			
Total Economic Cost		\$450 + X		\$165 + X
Seller Fee		\$150		\$100
Buyer Fee		\$150		\$175

Assumptions:

Wait for pick-up is time from lessee delivery of car to dealer until car is picked-up by physical auction.
 Ready for sale is time from delivery at physical auction site to the time car is ready for sale. Includes time to recondition.

Used car has a sale value of \$13,483. Interest rate / cost of capital assumed to equal 8%. Each day, therefore, costs seller $8\% \times \$13,483 / 365 = \2.96 per day in capital costs.

Used car values decline or depreciate by 12% per year. Each day, therefore, costs seller $12\% \times \$13,483 / 365 = \4.43 per day in depreciation costs / forgone sales price.

Inspection cost for physical auction assumes 15 minutes at a cost of \$20 per hour; for Autodaq, is the cost to Autodaq.

Dealer travel cost assumes that dealer travels a total of two hours and buys four cars for an average of 0.5 hours per car. Dealer time is valued at \$40 per hour.

Shipping cost is two shipments at \$50 each for the physical auction; one shipment at \$60 for the Autodaq process.

Reconditioning costs assumed to be the same for both processes.

TABLE A.2
PROCESS COST OF COMMERCIAL LOAN PROCESS:
PHYSICAL / EXISTING PROCESS VERSUS CAPITAL THINKING INTERNET PROCESS

	<i>Physical / Existing</i>		<i>Capital Thinking / Internet</i>	
	TIME (DAYS)	DOLLARS	TIME (DAYS)	DOLLARS
1. Creating Loan Request (Total)	24.0		5.0	
Polling Financial Market	6.0		0.5	
Inputting Data	4.0		1.0	
Formatting Information	5.0		1.5	
Ancillary Information	2.0		0.5	
Ancillary Documentation	3.0		1.0	
Select Lenders / Submit	4.0		0.5	
2. Application / Term Sheet	5.0		2.0	
3. Post-Term Sheet Due Diligence	30.0		14.0	
Coordinate Due Diligence`	4.0		1.0	
Select 3 rd Party Vendors	5.0		1.0	
Receive / Review 3 rd Party Work	13.0		8.0	
Complete Internal Model / Approval	8.0		4.0	
4. Commitment (Create and Send)	6.0		3.0	
5. Post Commitment / Closing	33.0		17.0	
Establish legal due diligence / closing procedures	5.0		2.0	
Select / Engage 3 rd party Vendors	5.0		1.0	
Receive / Review 3 rd Party Work	15.0		10.0	
Finalize Closing Arrangements	8.0		4.0	
Total	98.0		41.0	

Assumptions:

TABLE A.3
PROCESS COST OF NUTRACEUTICAL PROCUREMENT PROCESS:
PHYSICAL / EXISTING PROCESS VERSUS NUTRABID / INTERNET PROCESS

	<i>Physical / Existing</i>		<i>Nutravid / Internet</i>	
	TIME (DAYS)	DOLLARS	TIME (DAYS)	DOLLARS
1. Develop, Mail RFP to Suppliers and Receive Responses	21		14	
2. Analyze RFP, Screen Suppliers	14		7	
3. Plan Negotiations, Schedule, Conduct 2-3 Rounds of Face to Face Negotiations	49		7	
Total	84		28	

Assumptions:

TABLE B.1. AUTODAQ: DESCRIPTIVE STATISTICS

Variable	Obs	Mean	Std. Dev.	Min	Max
Sold	1752	0.393	0.489	0.000	1.000
Sell Price[\$10000]	689	1.3483	0.536	0.310	3.270
Book Value (KBB) [\$10000]	1752	1.491	0.600	0.335	7.850
Sale Price to Book Value	689	0.899	0.079	0.605	1.103
Estimated Physical Value[\$10000]	747	1.5832	0.336	0.719	3.266
Reserve Price to Book Value	1752	0.949	0.106	0.585	1.456
Virtual to Physical Value Ratio	747	1.021	0.089	0.690	1.395
Mileage (1000)	1752	41.517	11.636	0.352	90.190
Age (2000-year)	1752	3.223	0.600	1.000	6.000
Number of Damage	1752	5.706	4.906	0.000	26.000
Number of Bidders	1752	0.685	1.012	0.000	7.000
Number of Auction Cycles	1752	2.345	0.898	1.000	3.000
Sold Auction Cycle	689	1.360	0.637	1.000	3.000

TABLE B.2. CORRELATION MATRIX

	Sold	Sell Price	Reserve Price to book Value	Kbb Price	Estimated Physical Value	Mileages	Age	Number of Damage	Number of Bidders	Number of Auction Cycles
Sold	1									
Sell Price		1								
Reserve Price to book Value	-0.4663	0.3561	1							
Kbb Price	0.0038	0.9759	-0.0538	1						
Estimated Physical Value	0.2272	0.9281	-0.0182	0.9381	1					
Mileages	0.1036	-0.152	-0.4239	-0.0093	-0.0565	1				
Age	0.1628	-0.3676	-0.1321	-0.2603	-0.4717	0.4191	1			
Number of Damage	-0.0621	-0.1009	0.0495	-0.0835	-0.0604	0.0035	0.016	1		
Number of Bidders	0.4853	0.2262	-0.1994	0.1543	0.1569	0.0025	0.0215	-0.0698	1	
Number of Auction Cycles	-0.8832	0.031	0.429	-0.0011	-0.1925	-0.1016	-0.1753	0.0365	-0.4078	1
Sold Auction Cycle y		0.031	0.0914	0.0242	0.0425	-0.0141	-0.0851	-0.0337	0.1013	
Virtual to Physical Value Ratio		0.37	0.5177	0.1918	0.0056	-0.4365	0.152	0.0052	0.0142	-0.1

TABLE B.3. PROBABILITY OF SALE)
(Probit Estimates)

<i>Independent Variables</i>								
	Mileage (000)	Damages	Age of Vehicle	Kbb Price (\$0000)	Number of Bidders	Options Dummies	Intercept	Pseudo-R. Square (n)
(1)	0.0113** (0.0026)						-0.7402** (0.1132)	0.008 1752
(2)	0.0113** (0.0026)	-0.0164** (0.0062)					-0.6501** (0.1183)	0.0109 1752
(3)	0.0048* (0.0029)	-0.0173** (0.0063)	0.3083** (0.0565)				-1.3672** (0.1781)	0.0238 1752
(4)	0.0042* (0.0029)	-0.0164** (0.0063)	0.3347** (0.0588)	0.0858* (0.0526)			-1.5641** (0.2155)	0.0249 1752
(5)	0.0066** (0.0032)	-0.0124* (0.0068)	0.2847** (0.0631)	-0.12** (0.0612)	0.6765** (0.0345)		-1.7124** (0.234)	0.2065 1752
(6)	0.0057* (0.0032)	-0.0129* (0.0068)	0.2857** (0.0641)	-0.267** (0.0749)	0.6751** (0.0348)	Yes	-1.6507** (0.2427)	0.213 1752

* Significant at 10% level; ** Significant at 1% level.

TABLE B.4. TIME TO SALE (IN CYCLES)
(Tobit Regression Estimates)

<i>Independent Variables</i>								
	Mileage (000)	Damages	Age of Vehicle	Kbb Price (\$0000)	Number of Bidders	Options Dummies	Intercept	N
(1)	-0.0301** (0.0068)						5.6968** (0.3064)	1752
(2)	-0.0302** (0.0068)	0.0331** (0.0163)					5.5145** (0.3172)	1752
(3)	-0.0124* (0.0074)	0.034** (0.0161)	-0.7472** (0.1381)				7.1708** (0.4475)	1752
(4)	-0.0107* (0.0074)	0.0314* (0.0161)	-0.8311** (0.1447)	-0.269* (0.138)			7.7855** (0.5513)	1752
(5)	-0.0141** (0.0066)	0.0125 (0.0143)	-0.6519** (0.1276)	0.168* (0.128)	-1.3333** (0.0712)		7.6921** (0.4936)	1752
(6)	-0.0126* (0.0067)	0.0128 (0.0143)	-0.6415** (0.1286)	0.423** (0.155)	-1.324** (0.0713)	Yes	7.4985** (0.507)	1752

* Significant at 10% level; ** Significant at 1% level.

TABLE B.5. RESERVATION PRICES TO BOOK PRICE
(OLS Estimates)

<i>Independent Variables</i>								
Mileage (000)	Damages	Age of Vehicle	Number of Bidders	ABS	CD	Leather	Intercept	R. Square (n)
-0.0038** (0.0002)							1.1085** (0.0085)	0.1797 1752
	0** (0)						0.9486** (0.0033)	0.0081 1349
		-0.0232** (0.0042)					1.0236** (0.0137)	0.0175 1752
			-0.0095** (0.0042)				0.9628** (0.0067)	0.0029 1752
-0.0044** (0.0002)	0** (0)	0.0132** (0.0048)					1.0858** (0.0149)	0.2134 1349
-0.0043** (0.0002)	0** (0)	0.0113** (0.005)	-0.0059 (0.0046)				1.0991** (0.0181)	0.2143 1349
-0.0044** (0.0002)	0** (0)	0.0151** (0.0049)	0.0005 (0.0045)	-0.0211** (0.0025)			1.0937** (0.0177)	0.253 1349
-0.0042** (0.0002)	0** (0)	0.0112** (0.005)	0.0017 (0.0053)	-0.022** (0.0054)	-0.001 (0.0056)	-0.0072 (0.0065)	1.101** (0.0184)	0.2251 1349

TABLE B.6. SALE PRICE TO BOOK PRICE RATIO
(OLS Estimates)

<i>Independent Variables</i>								
	Mileage (000)	Damages	Age of Vehicle	Kbb Price (\$0000)	Number of Bidders	Options Dummies	Intercept	R Sq. N
(1)	-0.0029** (0.0002)						1.0251** (0.0098)	0.207 689
(2)		0 (0.0006)					0.8988** (0.0045)	0 689
(3)			-0.0133** (0.0041)				0.9431** (0.014)	0.0151 689
(4)	-0.0029** (0.0002)	0.0003 (0.0005)					1.0239** (0.0102)	0.2072 689
(5)	-0.0034** (0.0003)	0.0002 (0.0005)	0.0142** (0.0042)				0.9944** (0.0133)	0.2204 689
(6)	-0.0036** (0.0002)	0.0005 (0.0005)	0.0234** (0.0045)	0.0268** (0.0051)			0.931**	0.2507 689
(7)	-0.0035** (0.0002)	0.0007 (0.0005)	0.0243** (0.0044)	0.0236** (0.0051)	0.0106** (0.0027)		0.9166** (0.0179)	0.2674 689
(8)	-0.0035** (0.0003)	0.0014** (0.0006)	0.0263** (0.0045)	0.024** (0.007)	0.0104** (0.0028)	YES	0.8819** (0.0259)	0.3312 689

TABLE B.7. SALE PRICE TO BOOK PRICE RATIO
(Tobit Estimates)

<i>Independent Variables</i>								
	Mileage (000)	Damages	Age of Vehicle	Kbb Price (\$0000)	Number of Bidders	Options Dummies	Intercept	N
(1)	-0.0029** (0.0002)						1.0251** (0.0098)	1752
(2)		0 (0.0006)					0.8988** (0.0044)	1752
(3)			-0.0133** (0.0041)				0.8988** (0.014)	1752
(4)	-0.0029** (0.0002)	0.0003 (0.0005)					0.9431** (0.0101)	1752
(5)	-0.0034** (0.0002)	0.0002 (0.0005)	0.0142** (0.0042)				0.9944** (0.0132)	1752
(6)	-0.0036** (0.0002)	0.0005 (0.0005)	0.0234** (0.0044)	0.0268** (0.0051)			0.931** (0.0177)	1752
(7)	-0.0035** (0.0002)	0.0007 (0.0005)	0.0243** (0.0044)	0.0236** (0.0051)	0.0106** (0.0027)		0.9166** (0.0179)	1752
(8)	-0.0035** (0.0002)	0.0014** (0.0006)	0.0263** (0.0044)	0.024** (0.0068)	0.0104** (0.0028)	Yes	0.8819** (0.0254)	1752

TABLE B.8. INTERNET TO PHYSICAL WORLD PRICE RATIO
(OLS Estimates)

<i>Independent Variables</i>								
	Mileage (000)	Damages	Age of Vehicle	Kbb Price (\$0000)	Number of Bidders	Options Dummies	intercept	R. Square (n)
(1)	-0.0036** (0.0005)						1.1527** (0.0222)	0.1906 230
(2)		0.0001 (0.0013)					0.9943** (0.0087)	0 230
(3)			0.0231** (0.01)				0.9212** (0.0322)	0.0231 230
(4)	-0.0036** (0.0005)	0.0004 (0.0011)					1.1509** (0.0228)	0.1911 230
(5)	-0.0053** (0.0005)	0.0005 (0.001)	0.0684** (0.0092)				1.008** (0.0281)	0.3499 230
(6)	-0.0053** (0.0005)	0.0006 (0.0009)	0.0998** (0.0097)	0.0838** (0.0128)			0.7526** (0.0469)	0.4534 230
(7)	-0.0053** (0.0005)	0.0007 (0.001)	0.1009** (0.0099)	0.0843** (0.0129)	0.003 (0.0045)		0.7424** (0.0493)	0.4545 230
(8)	-0.0054** (0.0004)	0.0006 (0.0009)	0.0893** (0.0101)	0.0486** (0.0151)	0.0043 (0.0044)	Yes	0.8175** (0.052)	0.4941 230

* Significant at 10% level; ** Significant at 1% level.

TABLE B.9. INTERNET TO PHYSICAL WORLD PRICE RATIO
(Censored Normal MLE Estimates)

<i>Independent Variables</i>								
	Mileage (000)	Damages	Age of Vehicle	Kbb Price (\$0000)	Number of Bidders	Options Dummies	intercept	R. Square (n)
(1)	-0.0031** (0.0004)						1.0589** (0.0188)	747
(2)		-0.0016* (0.0011)					0.9248** (0.0081)	747
(3)			0.0302** (0.0098)				0.8219** (0.0316)	747
(4)	-0.0031** (0.0004)	-0.0014* (0.0009)					1.0667** (0.0194)	747
(5)	-0.0043** (0.0004)	-0.0015* (0.0008)	0.0641** (0.0088)				0.9231** (0.0272)	747
(6)	-0.0047** (0.0004)	-0.0007 (0.0008)	0.1108** (0.0084)	0.131** (0.0103)			0.5726** (0.0381)	747
(7)	-0.0046** (0.0004)	-0.0003 (0.0008)	0.112** (0.0086)	0.124** (0.0106)	0.0191** (0.0034)		0.5538** (0.0394)	747
(8)	-0.0047** (0.0004)	-0.0003 (0.0008)	0.1017** (0.0086)	0.0908** (0.0122)	0.019** (0.0033)	Yes	0.6238** (0.0408)	747

* Significant at 10% level; ** Significant at 1% level.