University of Alberta

Two Essays on Facilitating Consumer Purchase under Limited Information

by

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ABSTRACT

The thesis includes two essays on facilitating consumer purchase in the presence of limited information.

In the first essay, "Empirical Testing of the Reference Price Effect of Buy-now Prices in Internet Auctions," I shed new light on the role of buy-now prices (BNPs) in online auctions by focusing on the case where consumers are uncertain regarding the value of auctioned products. As a result, auction sellers can use a BNP as an external reference price to facilitate consumers' evaluation of products' values. I study under what conditions a BNP can be effectively used as an external reference price. Through three empirical studies, I find that BNPs have a reference price effect, and that this effect is moderated by (1) the ease of value assessment and (2) product class (i.e., high vs. low-end products).

In the second essay, "Facilitating Consumer Learning: Used Markets, Buybacks, and Rentals," I examine a stylized model to show how used markets facilitate consumer learning about novel "slow-to-evaluate" experience products. Value is created because the risk of learning about a product is reduced. Used markets can serve this function in two ways. First, consumers have recourse to resell if they do not like a new product. Second, consumers can try a used product, before investing in a new product. Analogous functions are provided, in the absence of used markets, through seller policies such as guaranteed buybacks and product rentals. For all these cases, trading in used products makes consumers more willing to pay for new product and prevents market failure, and the seller is better off. The learning strategies of consumers also have implications for retailer logistics, ecology, and conspicuous consumption.

DEDICATION

To my son Kevin and my daughter Grace

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Consumers often have to make a purchase when they do not possess the necessary information that is needed for such decision making, for example, the information about price and quality. The lack of information imposes decision difficulty on consumers (e.g., Simmons and Lynch 1991) and reduces their willingness to pay (e.g., Rasmusen 2001). As an extreme case, such lack of information can lead to market failure (Arklof 1970).

In view of this information problem, firms have adopted a number of marketing mix variables to provide information to consumers in the hope that such provision will prompt consumers to purchase. These variables include advertising, brand, price, warranties, etc. Many of these marketing mix variables serve as signals that can convey credible information to consumers. Correspondingly, research in economics and marketing has documented the effectiveness of the above strategies, for example, branding (e.g., Erdem 1998), price (e.g., Lichtenstein and Burton 1989), advertising (e.g., Milgrom and Roberts 1986), warranties (e.g., Boulding and Kirmani 1993), guarantees (e.g., Moorthy and Srinivasan 1995), etc. This thesis consists of two essays, which follows a line of inquiry dealing with consumer decisions under incomplete information, and discusses how sellers can facilitate consumers' purchases in two different marketplaces where a lack of full information prevails.

In the first essay, "Empirical Testing of the Reference Price Effect of Buy-now Prices in Internet Auctions," I study the role of buy-now prices (BNPs) in online auctions. A BNP is an option offered by the seller in an auction that provides for the selling of an item immediately to consumers at a fixed price. I provide a comprehensive theory for the usage of BNPs by proposing a conceptual model of BNP usage. I postulate that when bidders are uncertain concerning the value of an item on auction, a BNP may serve as an external reference price. I focus on the effect of BNPs on bidders' willingness to pay (WTP) and study under what conditions a BNP can be effectively used as an external reference price. Results of three empirical studies clearly indicate that BNPs reduce consumer uncertainty and increase their willingness to pay.

In the second essay, "Facilitating Consumer Learning: Used Markets, Buybacks, and Rentals," I analytically show how used markets facilitate consumer learning about novel "slow-to-evaluate" experience products (Nelson 1974) and, eventually, lead to the purchase. When consumers do not have information regarding their own preferences for the products, used markets create value because the risk of learning about a product can be reduced. Used markets can serve this function in two ways. First, consumers have recourse to resell if they do not like a new product. Second, consumers can try a used product, before investing in a new product. In the absence of used markets, similar results can be obtained through retail policies such as guaranteed buybacks and product rentals. In all these cases, the costs to consumers to learn their own preferences are reduced.

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2. Empirical Testing of the Reference Price Effect of Buy-now Prices in Internet Auctions

2.1. Introduction

More and more retailers are using Internet auctions as an alternative way of selling their products. Currently, over 724,000 American retailers use the Internet auction website eBay.com as a major channel of distribution; another 1.5 million individuals supplement their income by selling on eBay (eBay 2005). In addition, major manufacturers and retailers such as IBM, Motorola, Sears, and Sony have their own eBay outlets. Together these businesses account for the majority of sales on eBay, which was over $52.4 billion in 2006; an increase of 18% over 2005 (eBay annual report, 2006).

The rapid development of Internet auctions is due to the fact that the Internet has created a different way of auctioning items. While traditional auctions tend to be of short duration (lasting several minutes or even seconds), most Internet auctions tend to last for days. In addition, the types of item sold differ; traditional auctions are generally used to sell unique items and collectables, while Internet auctions are commonly used to sell new consumer goods. More than half the items listed on eBay are new consumer goods (eBay annual report, 2005). This different way of selling goods has also led to the creation of new features not available in traditional offline auctions: such as proxy bidding machines, feedback mechanisms, and buy-now prices (hereafter, BNPs). Given the increased importance of Internet auctions for retailers, there is an increased need to study these new features (Cheema et al. 2005).

In this essay I focus on BNPs, an important feature that is frequently used in Internet auctions. A BNP or a buy-now option is a fixed price offer by the seller which, when met, instantly ends an auction and sells the item to the bidder at the fixed price. Similar to "obo" (or best offer) in used-goods markets, auctions using BNPs allow consumers to purchase an item immediately at the given prices, without having to wait until the completion of the auction. Nevertheless, because a BNP imposes an upper bound on selling prices,[1] it has been argued that auctioneers who seek to maximize auction outcomes should not use them (Budish and Takeyama 2001). In spite of this assertion, BNPs are widely used in Internet auctions.[2] Thus, obtaining a better understanding of how BNPs work is of both theoretical and managerial importance.

Several researchers in economics and marketing have studied the above paradox, and have generated several hypotheses concerning motives for using BNPs. Budish and Takeyama (2001) suggest that a BNP can be used as a device to offer insurance to risk-averse bidders. That is, due to payment variation in auctions, bidders may want to avoid the risk of paying too much, or of losing the auction to a higher bidder. Other research

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[1]This does not have to be the case in eBay auctions, where the BNP disappears when a bidder places a bid below it.

[2] According to studies conducted by Reynolds and Wooders (2002) and Wang, Montgomery and Srinivasan (2004), and my preliminary observations (see Table 2), about 40-50% of eBay auctions provide BNPs. On other auction websites, in some product categories such as laptops, 90% of auctions used BNPs and about 40% of auctions ended via BNPs (Park and Bradlow 2005).

has considered BNPs as a tool for segmenting bidders with different waiting costs (e.g. Mathews 2004). In an Internet auction, which tends to last for more than one day, bidders with high waiting costs can use the buy-now option to purchase the item immediately. Others may use it to minimize transaction costs by avoiding frequent log-ons to auction sites to check the ongoing results of auctions (Wang et al. 2004; Carare and Rothkopf 2005).

While these studies have provided different explanations for the use of BNPs, they fail to explain the considerable variation in their usage, by both sellers and bidders, across product categories. This raises questions of the various motives for using BNPs, for bidders and retailers, and their impact on selling prices in auctions. In particular, how do BNPs affect bidding outcomes across product categories, and what is the underlying mechanism for this effect? Answering these questions is the objective of this essay.

To do so I first propose a conceptual model that considers the different usages for BNPs in Internet auctions, across different product categories. This conceptual model incorporates the different usages suggested in the literature, as well as a usage as a reference price, which will be the studied by this essay. This model provides a better understanding of the usage of BNPs and, linked through different theories; it offers a comprehensive explanation of the alternative usages of BNPs that have been observed empirically.

The most important underlying factor of my conceptual model is the ease (or difficulty) of assessing the value of an item. I propose that, when it is difficult for bidders to assess the value of an item up for auction, a BNP can serve as an external reference price. This reference price plays a more important role in the construction of bidders' valuations when it is more difficult to assess the value of an item; therefore, I argue that BNPs can have a positive effect on bidders' valuations, even when bidders do not use it.

I make several important contributions to the literature. First, I provide a conceptual model that can guide retailers to use BNPs for different purposes and different types of products. Second, I show that BNPs may serve as reference prices, favourably influencing bidders' valuations. Third, I determine under what conditions BNPs may act as external reference prices, and under what conditions such an effect will be stronger (or weaker). The results of three different studies provide considerable evidence that BNPs have a positive effect on bidders' valuations. In addition, I find that the effect is moderated by the ease of value assessment and product class (whether a product is a high or a low-end one).

The remainder of this essay is organized as follows: Section 2 proposes a conceptual model of BNPs and derives my hypotheses, Section 3 provides the results of two experiments, and an empirical test using real-world bidding data obtained from eBay, and finally Section 4 contains concluding remarks and possible topics for future research.

2.2. Conceptual Model and Hypotheses

2.2.1. Formation of Bidders' Valuations

Asymmetry of information is a fundamental feature of many auctions, because sellers possess more product information than bidders. Consequently, bidders are uncertain concerning the value of items (Milgrom and Webber 1982).[3] In Internet auctions, sometimes information asymmetry is aggravated for bidders because they have to determine the value of an item without being able to physically inspect it. Consequently, in order to form their valuations, bidders need to rely on product descriptions, pictures of the item, and other information cues, including the retailer's characteristics (e.g., feedback scores may indicate a retailer's trustworthiness), and external reference price information (e.g., BNPs). Hence, only after visiting an auction can bidders determine their valuation based on information provided by the retailer.[4]

This process of valuation formation for bidders is similar to that for consumers. Marketing literature has indicated that consumers use both previously formed internal reference prices and external reference prices to form their valuation for an item (Mayhew and Winer 1992; Mazumdar and Papatla 2000; and Mazumdar, Raj and Sinha 2005). For standardized products (e.g. CDs, books, and consumer electronics) which have numerous identical items for auction on the Internet, bidders can easily assess a product's value and determine their valuation. In such instances where bidders either have a well-established internal reference price or mainly rely on the product description to determine the value of an item, external reference prices may have little influence. However, in instances where product values are difficult to assess, for example, when

[3] While auction theory distinguishes between two basic models of how bidders form valuations: the *private-values* model and the *common-values* model (Milgrom and Weber 1982). Most real-world auctions tend to have both a private value element as well as a common value element, inducing uncertainty concerning values (Laffont 1997).

[4] Auction theory has proposed two different models of how bidders form their valuation for an auctioned product. The first model suggests that buyers know their valuation prior to deciding to enter an particular auction (e.g. McAfee 1993). The other model assumes that bidders learn their valuation after visiting an auction and inspecting the product (e.g. Peters and Severinov 1997; and Wolinsky 1988). The latter is more applicable in Internet auctions where bidders first need to read the product descriptions and other terms in order to determine the value of a item

supply is scarce, or when the product is non-standardized or used (e.g., collectables, jewellery, and paintings), bidders may rely on different kinds of information to form valuations. I expect that in such cases external reference prices will play an important role in the formation of valuations. This is consistent with previous research in marketing that suggests that external reference prices play a key role in the formation of consumers' valuations (Kalyanaram and Winer 1995; Kopalle and Lindsey-Mullikin 2003; Mazumdar, Raj and Sinha 2005), as well as the literature on Internet auctions that indicates that bidders are influenced by external reference prices such as reserve prices (Kamins, Dreze, and Folkes 2004; Suter and Hardesty 2005).[5]

Consequently, I propose that retailers can use BNPs as external reference prices to influence bidders' valuations. A higher BNP, even if it is not used by bidders, may provide a higher reference price and lead to higher auction outcomes. Note that this process of formation of valuations in Internet auctions is similar to that in conventional purchase situations, which have already been extensively studied in marketing (e.g., Bettman, Luce, and Payne 1998).

2.2.2. Conceptual Model of BNPs

As background information, existing theories cannot explain the considerable variation in the usage of BNPs across product categories. For example, retailers frequently use BNPs in auctions for consumer electronics and computer products (in about 55% of the auctions) and for jewellery, watches and crafts (in about 30% of the

[5]Northcraft and Neale (1987) also found that the listing price for a home may serve as a reference price, as higher listing prices result in higher estimates of value. Interestingly, even experts were influenced; real estate agents provide estimates biased in the direction of the initial reference point.

cases).[6] Nevertheless, only 3.5% (4%) of eBay auctions with a buy-now option for jewellery and watches end via bidders using this option versus 37.8% and 37.0% for consumer electronics and computer products, respectively. Why do bidders use BNPs so much less for jewellery and watches than for consumer electronics? And more importantly, why do retailers use BNPs if so few bidders take them? Theories proposed in the literature do not provide a convincing rationale for such a huge variation,

In accordance with my discussion on the consumer reference effect, I suggest a conceptual model that (1) summarizes the usage of BNPs in Internet auctions, and (2) guides the rest of the paper to test the existence of the reference price effect of BNPs. I propose that bidders are trading off two types of risk when using BNPs. The first is the risk of the so-called winner's curse, paying more than the product's value (e.g. Cox and Isaac 1984). This is associated with bidders' uncertainty concerning the value of a product as a result of difficulty in assessing that value. The second type of risk is the risk of losing an auction, and being unable to win in a subsequent auction. This is related to product availability. Thus, I can map bidders' decisions regarding BNPs in a two-dimensional plane where the two axes are (1) the ease of value assessment and (2) product availability.[7]

Figure 1 depicts such a decision map. The upper-left quadrant reveals a scenario in which the product is abundantly available and it is easy for bidders to assess the value of it. In this case, bidders have little uncertainty regarding the product's value, and may utilize a BNP when either the BNP is below their valuation, or when waiting costs (e.g.,

[6] Based on data collected from over 3 million completed auctions on eBay from January 06-16, 2006.

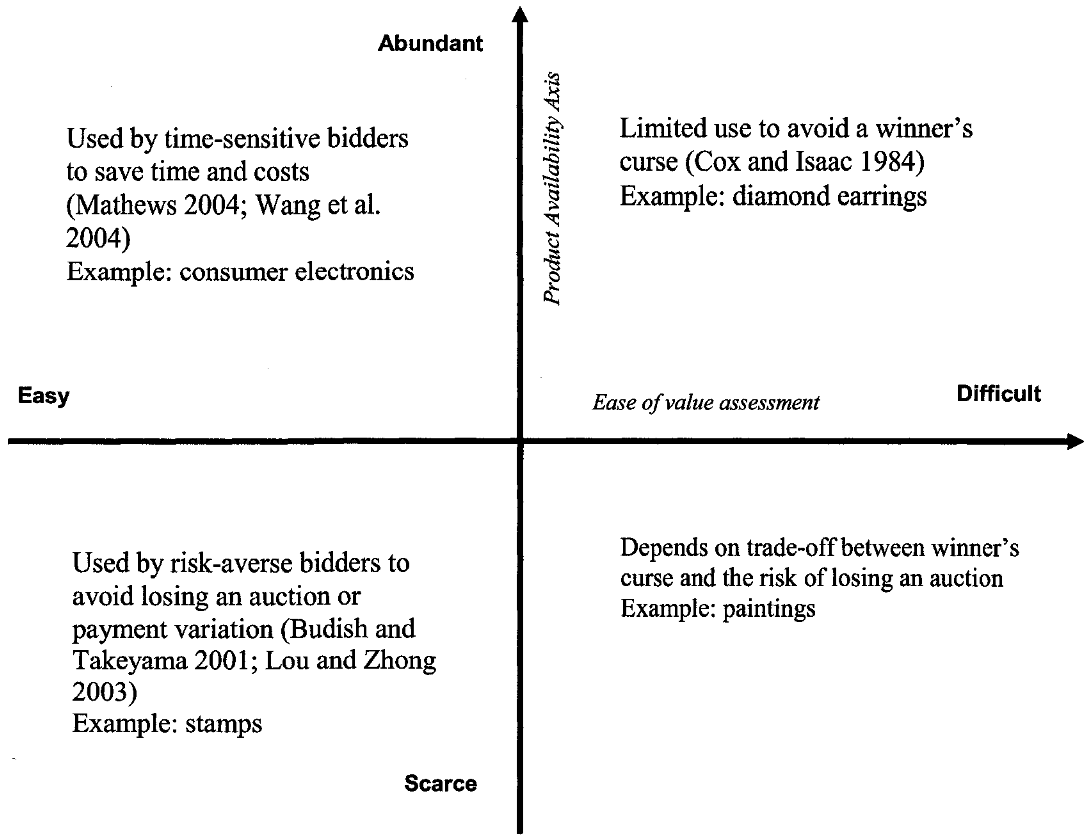
Mathews, 2004) and/or transactions costs (Wang et. al., 2004) are such that bidders are willing to pay a premium to purchase the item immediately. The literature has shown that auctions for some items such as computer products s are very likely to set a BNP, which has a high probability of being taken by bidders (Bradlow and Park 2007).

The lower-left quadrant depicts when product availability is limited and assessing the value of the product is easy. This scenario is most consistent with the basic framework for independent private value models in auction theories (e.g., Vickrey 1965). Risk-averse bidders may use BNPs to avoid losing the auction due to scarcity of supply (Lou and Zhong 2003), or to avoid variation in payment caused by competing bids (Budish and Takeyama 2001).

The lower-right quadrant is the scenario considered by most previous research into auction models. When product supply is scarce and it is difficult to assess the value of a product bidders have to trade off the risk of overpaying with the risk of losing the auction; this will decide whether they use a BNP or not. Examples of products fitting this quadrant are paintings and collectables. Bajari and Hortacsu (2003) have shown that people tend to bid very conservatively on eBay for collectable coins in order to avoid a possible winner's curse. Retailers may use a BNP as a reference price for bidders, however, retailers are also faced with uncertainty concerning bidders' valuations and therefore tend to avoid setting a BNP for fear of setting it too low (Zeithammer and Liu 2006). Thus, I am unlikely to see many BNPs set for auctions in this quadrant.[8]

[7] We do not assume the two factors are independent. They are plotted in a two-dimensional plane for expositional purposes.
[8] For example, based on the same eBay data as above, I find that less than 10% of sellers set a BNP for paintings (compared to close to 30% for jewellery).

Figure 2-1: Conceptual Model: Bidder's decision to use BNPs



When a product is abundant and it is difficult to assess its value (the upper-right quadrant), bidders have little incentive to use BNPs. Abundance of supply diminishes the likelihood of failing to obtain an item, while the difficulty of assessing the value increases the potential of winner's curse (that is the possibility of paying too much). This scenario has not yet been studied, and I propose that in this case retailers could benefit from using BNPs as external reference prices for bidders. One example is non-standardized jewellery. The value of such products is difficult to assess because attributes are less standardized and bidders are unable to inspect the items.

Our research focuses on the upper right quadrant– when it is difficult to assess the value of an item, supply is abundant, and few bidders are inclined to use BNPs.

2.2.3. Hypotheses

Based on the above discussion I propose several hypotheses related to the influence/usage of BNPs in Internet auctions. First I propose that BNPs have a positive reference price effect on bidders' valuations, leading to higher auction outcomes. This leads to the following hypothesis:

H1. Both the presence and absolute level of a BNP have a positive impact on bidders' valuations.

As discussed above, I expect that the positive effect of a BNP is moderated by the ease of value assessment. In particular, the reference price effect of a BNP increases as the difficulty of assessing the value of an item increases. This is consistent with the findings of Brint (2003), who report that setting a higher reserve price especially benefits a retailer for items with no real price guide. This leads to the following hypothesis:

H2. The positive effect of a BNP on bidders' valuation is greater when bidders find it more difficult to assess the value of the auctioned item.

I propose that a BNP is an informative price point and bidders will assimilate this information in order to update their valuations (Grewal, Krishnan, Baker and Borin 1998).

For this reason, a BNP should facilitate the formation of valuations, making it easier for bidders to assess product value. This leads to the following two hypotheses:

H3. Bidders in auctions where a BNP is present find it easier to assess the value of the items being auctioned.

H4. The presence of a BNP reduces the variance in bidders' valuations.

Hypothesis 3 suggests that the reference price effect of a BNP is affected by factors that influence consumers' assessment of product value. One major source of uncertainty related to assessing product value is uncertainty concerning product performance and attribute levels (e.g., Heiman et al. 2002). As a result, product class or, more specifically, the difference between low and high-end products may be an important moderator of the effectiveness of BNPs. This I will address next.

Differences in product attribute levels affects decision making and create difficulty in construction of consumer valuations (Shugan 1980; Weathers 2002). Attributes that differentiate products to a greater extent make it more difficult for consumers to assess the trade-off between increased price level and increased attribute level (Dellaert, Brazell, and Louviere 1999). Hence, attribute levels play an important role in the ease of assigning value to an item. For high-end products, this trade-off is more consequential because the risk of making a "wrong" purchase decision increases, further increasing the perceived uncertainty. In addition, the possible range (lower and upper bounds) of the valuations for high-end products is considerably greater than for low-end products, making high-end products more difficult to assess. For this reason, I hypothesize that the reference price effect of a BNP will be stronger for high-end products than for low-end products.

H5. The reference price effect of a BNP is stronger for high-end products than for the low-end products.

I expect this effect to be moderated by the ease of value assessment. Due to differences in product characteristics, the assessment of product class differs across product categories (Weathers 2002). In particular, this is the case in Internet auctions where no physical product examination is possible prior to bidding. For certain products, differences in key product attributes are easily observable and verifiable even without a physical examination, for example, the screen size of a monitor and the storage space of a memory card. For other products (e.g., less standardized products), this will not be the case and consumers will be more uncertain concerning value (e.g., diamond earrings)

Thus, I hypothesize an interaction effect between the ease of value assessment and product class (high-end products).

H6. The reference price effect of BNPs for high-end products is stronger when a consumer has more difficulty in assessing the value of a product.

2.3. Empirical Results

Next I will provide the results from three different studies. Study 1 is a controlled field experiment that studies the reference price effect of BNPs on bidders' valuations in real-life auctions where bidders commit their own money. Study 2 is a laboratory experiment that focuses on the moderating effects of 1) difficulty in assessing a product's value and 2) of product class (low versus high end products). Finally, Study 3 examines whether BNPs have a reference price effect under competitive market conditions on eBay.

2.3.1. Study 1: A Controlled Field Experiment

Study 1 tested the main hypothesis that a BNP has a positive reference price effect on bidders' valuations. It was conducted as a controlled field experiment run on a local Internet auction website. I had complete control over both the layout of the website and the content of the items on the website for the duration of the study. This allowed us to control for different confounding variables (e.g., competing auctions with different BNPs and/or reserve prices).

All registrants of the auction website where Study 1 was conducted were residents of a major North American city. At the time of the study, the auction site had over 2,000 registered users. All the experimental items were featured on the main page of the auction website, and no identical items were sold by other retailers during the duration of the study. Upcoming auctions were advertised by e-mail to registered users as well as through posters that were strategically-placed for the duration of the study.

Design of Experiment

A 2 (presence of a BNP) × 75 (different products) full factorial design was adopted as the basic design. Seventy-five pairs of identical products were auctioned off in a systematic manner. Each product was sold once with a BNP and once without a BNP. In total, 150 auctions were run over a period of two weeks. Fifteen different products were auctioned off each day from Monday to Friday. Because a variable ending rule was used – which automatically extends the duration of the auction by five minutes if a bid arrives in the last five minutes of the auction – the duration of all auctions was approximately 23 hours. Products were randomly assigned to days of the week, and half were randomly picked to be auctioned first with a BNP; the others were first auctioned without a BNP. Thus BNP was counter-balanced by the product and the day of the week.

To obtain a strong reference effect I set the BNP equal to the actual retail price of the item. A BNP which is set too high may not be perceived as credible, and thus may have a much smaller effect or be discarded (Kopalle and Lindsey-Mullikin 2003). Nevertheless, previous research has also shown that exaggerated external reference prices can also raise bidders' internal reference prices (Urbany, Bearden, and Weilbaker 1988). In any case, a discussion of the optimum BNP is left for future research.

Table 2-1: Summary Statistics Study 1

Ease of Assessing Product Value with and without BNPs

Category	Ease of value assessment w/o BNPs [a] (mean score)	Ease of value assessment w BNPs [a] (mean score)	Average % of WTP increase due to BNPs
Computer accessories	3.00	2.75	2.00%
Gift certificates	3.25	3.00	3.75%
Electric appliances	4.60	3.00	10.70%
Household goods	4.67* [b]	3.40	26.75%** [c]
Consumer electronics – cheap items	4.80	3.75	27.67%
Jewelry	6.00**	3.00	36.83%**
Handicrafts and collectables	7.33***	4.93	15.56%*
Consumer electronics – expensive items	7.00***	3.60	34.00%**
Grand average	5.34	3.60	23.05%

[a] Based on a 11-point scale where "0" means very easy and "10" means very difficult.
[b] Indicates statistical significance at the corresponding level given by the number of asterisks on a t-test comparing the ease of value assessment for each product, with and without BNPs (column 2 vs. 3).
[c] Indicates statistical significance at the corresponding level given by the number of asterisks based on a t-test comparing the percentage change in selling price due to BNPs with zero.
* $p < .1$; ** $p < .05$; *** $p < .01$; p-values are based on a one-tailed test for directional hypotheses.

Product Selection

To test BNPs' reference price effect, it is important to rule out alternative usages of BNPs (for example, by risk-averse or time-sensitive bidders). In order to do this, I selected products that are readily available in the local marketplace, and allocated to all auctions the duration of one day. Winning bidders were required to wait several days to pick up the item, even if they used a BNP. In this way I ruled out alternative motives for using BNPs.

The products for auction included new consumer goods such as electronic devices (e.g., digital cameras, stereos, and cordless telephones), computer products (e.g., CD burners and CD-R spindles); household goods (e.g., 20-piece dinner sets, cookware sets); and jewellery items, collectables, crafts and art work.9 Table 1 provides a summary of the product categories and the corresponding mean scores of the perceived difficulty in assessing the product values, as well as the percentage changes in auction outcomes. I can see that product categories differed with regard to the difficulty of assessing the value of the item, and the more difficult the assessment, the greater the impact of a BNP on bidders' WTPs.

Data Collection

The products were auctioned off according to the rules of the common ascending-bid (English) method, where the product is sold to the highest bidder at the completion of the auction. Each auction consisted of a picture and a verbal description of

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[9]These products are commonly sold in Internet auctions and are consistent with those used in previous empirical research on Internet auctions (e.g. electronic devices or computer products in Ariely and Simonson 2003; Park and Bradlow 2005; Zeithammer and Liu 2006; and art or

the product, and starting bids were set at one cent. All products were auctioned off by the same seller with an established feedback profile (over 80 feedbacks), which remained constant over the period of the study. Data were collected on the complete bidding history of all 150 auctions. In addition to information on the amount of the winning bid, I also had access to the willingness-to-pay (WTP) of the winning bidder.[10] A bidder's WTP is defined as the highest bidding amount cast by that bidder, and is used to measure that bidder's valuation. At the completion of an auction, the winner was contacted by e-mail. Pick-up of the sold items was arranged through a local retailer. Each winner was asked to complete a survey upon collecting the item won in the auction (the response rate was 81%). For those auctions in which winning bidders did not fill-out the survey, I used survey responses from the second highest bidder. This left us with a total of 143 responses out of a possible 150. A copy of the survey is provided in Appendix A.

Manipulation and Confounding Checks

All 150 auctions ended via bidding; hence none of the bidders used the BNP. This indicates that my manipulation successfully eliminated bidders' incentives to use it.

For a BNP to be an effective reference price, it is important that bidders be exposed to the reference price and, moreover, that the reference price not be implausibly high (Kopalle and Lindsey-Mullikin 2003). Additional information from the post-auction survey provides insight into this. First, all survey respondents answered in the

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collectables in Bajari and Hortacsu 2003; Brint 2003; Häubl and Popkowski Leszczyc 2003; Kamins, Drèze and Folkes 2004; Ku et al. 2005; Reiley 2006).

[10] In most instances, (previous research provides information about only the winning bid, which is equal to the valuation of the second highest bidder. Since I have access to the actual amount of the proxy bids by the winning bidders in this study, I also know the WTP of the winning bidder.

affirmative to the question "Did you notice a BNP in this auction?" Second, in order to check the credibility of BNPs, winners of auctions with a BNP present were asked, "Do you think the BNP was an accurate reflection of the retail value?" A mean score of 6.29 (S.D. 2.29) indicated that BNPs were perceived accurate by bidders (on an 11-point scale, where 0 = not accurate at all and 10 = very accurate). Results of a t-test revealed that this mean score was statistically significant from the midpoint of the scale (based on a one sample $t = 4.77$, $df = 70$, $p < .01$). I also asked, "To what extent did the presence of BNPs influence your bid amount?" A mean score of 4.88 (S.D. 2.23) indicated a moderate self-reported influence of BNPs (on an 11-point scale, where 0 = no influence and 10 = highly influenced). Finally, a confounding check for the week in which the auction was conducted showed no significant effect on WTPs ($M_{\text{Week one}}$= \$24.06 vs. $M_{\text{Week two}}$ = \$22.10; $t = 0.51$, $df = 148$, $p > .8$, NS).

The Effect of BNPs on Bidders' Valuations

When testing the reference price effect of BNPs (Hypothesis 1), I were interested in two effects: the *within-product* effect and the *between-product* effect. The within-product effect measures the extent to which bidders' valuations in an auction with a BNP will be greater compared to that in the auction for the same product without a BNP. Thus, the within-product effect investigates the effect of the presence of a BNP. This effect is tested via a paired sample t-test. In contrast, the between-product effect evaluates the extent to which auctions of different products with higher BNPs will obtain relatively higher auction outcomes. Thus, the between-product effect examines the effect of the magnitude of BNPs and is estimated using regression analysis.

I first tested the within-product effect of BNPs. On average, when a BNP was present, the WTP increased by 23.05% from \$20.70 to \$25.47 (with a 23.42% increase in the ending price in the auction, from \$19.35 to \$23.89). A paired sample t-test indicated that the within-product effect was significant (t = 3.840, df = 74, $p < .001$). This provided support for Hypothesis 1, indicating that the presence of a BNP positively influences bidders' valuations. To consider the between-product effect of BNPs I next conducted a regression analysis.

Results of Regression Analysis

To test Hypotheses 1 and 2, I estimated a linear regression model with the dependent variable being the logarithm of the ratio between the WTPs in auctions with and without a BNP, for two identical products. The rationale to use the ratio of WTPs instead the difference between WTPs is to remove any spurious effect caused by the inherent value of the product. Thus, this model has the advantage that it controls for any variation in value for the different products and it solves the problem of a BNP's being correlated with a product's value.[11] A logarithm transformation was taken to increase the normality. The independent variables included were the logarithm of the BNP set for one of the two identical auctions, the difference in the difficulty of assessing the value of the product (DVA), the difference in the bidders' search activities (DSA), and the difference in the bidders' number of feedbacks (DFB). I therefore estimated the following linear model:

[11] The product value is positively correlated with the BNP by design, since it was set equal to the retail price. In a regression model where I use the valuation of the high bidder as the dependent variable this may lead to a spurious effect for the BNP, since higher bidder valuations tend to be driven by higher product values.

$$\ln\left(\frac{v_i^{BNP}}{v_i}\right) = \alpha + \beta_1 \ln(BN_i) + \beta_2 DVA_I + \beta_3 DSA_i + \beta_4 DFE_i + \varepsilon, \qquad (2\text{-}1)$$

where, v_i^{BNP} and v_i are bidders' valuations in auctions, with and without a BNP, for product i. Bidders' valuations are obtained from the winning bidders' WTP (the amount of the proxy bid from the highest bidder).

α is the intercept; BN_i is the actual dollar amount of the BNP for product i, which was set equal to the retail price of the product.

DVA_I is the difference in the difficulty of assessing the value of the item by the winning bidders, for an auction of product i with and without a BNP. The difficulty of assessing the value is obtained from question 12 in the post-auction survey provided in Appendix A. A larger value for *DVA* indicates that BNPs reduced bidder uncertainty for that product.

DSA_i is the difference in search activities between winning bidders, for an auction of product i with and without a BNP. Search activity is based on question 8 from the survey: "Did you actively search for information for the item?" where yes = 1, and no = 0. A positive value for *DSA* indicates that winning bidders in auctions with a BNP searched more.

DFE_i is the difference between the number of feedbacks for the winning bidders, for an auction of product i with and without a BNP. After the completion of a transaction both buyers and retailers may leave each other either a positive, neutral or negative feedback. The cumulative number of feedbacks is a measure of the degree of expertise of bidding.

Table 2-2 summarizes the regression results. I found a positive significant effect for the magnitude of the BNP ($\hat{\beta}_1$ = 0.54, t = 3.45, p < .001), indicating a stronger reference price effect for higher BNPs, in support of Hypothesis 1. I also found support for Hypothesis 2, as the coefficient of DVA (the difference in the difficulty of assessing the value) was statistically significant ($\hat{\beta}_2$ = 0.28, t = 1.83, p < .05 – based on a one-tailed t-test). This implies that the reference price effect of BNPs is greater when bidders find it more difficult to assess the value of the auctioned item.

DSA (the difference in the amount of search) was not statistically significant, indicating that the effect of BNPs was not influenced by search. DFE (the difference in the number of feedbacks) was not statistically significant, either. This is consistent with the idea that BNPs are informative reference prices influencing both experienced and inexperienced bidders (Northcraft and Neale 1987). I also estimated various other models that included the influence of other bidders and the perceived accuracy of the BNP as independent variables; however, since these variables were not significant, I did not include them in the model.

Behavioural Response

Finally, Hypothesis 3 predicts that bidders in auctions where BNPs are present find it easier to assess the value of the auctioned items. To test this hypothesis, I compared the mean scores for the following question in identical auctions with and without BNPs: “Based on the information provided in the auction, how easy or difficult was it for you to assess the value of the item you won?” ($M_{No\ BNPs}$ = 5.21 vs. M_{BNP}= 3.80, where 0 = very easy and 10 = very difficult to assess the value). The result of a paired-sample t-test (t = 3.76, *df* = 74, $p < .001$) provided strong support for Hypothesis 3.

Table 2-2: Model Results Study 1:
Variables influencing Selling Prices in Auctions

	Coefficient	*t-statistic*
Constant	-0.73 (0.27)[a]	-2.71
Ln(BNPs)	0.54*** (0.16)	3.45
DVA (Difference in difficulty of assessing the value)	0.28** (0.15)	1.83
DSA (Difference in the amount of search)	0.11* (0.07)	1.46
DFE (Difference in the number of feedbacks)	0.005 (.005)	1.02

$R^2 = 0.20$.
[a]Std error in the parenthesis.
* *p < .1;* ** *p < .05;****p < .01;* p-values are based on a one-tailed test for directional hypotheses.

Discussion of Study 1

The results of Study 1 provide support for my hypothesis that retailers in auctions can use BNPs to positively influence the selling prices obtained. In addition, this effect was stronger when bidders perceived the value of an item to be more difficult to assess. Finally, on average, bidders found it easier to assess the value of an item when a BNP was present, indicating that bidders may use BNPs in assessing the value of items. This is consistent with Table 2-1which shows that bidders' WTPs for products for which the value is more difficult to assess were influenced more by BNPs.

Nevertheless, Table 1 also indicates that low-end consumer electronics (e.g. clock radios, portable CD players, headsets, and more) were easier to assess the value of and, therefore, their selling prices were not influenced by the presence of a BNP. On the other hand, the opposite is true for high-end consumer electronic products, like DVD players, home theater systems, and digital cameras. This raises an interesting question regarding the moderating role of product class, which will be addressed in Study 2.

2.3.2. Study 2: A Laboratory Experiment

In Study 2, I further investigated the reference price effect of BNPs and its moderating factors. I tested the hypotheses (Hypotheses 4, 5, and 6) regarding two moderating factors: 1) the ease of value assessment and 2) product class.

Although Study 1 considered the moderating effect of the ease of value assessment on the effectiveness of BNPs, these analyses were affected by the usage of a broad range of products which varied widely in this regard. To obtain a clearer separation based on this dimension, in Study 2 I selected two products with different degrees of assessment difficulty. Based on the results of a pre-test I selected memory cards and diamond earrings.[12] In addition, I manipulated product class within each product by varying the level of the main attribute. Thus, both memory cards and diamond earrings were manipulated to obtain either a high-end or low-end product. To test my hypotheses, I conducted a two (product category: memory cards vs. diamond earrings) by two (product class: high-end vs. low-end) by two (BNP: presence vs. absence) mixed design with product category as the within-subject factor.

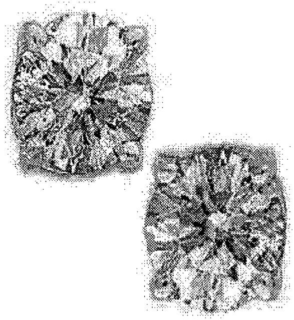
Experimental Procedure

I created different webpages with an auction for each product category and product class. An example of an auction for a high-end diamond earring is provided in Figure 2-2. Each auction provided a product description and pictures of the product, and either a BNP was present or was not. I manipulated the product class on the most salient attribute, the storage space for the memory cards (4,112 megabytes vs. 256 megabytes), and the weight for the diamonds (.14 carat vs. 2 carats).

[12] 45 participants rated 15 different products on the "ease of assessing the value of the good" based on an 11-even point scale, where 0 = very easy and 10 = very difficult. Diamond earrings were assessed to be difficult to evaluate (M = 7.9), and memory cards easy to evaluate (M = 3.4).

Figure 2-2: Example Auction from Study 2
(High-end diamond earrings with BNP)

2.0 CARAT CERTIFIED WHITE GOLD DIAMOND STUD EARRINGS



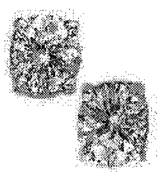
Starting bid:	**CA $1.00**
Buy It Now Price:	**CA $1,999.00**

Note: Buy now price means if you pay ***$1,999.00,*** you will win the auction immediately.

Description

DiMa jewelry

14K White Gold PRINCESS Diamond Stud Earrings 2.00ct. H/I, I1



Metal Type	14K White Gold
Carats	2.00
Color	H/I
Clarity	I1

You are bidding at a beautiful pair of PRINCESS cut Diamond studs. They come with SCREW backs (unless you want a push back), avail. in white or yellow gold. The Total weight is 2.00ct. H/I color, I1 clarity (eye clear). These are very BRILLIANT because they are cut to an IDEAL cut to maximize the sparkle.

Diamond Color Grade

Color	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	Fancy
Scale	Colorless			Near Colorless				Faint Yellow			Very Light Yellow					<-----Light Yellow----->								Color

Diamond Clarity Grade

Clarity	FL	IF	VVS^1	VVS^2	VS^1	VS^2	SI^1	SI^2	I^1	I^2	I^3
Scale	Flawless-Internally Flawless		Very Very Slightly Imperfect		Very Slightly Imperfect		Slightly Imperfect		Imperfect		

A total of 87 undergraduate business students from a major university in North America participated in the study in exchange for course credits. The experiment was conducted in a laboratory equipped with 15 computers. Upon arrival, participants were randomly assigned a code (for one of the eight conditions) which gave them access to a website with an experimental auction. Participants were told that they had to evaluate the product in the auction. After browsing the webpage for approximately three to five minutes, participants were instructed to click on a button and answer several questions related to the auction. I asked participants' willingness-to-pay (WTP) for the item, and their estimate of the retail value (ERV), both in dollar terms. I used WTP and ERV to measure their valuations. To measure the ease of value assessment, I asked participants to rate the statement "It is difficult to judge the value of the product" on a nine-point Likert scale anchored by "-4" "strongly disagree" and "4" "strongly agree." Participants then proceeded to another auction for the other product category. Product class was randomly selected but I kept the BNP condition constant across the two auctions.

Manipulation Checks

Results of a one-way ANOVA on product category suggested that the value of the diamonds earrings was perceived as being more difficult to assess ($M_{\text{Dimaond earrings}}$ = .1.72 vs. $M_{\text{Memory cards}}$ = .13, $F_{(1,173)} = 28.36$, $p < .001$). In addition, testing the mean score of diamond earrings against the middle point (which is zero) revealed a significant difference ($t = 8.62$, $df = 86$, $p < .001$). These findings indicate that my selection of product categories was successful.

I further compared the effect of product class on the ease of value assessment. Consistent with my expectations, participants found it more difficult to assess the value of high-end products. However, this difference was statistically significant only for diamond earrings ($M_{High\ end}$ = 2.16 vs. $M_{Low\ end}$ = 1.11, t = 2.66, df = 85, p < .01), not for memory cards ($M_{High\ end}$ = .32 vs. $M_{Low\ end}$ = -.14, t = .1.03, df = 85, p > .3).

I did not find any significant order effect for the within-subject factor (For memory cards, $F_{(1,85)}$ = 1.94, p > .15 for WTP, and $F_{(1,85)}$ = 1.75, p > .15 for ERV; for diamond earrings, $F_{(1,85)}$ = 1.23, p > .25 for WTP, and $F_{(1,85)}$ = .56, p > .45 for ERV.) Thus, I pooled all the observations for subsequent analyses.

Moderating Effect of Product Class

I conducted two separate three-way ANOVA on the two dependent variables: WTP (willingness-to-pay) and ERV (estimate of retail value). Analyses yielded a significant two-way interaction effect between product class and presence of BNPs for both WTP and ERV ($F_{1,166}$ = 7.13, p < .01 for WTP, and $F_{1,166}$ = 5.51, p < .05 for ERV) and a significant three-way interaction effect for WTP ($F_{1,166}$ = 4.86, p < .05) and ERV ($F_{1,166}$ = 5.64, p < .05), respectively. The three-way interaction effect implied that participants' valuations varied according to whether a BNP was present or not; this effect differs for diamond earrings as compared to memory cards and for high-end products versus low-end products. In order to further interpret these results, I conducted planned contrasts.

The planned contrasts involved product category and product class (mean values of WTPs and ERVs of experiment conditions are summarized in Table 2-3). I found a significant difference for both WTP and ERV for high-end diamond earrings (M_{BNP} = 1267.59 vs. $M_{NO\ BNP}$ = 825.59, $F_{1,166}$ = 14.90, p < .001 for WTP, and M_{BNP} = 1629.35 vs. $M_{NO\ BNP}$ = 1056.18, $F_{1,166}$ = 15.91, p < .001 for ERV). On the other hand, BNPs did not influence WTP and ERV for low-end diamond earrings ($F_{1,166}$ = 1.38, p > .2, for WTP, and $F_{1,166}$ = .85, p > .3 for ERV). The planned contrast for memory cards did not reveal any significant effect due to BNPs for either high-end products ($F_{1,166}$ = .21, p > .6, for WTP, and $F_{1,166}$ = .03, p > .9, for ERV) or low-end ones ($F_{1,166}$ = .003, p > .9, for WTP, and $F_{1,166}$ = .001, p > .9, for ERV).

Table 2-3: Willingness to Pay and Estimated Retail Value for Different Product Categories

Experimental conditions	Willingness to pay	Estimated retail value
.14 CT Diamond Earrings without BNPs	\$206.59 (199.13)[a]	277.50 (210.42)
.14 CT Diamond Earrings with BNPs	52.00 (42.02)	125.43 (124.63)
2 CT Diamond Earrings without BNPs	825.59 (761.35)	1056.18 (961.32)
2 CT Diamond Earrings with BNPs	1267.58 (518.00)	1629.35 (452.39)
256 MB Memory Card without BNPs	30.59 (17.22)	35.53 (18.57)
256 MB Memory Card with BNPs	23.53 (10.86)	32.65 (15.22)
4 GB Memory Card without BNPs	98.33 (80.81)	216.36 (343.92)
4 GB Memory Card with BNPs	148.50 (93.33)	209.50 (92.31)

[a] Standard errors is in the parenthesis.

These results indicated several interesting patterns. First, BNPs did not affect auctions of memory cards (whose value is easier to assess). Second, in none of the cases did BNPs have an influence on low-end products. I found a significant effect only for the high-end diamond earrings. Thus, I found support for Hypothesis 6, indicating that the effect of BNPs for high-end products is stronger when a person has more difficulty assessing the value of the product.

I also propose that a BNP should facilitate the formation of valuations, making it easier for people to assess the product value by reducing their uncertainty; therefore, I next examined the effect of BNPs on the dispersion of WTPs and ERPs.

Effect on Dispersion of Valuation Estimates

According to Hypothesis 4, the presence of a BNP reduces variance in the estimate of WTP. For this reason, I conducted Levene's F-test, a commonly used test to assess the equality of variance in different samples. Results indicated that variances for memory cards were not statistically significant whether a BNP was present or not. In comparison, for high-end diamond earrings the variance for WTPs and ERVs were both significantly smaller when a BNP was present ($F = 4.31$, $p < .05$ for WTP, and $F = 9.06$, $p < .01$ for ERP). For low-end diamond earrings, only the variance of WTPs was significantly smaller when BNPs were present ($F = 13.44$, $p < .001$).

Discussion of Study 2

The results of Study 2 provide further support for the reference price effect for BNPs. In particular, I found support for two moderating variables that influence this relationship, the ease of value assessment and product class.

I did not find direct support for Hypothesis 5 (that the reference price effect of a BNP is stronger for high-end products than for low-end products); however, I did find that BNPs had a positive effect on bidders' WTPs for the high-end diamonds, which were difficult to assess (providing support for Hypothesis 6). I also found that the presence of a BNP reduced the dispersion in the WTP, providing additional support for the supposition that people use BNPs in constructing their valuations.

In Studies 1 and 2, I have considered the effects of BNPs in manipulated environments. The conditions in both studies differ in two important ways from those on eBay.com, the largest auction website in the world. First, in eBay auctions BNPs disappear as soon as a bid has been placed, and (or) a secret reserve price has been met. Second, there are many competing auctions on eBay, potentially with different levels of BNP. Both factors will limit a BNP's reference price effect. For this reason, in Study 3, I investigated whether BNPs also have a reference price effect in real world auctions such as those on eBay.

2.3.3. Study 3: An Empirical Analysis of eBay Auctions

Data from completed eBay auctions were used to examine the existence of the reference price effect of BNPs. The product category selected was diamond stud earrings, because the results of Study 2 indicated this is a product category where consumers have difficulty assessing the value of items.

Data

From February to March 2004, a spider program was written to automatically collect data from eBay.com on 786 auctions for stud diamond earrings. This program recorded the data of newly-posted auctions at three-hour intervals and, as well, the complete bidding history and data of the completed auctions.[13] Information collected included product characteristics, seller characteristics and auction characteristics. From auction's product descriptions, I collected data on the product characteristics used to determine the value of diamonds: carat weight, clarity, and color,[14] as well as on whether an appraisal certificate was provided. Seller characteristics included the sellers' reputations (based on the number of positive and negative feedbacks). Auction characteristics collected included: the starting bid, the presence of a BNP, the amount of the winning bid, and each bidder's highest bid. I later from my dataset removed 349 auctions of "pseudo diamond earrings" such as cubic Zirconium and artificial diamonds.

Since the unit of analysis is individual bidders rather than auctions, I removed all auctions with zero bids. The remaining sample used for analysis consisted of 434 bidders, participating in 69 auctions. Though only a small portion of the data was suitable for analysis, these 69 auctions accounted for 70% of the total transaction amount for stud

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[13] We collected data every 3 hours since the BNP used on eBay disappears after the first bid is placed in an auction (unless the bid is equal to the BNP, which ends the auction).

[14] The 4 C's (Cut, Clarity, Color and Carat Weight) are four attributes that are commonly used to appraise the value of a diamond. We did not include diamond cut, since most auctions did not report the cut of their diamonds.

diamond earrings. All auctions had at least one bidder, and 51.5% of the auctions set a BNP, but *none* of them was executed by bidders.[15]

Model Specification

To model the relationship between BNP and bid amount I incorporate several aspects. First, I accounted for the potential dual causality between BNPs and selling prices. BNPs may be endogenous, as a particular retailer may base a BNP in part on his or her expectations. For this reason, I estimated a recursive system consisting of two models. In the first model I specified BNP as a function of starting bid and product attributes. In the second model I estimated the equation for the bid amount, as a function of BNP, product attributes, and auction characteristics. Accordingly, a two-stage estimation procedure (e.g., Heckman 1976) was used where I first estimated the model for BNP and then, the model for the maximum bid amount, where the estimated BNP from the first model was included as the independent variable. This will account for the endogeneity problem mentioned above because the estimated BNP excluded any retailer-imposed expectations that were based on previous auction outcomes.

$$BNP = \gamma + \lambda_1 SB + \lambda_2 C1 + \lambda_3 C2 + \lambda_4 C3 + \lambda_5 C4 + \lambda_6 NBv \text{,}^{16} \qquad (2\text{-}2)$$

[15] To test for a potential reference price effect, I must first identify those bidders who were exposed to BNP and those who were not. In only 35 out of the 69 auctions, where sellers specified a BNP option, bidders may be exposed to the BNP. Furthermore, given that in eBay auctions BNP disappear after the first bid is placed, only the 35 bidders who placed the first bid in an auction with a BNP are considered to have been exposed to the BNP. It is possible that other bidders may have seen the BNP; however, any significant effects I find will therefore be and underestimate of the total reference price effect.

[16] For notation convenience, the subscript i in (2-2) is dropped.

where SB_i is the starting bid of auction i; $C1_i$ is the color of the diamond in auction i. $C1_i = 1$ if the color is colorless (D - E - F) or nearly colorless (G - H - I - J), else $C1_i$=0;[17] $C2_i$ is the carat weight of the diamond in auction i measured in carats; $C3_i$ is the clarity of the diamond in auction i. $C3_i$=1 if the clarity grade is above VS2 (difficult to see under 10X magnification) the diamond in auction, else $C3_i$=0; $C4_i$ is the availability of an appraisal certificate. $C4_i = 1$ if the diamond in auction i has an authentic certificate, $C4_i$=0 else; NB_i is the number of bidders in the auction, it is used as a proxy for auctioneers' expected competition in auction i.

Second, I used a Tobit model for the bidders' maximum bids, where the upper bound is the ending price of the auction (since in a second price auction such as those on eBay the winning bidders' maximum bids are right censored). Formally, the Tobit model is specified as follows:[18]

$$\begin{aligned} LNBid_{ij}^* = a + (\beta_1 + \beta_2 BNP_i) DBNP_i + \beta_3 SB_i \\ + \beta_4 C1_i + \beta_5 C2_i + \beta_6 C3_i + \beta_7 C4_i + \beta_8 LBR_j + \varepsilon_{ij}; \end{aligned} \tag{2-3}$$

$$LNBid_{ij} = Min(LNP_i, LNBid_{ij}^*) \tag{2-4}$$

where, $LNBid_{ij}^*$ is the logarithm of the maximum bid placed by bidder j in auction i; BNP_i is the estimated buy-now price for auction i from equation (1), BNP_i = n.a. if that auction did not have a BNP; $DBNP_i$ is a dummy variable indicating the presence of

[17] Color and clarity are defined as ordinal variables and in my sample each has four different ranks. We first estimated a model with 3 different dummy variables for each variable, but hypotheses tests indicated that only one dummy variable was needed for each.

a BNP in auction i (1 = yes; and 0 = no); LBR_j is the eBay feedback rating for bidder j. It measures individual bidder's experience with eBay auctions; ε_{ij} is the error term; $\varepsilon_{ij} \sim N(0, \sigma^2)$.

When $DBNP_i$=1, I obtain a model in which bidders were exposed to a BNP:

$$LNBid^*_{ij} = a + \beta_1 + \beta_2 BNP_i + \beta_3 SB_i + \beta_4 C1_i + \beta_5 C2_i + \beta_6 C3_i + \beta_7 C4_i + \beta_8 LBR_j + \varepsilon_{ij}; \quad (2\text{-}5)$$

$$LNBid_{ij} = Min(LNP_i, LNBid^*_{ij}). \quad (2\text{-}6)$$

When $DBNP_i$= 0, I obtain a model in which bidders were *not* exposed to a BNP:

$$LNBid^*_{ij} = a + \beta_3 SB_i + \beta_4 C1_i + \beta_5 C2_i + \beta_6 C3_i + \beta_7 C4_i + \beta_8 LBR_j + \varepsilon_{ij}; \quad (2\text{-}7)$$

$$LNBid_{ij} = Min(LNP_i, LNBid^*_{ij}). \quad (2\text{-}8)$$

Thus, the combined model includes two specifications: one for those exposed to a BNP and the other for those who were not. The total effect of BNPs on the maximum bid is $(\beta_1 + \beta_2 BNP)$. I also used LBR, the only bidder-specific variable in the model, as a covariate for testing of heteroskadasticity; the estimation results indicated that error terms were well-behaved and not related to it (t = 1.36, p < .17). Therefore, we proceeded with the Tobit estimation without worrying about heteroskadasticity.

I estimated a combined specification to increase efficiency, and the results of this model are provided in Table 2-4.

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[18] We also estimated a random-effects model, but this model did not improve the overall fit (based on likelihood ratio tests). Therefore, I only present the results of the simpler model without heterogeneity.

Table 2-4: Tobit Model Results Study 3

	Coefficient	*t-statistic*
Constant	1.75 (0.79)[a]	2.21
DBNP (Dummy of setting BNPs)	2.99 (0.86)	3.45**
BNPs	-8.78E-04 (4.04E-04)	-2.16*
SB (Starting bid)	1.63E-03 (4.65E-04)	3.51***
C1 (Carat)	1.24 (0.28)	4.39***
C2 (Color)	0.39 (0.18)	2.20**
C3 (Clarity)	0.31 (0.21)	1.48**
C4 (Certificate)	-0.15 (0.21)	-0.71
LBR (Bidder rating)	3.11E-03 (1.39E-04)	-2.24**

LLR = -712.96

[a] Std error in the parenthesis
* $p < .1$; ** $p < .05$; *** $p < .01$; p-values are based on a one-tailed test for directional hypotheses.

I found, controlling for all other variables, that BNPs had, in general, a positive effect on bidders' maximum bids. In addition, the starting bid and product attributes except for certificate had significant positive effects on bidders' maximum bids. Since the effect of a BNP on bidders' maximum bids is $(\beta_1 + \beta_2 BNP)$, the positive sign for $\hat{\beta}_1$ ($\hat{\beta}_1 = 2.99$, $t = 3.45$, $p < .01$) suggested that in general, there was a positive BNP effect on bidders' maximum bids for those bidders who were exposed to it. However, the negative sign of $\hat{\beta}_2$ ($\hat{\beta}_2 = -$ 8.78E-04, $t = -2.16$, $p < .02$) implied that the positive BNP effect was decreasing as BNPs increased. Further, when a BNP was set too high, it imposed a negative effect on bidders' maximum bids.[19]

Discussion of Study 3

I again found that the absolute value of a BNP, while controlling for product attributes, had a positive influence on bidders' maximum bids. Hence, I also found that the reference price effect of BNPs persist in an environment where there are many competing auctions for similar items, even though BNPs disappear after a binding bid has been placed.

In addition, as we categorized bidders who placed the subsequent bids after the first bid as those not exposed to BNPs, we potentially provide a biased estimate of effect of BNPs on bidders' valuations. The rationale is that some bidders who did not place the first bid in an auction may also have had access to the information of a BNP when they

[19] We also added seller reputation and an interaction with BNP but this was not significant, an interaction between starting bid and BNP was also insignificant. The variance-covariance matrix did not reveal any problems of multicollinearity.

browsed that auction at an earlier time. Thus, even though we did not treat these bidders as those who were influenced by a BNP, they actually were influenced by it. Thus, the estimates reported in Table 2-4 underestimated the effect of BNPs. Nevertheless, the estimation results are still statistically significant; this indicates that the reference price effect of BNPs was robust.

Results also showed that a high BNP may have a negative impact, as indicated by the negative interaction effect between DBNP and BNP. When the BNP is set too high, it can negatively affect auction outcomes. Awareness of this may stop retailers from setting a BNP that is too high.

2.4. General Discussion

Buy-now prices are a popular option used by retailers in online auctions. In the first essay I developed a conceptual model that extends previous theories on the usage of buy-now prices. The model provides an explanation for the usage of buy-now prices as an alternative (1) for consumers with high waiting costs, (2) for risk-averse bidders who would be afraid to lose the auction, and (3) as an external reference price for bidders who find product values difficult to assess. The concept of value uncertainty used in this essay relates to fundamental concepts in auction theory. Auction theory distinguishes between two basic models of how bidders form valuations: the *private-values model* and the *common-values model.* In the common-values model, the value of the item is the same for everyone, but bidders are uncertain about it (Rothkopf 1969). A good example is oil drilling rights; they have a highly uncertain value that is essentially the same for all bidders. In contrast, in private-values auctions a bidder's valuation of an item is based on her individual preferences and is independent of other participants' valuations of the object (Vickrey 1961). An example is the buying of a painting for enjoyment rather than for resale, where buyers' valuations may differ but are not influenced by the valuations of other bidders. Since many real-world auctions have both private and common value aspects, Milgrom and Weber (1982) develop the *affiliated-values model*, where items can be thought of as on a continuum with common and private values as the end points.

It is, however, important to realize that while traditionally it is assumed that bidders in a private-values context know their own valuations (while in a common-values context they do not), this does not have to be the case. The difference between common and private-values items is related to the question of whether information from other bidders is informative or not; it is not the uncertainty concerning the value that distinguishes common-values goods from private-values goods. For example, if a bidder's valuation is not affected by that of other bidders, this is a private-values good (for this bidder), regardless of how certain or uncertain her valuation may be (Popkowski Leszczyc and Rothkopf 2006). In conclusion, it is whether information from other bidders is informative not the uncertainty concerning the value that distinguishes between common and private-values goods. Since my research is based on the concept of value uncertainty, I use this basic construct rather than common-values/private values from auction theory.

In addition, there are strongly divergent opinions about the classification of common versus private-values goods, even by auction experts. Boatwright, Borle and Kadane (2006) find that auction researchers disagree on the classification of most products; even more surprisingly, some products are classified in opposing groups (e.g. about half the experts participating in the study classified electronic products as private-values, while the others classified them as common-values). Therefore, although common and private-values are important concepts in theoretical models, they tend to be difficult to implement in empirical work.

Results of the first essay have important implication for both consumers and retailers. Consumers bidding in an auction should be careful when determining the value of an item in an auction, and should not rely too much on buy-now prices as an information source. Our conceptual model shows how retailers can use buy-now prices strategically. The level of the buy-now price depends on the product type and the specific objective. An optimum buy-now price will vary depending on whether retailers want to provide insurance to risk avers bidder, or segment time sensitive consumers or whether they use them as informative signals about the price of an item. Retailers can use buy-now prices as signals or external reference prices, and thereby positively influence auction outcomes. However, the effect of the signal diminishes as the buy-now price increases. Therefore, they should take precautions not to set buy-now prices too high.

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Appendix 2-1: A Survey of Auction Winners

Item bid on ____________________

1. How many times have you visited CampusAuctionMarket in the past week? ______ times

2. Are you a University Student? □ Yes □ No

3. How many bids did you place in this auction? _____ bids.

4. Did you notice a "Buy now" price in this auction? □ Yes □ No

If you answered No, please jump to question 8 and continue.

5. What was the amount of the "Buy now" price? $_______ □ Don't remember

6. Do you think the BNP was an accurate reflection of the retail value?

0	1	2	3	4	5	6	7	8	9	10
not accurate at all										very accurate

7. To what extend did the presence of the BNP influence your bid amount?

0	1	2	3	4	5	6	7	8	9	10
not at all influenced										highly

8. Did you actively search for information for the item?

□ Yes □ No

If you answered No, please jump to question 11 and continue.

9. Please circle the information source you have used (as many as applied)

□ Internet □ Shops □ News papers /fliers □ Friends/family members

□ Other, please specify ____

10. To what extent did information search for the item influence your bid amount?

0	1	2	3	4	5	6	7	8	9	10
not at all influenced										highly

11. To what extent did the bidding behavior of other bidders influence your bid amount?

0	1	2	3	4	5	6	7	8	9	10
not at all influenced										highly

12. Based on the information provided in the auction, how easy or difficult was it for you to assess the value of the item you bid on? Please circle one of the numbers.

0	1	2	3	4	5	6	7	8	9	10
very easy										very
difficult										

13. How much do you think the item won in the auction would cost if purchased locally? $______

14. In how many auctions have you participated in the past month by placing bids?
    ________ Number of bids in Campus Auction Market
    ________ Number of bids in other auction sites

3. Facilitating Consumer Learning: Used Markets, Buybacks, and Rentals

3.1. Introduction

Considerable marketing activity in newspapers, Internet auction sites, and retailing revolves around buying and selling used products. It is well-recognized that used markets help consumers dispose of durable products when they are needed for only a portion of their lives (e.g., Liebowitz 1982; Miller 1974). Less recognized is the role of used markets in facilitating consumer learning about products that require time, effort, and cost to evaluate.

The products that I study in this essay are experience goods (in the sense discussed by Nelson 1970). Consumers must personally interact with such products before learning the level of utility that these products provide. But I focus on one kind of experience good that requires an extended period of use for such learning. I refer to these as *slow-to-evaluate experience goods*.

An information asymmetry arises for such products. Consumers must commit monetary resources, time, and effort before they know whether they will value the product. If they like the product, there is a net gain; if not, there is a net loss. And if the prospective loss is too great, consumers may pass on product trial altogether, resulting in market failure.[20]

This essay considers how traditional and retail-administered used-markets circumvent this information problem. In particular, there are two ways that used markets can be used by consumers to facilitate low-risk learning about a slow-to-evaluate product. Consumers can "start new" by buying a new (not-previously-used) product first, and, if they do not like it, sell it later on the used market. Alternately, consumers can "start used" by buying a used product with a limited life first, and, if they like it, buy a longer-lived new one later. Thus, the risk to consumers is reduced because the initial outlay is either partly recoupable or kept to a minimum, respectively.

I first address three questions associated with the "starting-new" and the "starting-used" approaches to utilizing used markets. (1) How do these two approaches facilitate consumer learning? (2) What factors compel consumers to choose one or the other of these approaches? (3) What are the consequent implications for sellers of new (not-previously-used) products when setting price?

In addition, I consider two retail policies that create self-initiated used markets (often in the absence of formal used markets). Buyback policies (including money-back guarantees as a special case) enable consumers to "start new" by buying the new product first, and, if they do not like it, sell it back later to the retailer. Alternately, rental policies enable consumers to essentially "start used" by buying the service of the product for a limited term, and, if consumers like it, buy a longer-lived product later. Again, in both

[20] Note that because slow-to-evaluate experience goods require extended personal interaction to determine their value, word-of-mouth based on other consumers' experiences will not remove the information asymmetry.

cases, the risk to consumers is reduced because the initial outlay is either partly recoupable or kept to a minimum, respectively.

For buyback and rental policies, I consider three further questions. (4) How do these two policies facilitate consumer learning? (5) How should a seller optimally design these policies? (6) Which of these two policies works better for products with varying transactions costs and success rates?

To motivate my focus on slow-to-evaluate experience goods, I note that there are many instances of such goods. One type of slow-to-evaluate experience good involves "idiosyncratic quality" that requires consumers to interact with the product personally for a period of time before fully understanding whether they have a "preference match" (Heiman et al. 2002; Tirole 1988). Such is the case for clothing or any product for which the style, fashion, or technology may be relatively new to the market or to a particular consumer. A second type of slow-to-evaluate experience good involves utility cogeneration where the consumer must develop related skills to fully realize the value of the product, and first-time buyers may not know the ultimate level of skill that they will attain (this type of product might be referred to as a "skill good").

Such is the case for sports products, musical instruments, photographic equipment, software, and even power tools. Our purpose here in identifying both "idiosyncratic" and "skill-based" slow-to-evaluate experience goods is to point out that there are many instances of such experience goods.

To motivate my consideration of store-initiated buyback and rental policies (as well as used product sales by stores themselves), the authors conducted a phone census of retail policies of all specialty chains selling pianos, sports bicycles, and skis listed in the yellow pages of a particular metropolitan area in North America with population of about one million (see Table 1).

Table 3-1: Retail Sales Policies

Products	No. of Chains	No-fault return & refund	Buyback	Product rental	Used items for sales
Pianos	9	0	6	1	7
Sports Bicycles	11	1	2	0	8
Skis	11	2	0	7	1

This table reinforces what most consumers already know: that many retail chains offer buyback and rental policies (and many also sell used products). The table also suggests a differential application of these sales policies across product categories.

As mentioned, past literature has focused on the role of used markets in helping consumers dispose of durable products when they are needed for only a portion of their lives (e.g., Liebowitz 1982; Miller 1974). This literature recognizes that used products are substitutable with new products (e.g., Bulow 1982; Waldman 1993) and that the existence of used markets thereby affects sellers' profitability for new products (e.g., Liebowitz 1982; Fudernburg and Tirole 1998). The link between used and new product markets further gives rise to complications for channel management (e.g., Purohit and Staelin 1994; Johnson and Waldman 2003). These are important considerations. The current paper, by contrast, focuses on a different role that used markets serve in facilitating low-risk consumer learning about slow-to-evaluate experience goods.

While this role of used markets has not received much attention, a similar role has been acknowledged for money-back guarantees (e.g., Davis, Gerstner and Hagerty 1995; Heiman, et al 2002). According to this solution, the seller facilitates purchase and consumer learning by allowing the consumer to return the product to the seller for a full refund of the purchase price. I argue that used markets, product rentals, and partial refunds also facilitate consumer learning in similar ways, but with nuanced differences in terms of transactions costs, product wear-out, who maintains ownership of the product during the consumer learning process, exposure to risk, and the way that the product is recirculated to used markets or otherwise salvaged if the consumer does not like the product. The current paper studies these nuanced differences.

Overall, this essay discusses how a seller can effectively market slow-to-evaluate experience products to first-time consumers who can not know their ultimate valuations until after purchase. The paper is organized as follows. Section 2 lays out the model assumptions. Section 3 analyzes a monopolistic seller's pricing strategies and consumer learning strategies in the presence of a used market. Section 4 addresses a seller's choice of sales policy when external used markets are not available. Section 5 concludes with a discussion of managerial implications and suggests directions for future research.

3.2. Used-market Learning Model

I study a product that is *novel* to the consumer in the sense that the consumer does not initially know the value of it, but must spend time and effort interacting with it to learn.[21] This is distinct from products that are merely *new* in the sense that they have not been used before.

3.2.1. Durable Good Market with Valuation Differentiation

The product under consideration has durability *d*, which describes the length of time the product is usable. New products have $d = 1$; used products have $0 < d < 1$; and "used up" products have $d = 0$. Only one unit of the product can be consumed by an individual consumer at any instant in time.

For simplicity, there are exactly two types of consumers, types *h* and *l*, corresponding, respectively, to high and low valuation types. The utility function from consuming a product with durability *d* is

$$u_i(d) = v_i d, \tag{3-1}$$

where v_i is the valuation of the new product for the type *i* consumer, where $i \in \{l, h\}$.[22] I set $v_h \equiv v > v_l = 0$. Thus, type *h* consumers value a product with durability *d* as *vd* and type *l* consumers value such a product as zero.

Durability of all products is known with certainty.[23] Consumers initially do not know their own types, however. They do know the proportion, θ, of type *h* consumers.

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[21] The product category may be novel to the whole market or just novel to a particular consumer.

[22] We, thus, tie the valuation of durability with the literature on vertical product differentiation, which often assumes the same functional form for utility as (1), except that *d* is interpreted as product quality (*e.g.*, Gabszewicz and Thisse 1979; Shaked and Sutton 1982; Moorthy and Png 1992). More generally, I could consider any utility function for consumer type i such that $u_i(d)$ is increasing in d and $u_h(d) > u_l(d)$.

3.2.2. Learning Stage, Consumption Stage, Learning Costs, and Product Depreciation

Consumers learn their types only after an interval of product usage, which I call the *learning stage*. Consumers do not derive any utility from the product during this stage.[24] After engaging in the learning stage with a new product, consumers engage in what I refer to as a *consumption stage*. Consumers derive utility from the product during this stage.

During the learning stage, consumers incur a learning cost, *e*. This cost is interpreted as the total expense of effort, time, and possibly money (*e.g.*, fees for tutoring and coaching) spent on learning. Such costs exist for almost all skill-based products, including piano lessons, golf tutoring, and effort spent learning new software. Such costs also exist to learn whether there is a "preference match" for such non-skill-based goods as clothing or new furniture (to examine the fit with a consumer's style or the decor of a house).

At the end of the learning stage, product durability is reduced by δ, $0 < \delta < 1$, associated with product "wear and tear." This part of the product life can be thought of as "used up." So a product with initial durability d will have a leftover durability $d - \delta$ at the end of the learning stage. (Thus, any product used for learning purposes must have durability at least as large as δ.) Generally, I believe that δ varies across categories: it may be small for such items as software or clothing, but it may be large for such items as

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[23] This assumption helps us avoid concerns relating to the lemon's problem (Akerlof 1970). In this essay, uncertainty concerns consumers' knowledge of their own valuations (types), not product durability (or quality).

golf clubs or other sporting equipment. The parameter δ can be interpreted as measuring the proportion of a new product's life required for the learning stage; $1-\delta$ is the proportion remaining for the consumption stage.

3.2.3. Emergent Heterogeneity

For simplicity, consumers are risk-neutral. Prior to the learning stage, a product with durability, *d*, and price, *p*, gives rise to the same expected net surplus for all consumers:

$$ES = \theta(d - \delta)v - e - p - t_n. \qquad (3\text{-}2)$$

After the learning stage, consumers realize their types, and consumer taste heterogeneity emerges.

3.2.4. Used Market Prices and Transactions Costs

I assume that products are on sale on the used market. These used products have the same functionality as new products, but lower durability.

I define $s(d, p)$ as the used-market price for a product with the durability d, given the associated new product price p. In general, I expect $s(d, p)$ to be increasing in d and p, and, in fact, the used-market price might be more properly modeled as the endogenous outcome of assumed supply and demand conditions, which would give rise to various possible reduced forms for $s(d, p)$. For tractability, I instead assume a form for

[24] One could allow consumers to derive utility during the learning stage, but this only distracts from my main points.

$s(d, p)$ that can also be motivated by assuming combinability and divisibility of durability with perfect arbitrage,

$$s(d, p) = dp. \tag{3-3}$$

I also assume that there is a transactions cost of buying on the used market of t_b and a transactions cost of selling on the used market of t_s. The former includes, but is not limited to, search costs and costs of inspecting the durability of the product. The latter includes the costs of an intermediary service in the used market (*e.g.*, eBay) or promotional marketing expenditures (*e.g.*, fees to post in the classified). There is also a transactions cost of buying a new (not-previously-used) product, t_n. I include this for completeness, but often this is relatively low. In particular, I assume $t_b > t_n$ and $t_s > t_n$.

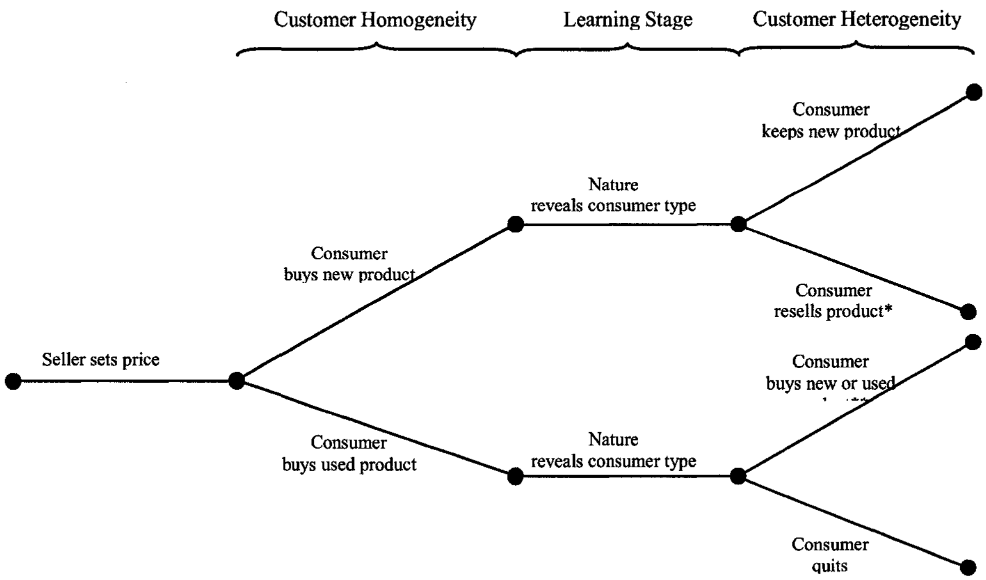
The new product is produced by the seller at a constant marginal cost c, where $0 < c < v$. To simplify my analysis, the market size is normalized to one.

3.2.5. Time Horizon and Order of Moves: Leader-Follower Structure

I examine a time horizon normalized to length one, which happens to coincide with the length of life of a new product. The objective of the consumer is to maximize the expected consumer surplus (utility less monetary and non-monetary costs over this time horizon). At the end of the time horizon, any product with remaining durability d is included in consumer surplus at an imputed value equal to the prevailing used-market price: $s(d, p) = dp$.

The model is, formally, a leader-follower game (see Figure 3-1). From the seller's perspective, the new product price, p, influences which learning approach the consumer will take.

Figure 3-1: Used-Market Learning Game: Leader-Follower Structure



*The consumer resells the product on the used market if it is profitable to do so; otherwise, the consumer disposes of the product.
** The consumer decides whether to buy a new or a used product for the consumption stage.

From the consumers' perspective, used markets can be utilized in one of two ways to facilitate consumers' learning their types:

Consumers can start by directly buying a new product to learn their type. If type l valuation is realized, the product can be sold back on the used market. I call this aggressive approach the *starting-new* approach.

Consumers can start by trying a used product. If type h valuation is realized, the consumer can continue consumption by buying a new product (or another used product). I call this conservative approach the *starting-used* approach.

I assume that the price, p, selected by the seller remains in effect throughout the game. Thus, the seller, by setting the new-product price, determines the schedule of used market prices $s(p, d)$, $0 < d < 1$, throughout the game. I summarize my notation in Appendix 3-2.

3.3. Analysis of the Used-Market Learning Game

I consider this game by analyzing (a) a benchmark case of market failure when there is no used market, (b) the starting-new approach, (c) the starting-used approach, (d) how these two used-market approaches avoid market failure, (e) consumer choice between these learning approaches, (f) seller pricing in this game, and (g) the stable outcome.

3.3.1. The "As-is" Benchmark – without a Used Market

Our benchmark case consists of consumers buying a new product in the absence of a used market. Following Davis *et al.* (1995), I refer to this as buying the product the "As-is."

For consumers to be willing to buy a new product the "As-is," the expected surplus from selling the "As-is" (herein, ES_{AsIs}) must be nonnegative. That is, I must have

$$ES_{AsIs} = (1-\delta)\theta v - e - p - t_n \geq 0 \quad (3\text{-}4)$$

Hence, the highest price that can be charged sets expected surplus to zero:

$$p^*_{AsIs} = (1-\delta)\theta v - e - t_n. \quad (3\text{-}5)$$

Since production costs are normalized to zero and the market size is normalized to one, the seller's optimal profit, $\pi^*_{AsIs} = p^*_{AsIs} - c$, is non-negative when

$$e \leq (1-\delta)\theta v - c - t_n \quad (3\text{-}6)$$

This yields my first result.

> ***Proposition 1.*** *When consumers are restricted to buying the new product the "As-is" (i.e., there is no used market), there will be market failure when Equation (3-6) is violated. Market failure arises from some combination of (a) high learning cost, e; (b) high learning depreciation, δ; (c) low probability of success, θ; or (d) high transactions cost, t_n.*

I consider this a *market failure* because some consumers have latent valuations that support positive prices (and profits), but the information structure is such that no product sales occur and no consumers ever attempt to learn their types.

Now I turn to the starting-new and starting-used approaches to help avoid such market failures. In the following analysis, to remove the ties in consumer decision making, I assume that when consumers are indifferent among several alternatives, they always prefer buying a product to not buying one, buying a new product to buying a used one, and keeping the new product to reselling it.

3.3.2. The Starting-new Approach

In the starting-new approach, consumers start by buying a new product at the given price p. After learning their valuations, type h consumers keep the product and derive utility $(1-\delta)v$ from consumption (since the remaining durability is $1-\delta$).[25] Type l consumers derive no utility from the product and decide to resell it, provided the used-market price exceeds the transactions cost—which, instead, yields the consumer $\max((1-\delta)p - t_s, 0)$

At the time of purchase, consumers do not know their type, however. Their expected surplus from starting-new, ES_N, is given by

$$ES_N = (1-\delta)\,\theta v + (1-\theta)(\max((1-\delta)p - t_s, 0)) - e - p - t_n \geq 0. \qquad (3\text{-}7)$$

When the above inequality holds, Equation (7) constitutes the consumers' participation constraint when starting-new.

The monopoly price arises by setting (3-7) to zero; which yields

$$p_N^* = \frac{(1-\delta)\theta v - e - (1-\theta)t_s - t_n}{\theta + \delta - \theta\delta} \text{ when } t_s \leq (1-\delta)p_N \text{, and} \qquad (3\text{-}8)$$

[25] It can be shown that type h consumers are at least as well off keeping the product than (a) selling the product on the used market for cash, or (b) selling the product on the used market and buying a new product instead.

$$p_N^* = (1 - \delta)\theta v - e - t_n, \text{ when } t_s > (1 - \delta)p_N. \quad (3\text{-}9)$$

Note that Equation (3-9) is the same as the "As-is" price (see **Error! Reference source not found.**). This is not a surprise. When the transactions cost is too high to justify having the type l customers resell the product on the used market, the starting-new approach collapses to "As-is".

3.3.3. The Starting-used Approach

In the starting-used approach, consumers start by buying a used product to learn their valuations. After learning their valuations, type h consumers either continue to consumer their currently-owned used product with a leftover durability $d - \delta$ or they buy a new product (or another used product). Type l consumers derive no utility from the product and sell the used product on the used market (if it is profitable to do so).

At the time of purchase, consumers do not know their type. The expected surplus from utilizing the starting-used approach ES_U (starting with a used product of durability d) is, thus,

$$ES_U = \theta(\,(1 - \delta)v - p - t_n + \delta p) - e - dp - t_b \geq 0\,. \quad (3\text{-}10)$$

For viability of the starting-used approach (*i.e.*, learning with a used product and then consuming a new product), all consumers must derive non-negative expected surplus, and type h consumers must be better off using the starting-used approach (buying the new product for all of the consumption stage) than either (i) selling the left-over durability and purchasing a used product with durability that lasts exactly the remainder of the time horizon. or (ii) retaining the used product until it is used up and then going to the used market to buy another used product for the remainder of the time horizon. This gives rise to one participation constraint (that requires consumers' expected surplus to be greater than zero, as indicated in Equation (3-10)) and two incentive compatibility constraints.

The first incentive compatibility constraint is

$$s(d-\delta, p_U)-t_s+(1-\delta)v-p_U-t_n+s(\delta, p_U)>s(d-\delta, p_U)-t_s+(1-\delta)v-s(1-\delta, p_U)-t_b \qquad (3\text{-}11)$$

The left-hand side arises from selling the left-over durability, purchase of a new product, consumption of it for the remaining 1− δ of the time horizon, and the imputed value of the left-over durability. The right-hand side arises from selling the left-over durability resulting from learning and purchasing a used product with durability that lasts exactly the remainder of the time horizon.

The second incentive compatibility constraint is

$$s(d-\delta, p_U)-t_s+(1-\delta)v-p_U-t_n+s(\delta, p_U)>(d-\delta)v+\max((1-d)v-s(1-d, p_U)-t_b, 0) \qquad (3\text{-}12)$$

The left-hand side is the same as in (3-11). The right-hand side arises from retaining the used product and going to the used market to buy another used product for the remainder of the time horizon (provided it is beneficial to do so).

If either (3-11) or (3-12) is violated, consumers will deviate from the starting-used approach. Nevertheless, I find that this does not happen when $t_b > t_n$, as summarized in the following.

> ***Lemma 1.*** *If $t_b > t_n$, (a) all consumers will choose a used product for learning with the minimum required durability $d = \delta$; and (b) type h consumers will purchase a new product, instead of a used one, at the end of the learning sage for consumption.*

The rationale for this is that if $t_b > t_n$, consumers who buy a used product with durability higher than δ cannot fully depreciate it during the learning stage. Consequently, they are either incurring an additional transactions cost (if they resell the residual product on the used market) or they are overusing the product for their learning. Consumers can avoid such situation by choosing a used product with the exact durability $d = \delta$. On the other hand, after the learning, type h consumers find they incur a higher transactions cost to buy a used product instead of a new one, thus they will choose to buy the new product.

Since I assumed that $t_b > t_n$,[26] the relevant part of the starting-used approach involves the consumer purchasing a new product for consumption. I, therefore, need no longer consider the cases where consumers deviate from the starting-used approach.

The seller's price under the stating-used approach, p_U, sets the consumers' expected surplus in Equation (3-10) to zero, after I substitute $d = \delta$ (from Lemma 1) and check the incentive compatibility constraints ((3-11) and (3-12)). This yields

$$p_U^* = \frac{\theta(1-\delta)v - e - t_b - \theta t_n}{\theta + \delta - \theta\delta}. \qquad (3\text{-}13)$$

This is the same as p_N^* in Equation (3-8) except that I have $t_b + \theta t_n$ in place of $t_n + (1-\theta)t_s$. Note that both of these latter terms represent the *expected transactions costs* in the two respective cases.

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[26] Incidentally, while making the assumption that $t_b > t_n$ condenses my analysis, I could easily present the same analysis assuming the reverse relationship $t_b < t_n$. The analysis and intuition would be essentially the same except that t_b would appear in place of t_n in several of the transactions cost equations for the starting-used approach. Since presenting both cases would add significantly to the page count of this essay, I restrict attention to what I believe to be the more realistic case, $t_b > t_n$.

Now I interpret the intuitive rationale for Equations (3-8) and (3-13). In both approaches, the monopoly price extracts the entire expected consumer surplus generated in the process of "using up" or depreciating product in this game. In the numerator, $\theta(1-\delta)v$ represents the expected gross surplus realized in the consumption stage (there is no utility from the learning stage). Subtracted from this is the learning cost, e, and the expected transactions costs ($t_b+\theta t_n$ under the starting-used approach and $t_n+(1-\theta)t_s$ under the starting-new approach). In the denominator, $\theta+\delta-\delta\theta$ represents the total quantity of the product that is "used up" under either approach (δ is used up in the learning stage and $(1-\delta)\theta$ used up by the type h consumers in the consumption stage). Thus, the price is the expected net surplus generated per unit that is used up.

3.3.4. Avoidance of Market Failure

This section shows that the above two approaches solve instances of market failure that can arise under the "As-is" approach. I begin by extending my analysis slightly and restate aspects of these results in a slightly different form:

Lemma 2.

(a) Two necessary conditions for the "starting-new" approach to be feasible are that
(i) $t_s \le t_1/(1-\theta)$,
(ii) $e \le (1-\delta)\theta v - t_n - c + \Delta_1$,
where $t_1 = (1-\theta)(1-\delta)((1-\delta)\theta v - e - t_n)$ *and* $\Delta_1 = (1-\theta)(1-\delta)c - (1-\theta)t_s$.
Together these conditions are sufficient for starting-new approach to be feasible.

(b) Two necessary conditions for the starting-used approach to be feasible are that
(i) $t_b < (1-\theta)t_n + t_1$,
(ii) $e \le (1-\delta)\theta v - t_n - c + \Delta_2$,
where $\Delta_2 = (1-\theta)(1-\delta)c - t_b + (1-\theta)t_n$

Together these conditions are sufficient for starting-used approach to be feasible.

Condition (a.i) requires the transactions cost of selling on the used market, t_s, not to be too high. Condition (a.ii) is a reformulation of the condition that $p_N^* \geq c$. Condition (b.i) requires the transactions cost of buying on the used market, t_b, not to be too high. Condition (b.ii) is a reformulation of the condition that $p_U^* \geq c$. That these various conditions are sufficient for the feasibility is perhaps no surprise, but they do set up my statement of conditions under which the starting-new and starting-used approaches avoid market failure.

Proposition 2.

(a) Given Condition (a.i) and Δ_1 (from Lemma 2), the starting-new approach avoids market failure that would otherwise occur under the "As-is" approach when

$$(1-\delta)\theta v - c - t_n < e \leq (1-\delta)\theta v - c - t_n + \Delta_1 . \qquad (3\text{-}14)$$

(b) Given Condition (b.i) and Δ_2 (from Lemma 2), the starting-used approach avoids market failure that would otherwise occur under the "As-is" approach when

$$(1-\delta)\theta v - c - t_n < e \leq (1-\delta)\theta v - c - t_n + \Delta_2 . \qquad (3\text{-}15)$$

Thus, both the starting-new and starting-used approaches (a) avoid market failure which might otherwise occur, (b) allow consumers to solve a problem that could not be solved in the absence of a used market, and (c) can be shown to increase seller profits compared to the "As-is" approach.

3.3.5. Consumer Choice

I now analyze the next step backward in the tree in Figure 1 to summarize consumer choice between the starting-new, starting-used, and "As-is" approaches.[27]

To motivate my results for how consumers choose between the starting-new, starting-used and the "As-is" approaches, I first consider a case where consumers view these three alternatives as equally desirable. Assuming that $t_s \leq p(1-\delta)$, I observe that Equations (3-4), (3-7) and (3-10) give rise to the same level of utility when

$$t_n + (1-\theta)t_s = t_b + \theta t_n = t_n + (1-\theta)(1-\delta)\,p\,.^{28} \qquad (3\text{-}16)$$

Equation (3-16) constitutes a condition of equivalence between the three approaches regardless of the parameters e, δ, and θ. Now, interpreting these equations, $t_n+(1-\theta)t_s$ is the expected transactions cost for starting-new, and $t_b+\theta t_n$ is the expected transactions cost of starting-used. The term $(1-\theta)(1-\delta)p$ at the end can be interpreted as the value of the wasted product under the "As-is" approach (since the $(1-\theta)$ low-type consumers derive no utility for the remaining $(1-\delta)$ life of the product after the learning stage). Thus, $t_n+(1-\theta)(1-\delta)p$ can be interpreted as the expected transactions cost plus the value of wasted product under the "As-is" approach. Since consumer utility is the same when (3-16) holds, I conjecture that consumers will prefer whatever approach has the lowest combined expected transactions cost and value of wasted product.[29] Of course,

[27] The "As-is" approach may be viewed as version of the starting-new approach when it is not beneficial for type 1 consumers to resell their product on the used market.

[28] When $t_s > p(1-\delta)$, consumers will prefer the "As-is" approach to the starting-new approach.

[29] Equation (3-16) also can allow us to interpret which of the three approaches might be most desirable when I relax some of the earlier assumptions, such as Equations (3-1) and (3-3). For

the nice thing about both the starting-new and starting-used approaches is that these approaches recirculate, and hence do not waste, the products that type l consumers no longer want. I formalize these ideas below. Note that p^*_{AsIs}, p^*_N, and p^*_U are defined in Equations (3-4), (3-8), and (3-13), respectively.

Proposition 3. *When facing price, p, consumer actions are governed by the following relationships:*

(a) If $t_n+(1-\theta)t_s < \min(t_n+(1-\theta)(1-\delta)p,\ t_b+\theta t_n)$, *the consumers will*
Start new, when $t_s/(1-\delta) \le p \le p^*_N$;
Not purchase at all, when $p > p^*_N$.

(b) If $t_b+\theta t_n < \min(t_n+(1-\theta)(1-\delta)p,\ t_n+(1-\theta)t_s)$, *the consumers will*
Start used, when $(t_b-(1-\theta)t_n)/(1-\theta)(1-\delta) \le p \le p^*_U$;
Not purchase at all, when $p > p^*_U$.

(c) If $t_n+(1-\theta)(1-\delta)p < \min(t_b+\theta t_n,\ t_n+(1-\theta)t_s)$, *the consumers will*
Purchase "As-is", when $p \le p^*_{AsIs}$;
Not purchase at all, when $p > p^*_{AsIs}$.

Although this proposition appears fairly complex, it really just formalizes my conjecture that the choice between starting-new and starting-used essentially depends on the relationships in Equation (3-16) among the various transactions costs. A further consideration for the "As-is" approach is that it wastes some unused durability (the value of which is described by the term $(1-\theta)(1-\delta)p$). Note that consumers revert to the "As-is" approach in Cases (a) and (b) when price is low, which again stems from the relationships in Equation (3-16).

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example, if $s(d, p) < dp$, the starting-used approach would intuitively become more desirable than the starting-new approach.

Proposition 3 also illustrates the importance about consumers' beliefs about their type, as described by the parameter θ (the probability of being type h). The starting-new approach entails transactions cost $t_n+(1-\theta)t_s$. The starting-used entails transactions cost $t_b+\theta t_n$. A necessary condition for the starting-new approach is that the transactions costs parameters lie in the set $\{(t_s, t_b, t_n) \mid t_s < t_b/(1-\theta) - t_n;\ t_s > 0, t_b > 0, t_n > 0\}$. The larger θ, the larger this set. Thus, when θ is large, the starting-new approach is more applicable, and when θ is small, the starting-used approach is more applicable.

3.3.6. Seller Pricing and Stable Outcomes

I now use Proposition 3 to determine the price that the seller would set in the used market learning game. Proposition 3 indicates that the transactions costs and other parameters determine whether cases (a), (b), or (c) applies. For each case, one expects that the seller should set the highest price, respectively, p^*_N, p^*_{AsIs}, and p^*_{AsIs}. To analyze the choice between these three prices, I need to specify a bit more about the supply side of the model. I begin by considering a simple idealized case:

> **Definition**: In *long-term used-market steady state*, the monopoly supplies sufficient quantity of new and used product (or absorbs stock of used product) to keep the total stock of used product in the market at the end of the time horizon the same as it was at the beginning.

By this definition, any potential reduction (or increase) in the stock of used product at the end of the time horizon that might have otherwise occurred is replenished (sold) or absorbed (bought) by the seller, pro rated at the prevailing price.[30]

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[30] We recognize that the above definition is fairly strong. A "back-story" behind this definition is as something like the following. Suppose there is regular demand for used product purely for consumption purposes that the seller is already supplying (in the background to this model), then

The point of this definition is to fix the relation between pricing and the supply decisions. I do not necessarily believe that the market is in long-run steady state, but it is useful to analyze long-run used-market steady state to build up intuition as to what might happen when the assumptions are relaxed. Also, one rationale for why the seller might need to replenish a shortfall (or absorb a surplus) of used stock is that the seller is a monopoly. A rational for having to absorb used stock is that failure to do so will undermine the balance of supply and demand in the used market. A surplus of used stock on the market would undermine the neutral pricing relationship in Equation (3) where price is a linear function of the durable product life. If the seller did not absorb the surplus used stock, the used price schedule would likely fall relative to the new price, p, and consumers with utility function in Equation (1) will generally have a tendency to buy the used stock before new stock. So the seller would feel essentially the same repercussions because it would not sell new stock until the excess supply of used stock is sold first. I leave a more complex model, where consumers value the service of used products less than new products, to future research. As a result of this definition, I obtain the following simple supply relationship.

Lemma 3. *In long-term used-market steady state, the seller's net sales are the total amount of (new or used) product life that consumers "use up" in the time horizon, based on the prevailing price regime.*

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the seller could effectively absorb used product from the market by supplying less than the amount needed to meet the on-going demand. Similarly, I can assume that the seller can produce product that can be perceived as used and sell it through (possibly anonymous) on-line outlets to supply used product to people that want it for learning or consumption purposes in this model. Perhaps such a view is only partially realistic.

This Lemma makes possible the seller's profit calculation.[31] The seller's pricing decision under this definition can now be advanced as follows, using p^*_{AsIs}, p^*_N, p^*_U, and t_1 as defined in Equations (3-4), (3-8), (3-13), and Lemma 2, respectively.

Proposition 4. *In long-run used market steady state in this game, I have:*

(1) The seller will choose the following prices:
$p^* =$ *(a)* p^*_N, *when* $t_n+(1-\theta)t_s < \min(t_b+\theta t_n,\ t_n+t_1)$, $e \le (1-\delta)\theta v - c - t_n + \Delta_1$, *and* $\Delta_1 \ge 0$.

(b) p^*_U, *when* $t_b+\theta t_n < \min(t_n+(1-\theta)t_s,\ t_n+t_1)$, $e \le (1-\delta)\theta v - c - t_n + \Delta_2$, *and* $\Delta_2 \ge 0$.

(c) p^*_{AsIs}, *when* $t_n+t_1 < \min(t_b+\theta t_n,\ t_n+(1-\theta)t_s)$, $e \le (1-\delta)\theta v - c - t_n$.

(2) Consumers will use the starting-new, starting-used, and the "As-is" approaches, respectively.

(3) The relationship between profits is as follows:

$$\pi^*_N = \pi^*_{AsIs} + \Delta_1,\quad \pi^*_U = \pi^*_{AsIs} + \Delta_2,\ \text{and}\ \pi^*_N = \pi^*_U + \Delta_3. \qquad (3\text{-}17)$$

where $\Delta_1 = (1-\theta)(1-\delta)c - (1-\theta)\,t_s$;
$\Delta_2 = (1-\theta)(1-\delta)c - t_b + (1-\theta)\,t_n$; *and*
$\Delta_3 = t_b - (1-\theta)(t_n + t_s)$, *and*
$t_1 = (1-\theta)(1-\delta)(\theta(1-\delta)v - e - t_n)$ *(as defined by Lemma 2).*

Propositions 3 and 4 summarize the steady state strategies for the used-market learning game depicted in Figure 3-1. For this game, the seller chooses the price of the new product; consumers make their decisions of whether to purchase, and, if so, whether to use the starting-new, the starting-used, or the "As-is" approach. Equation (3-17) of Proposition 4 establishes relationships among the costs of utilizing used and new markets that dictate whether the starting-new, the starting-used, and the "As-is" approaches are

[31] Lemma (3) is a simple benchmark. Optimal prices could also be calculated for other supply relationships.

more profitable. As summarized in Table 3-2, the starting-new approach is more profitable when there is a low used-market selling cost, t_s; a high used-market buying cost, t_b; and a low new-market buying cost, $t_{n;}$ The starting-used approach is more profitable when the reverse is true. The "As-is" is more profitable when there are high used-market costs (t_s and t_b); low production cost, c; and high depreciation, δ.

Table 3-2: Conditions under which Each Approach is Most Profitable

	Parameters	"As-is"	Starting-new	Starting-used
θ	Probability of being type h	high	high	low
t_s	Used market selling cost	high	low	high
t_b	Used market buying cost	high	high	low
t_n	New market transactions cost	low	low	high
δ	Learning depreciation	high	low	low
c	Unit (variable) production cost	low	high	high

The perceived probability to be type *h* consumers, θ, plays a particularly important role in determining the outcome. When θ is large, the starting-new approach represents a particularly desirable approach to learning for consumers, and there is not too much waste from type *l* consumers. But when θ is small, the total consumer costs for learning, including transactions costs, are smaller under the starting-used approach than under the starting-new approach.

Our last observation is that used markets give consumers countervailing power vis-à-vis the monopoly seller. Consumers have recourse to the used market to look for defensive responses to a monopoly trying to take advantage of the consumer's lack of information about his or her type. The two approaches provide defenses that cover different situations, depending on θ and the transactions.

3.3.7. Qualitative Assessment and General Steady state Considerations

In this section I summarize various general steady state and qualitative considerations for each of the three approaches analyzed above. Table 3-3 describes product flows within and between the used and new markets, my qualitative assessment of these product flows, and the consumer costs incurred.

Table 3-3: Comparison of Product Flows and Consumer Costs

		"As-is"	Starting-new	Starting-used
New Market:	Sales	1	1	θ
	Used Up	$-\theta+(1-\theta)\delta$	$-\theta+(1-\theta)\delta$	$-\theta(1-\delta)$
Used Market:	Additions	n.a.	$(1-\theta)(1-\delta)$	$\theta\delta$
	Used Up	n.a.	0	$-\delta$
	Net change	n.a.	$(1-\theta)(1-\delta)$	$-\delta(1-\theta)$
Used Market Maker	Absorbed	n.a.	$-(1-\theta)(1-\delta)$	
	Replenished	n.a.		$\delta(1-\theta)$
	Balance	n.a.	0	0
Flow Factors		low churn, but static	high churn	low churn
		no absorption	high absorption	low replenishment
		un-ecological	somewhat un-ecological	ecological
		easy to manage	hard to manage	easy to manage
Consumer Costs				
Wasted product		$(1-\theta)(1-\delta)$	n.a.	n.a.
Learning cost		$\delta+e$	$\delta+e$	$\delta+e$
Transactions costs		t_n	$t_n+(1-\theta)t_s$	$t_b+\theta t_n$
Total costs		$(1-\theta+\theta\delta)p+e+t_n$	$t_n+(1-\theta)t_s+\delta p+e$	$t_b+\theta t_n+\delta p+e$

The "As-is" approach has is the least desirable from the perspective of product waste. The problem is that all the leftover product life after the learning stage of the type l consumers, $(1-\theta)(1-\delta)$, is wasted. These consumers have no value for the product, but no recourse to sell it on a used market. And, although the seller sells more units, the seller does not profit thereby. This is because consumers, aware that the product has a high likelihood of not being useful for them, have lower willingness to pay. Beyond the model, this waste is not ecological.

The starting-new approach avoids wasting product after consumer learning. As a result, total consumer costs are lower – so long as transactions costs are relatively small, other things being equal. But, at the same time, there is a lot of movement of product, or *churn*, through the new and used markets, quite a bit in excess of the actual quantity of product being consumed, particularly if θ and δ are low. Instead of being wasted, as is the case for the "As-is" approach, the quantity $((1-\theta)(1-\delta))$ is injected as additional supply into the used market. Regrettably, no consumers avail themselves of this used supply, and the market is in surplus. To retain balance, the market maker (assumed to be the seller) must absorb this excess supply one way or another. This involves a large amount of effective repurchase activity – of product that the seller, itself, sold as new earlier in the time horizon. This activity is hard to manage. In addition, the starting-new approach may be somewhat un-ecological, since so much excess product was produced and not used in the current time horizon.

The starting-used approach, likewise, avoids wasting product after consumer learning. But this approach has lower general churn than the starting-used approach. There appears to be a more balanced flow through the new and used markets. Initially, all consumers spend δ for consumer learning, from product on the used market. Unlike the starting-new approach, there is not a mass amount of new product that effectively turns out to be over-distributed, and then is injected into the used market. Instead, type h consumers are supplied exactly with their need of θ units, most of which is consumed, and the balance of which goes to help replenish the used market of $\theta\delta$ of the δ consumed for learning. The seller then only needs to replenish the modest balance of $\delta(1-\theta)$ units of used product to keep the used market in long-run steady state. As a result this is the most ecological – few wasted natural resources in overproducing new product and lower overall logistics (transactions costs). And replenishing the used market is probably easier than absorbing products from it, since sellers are, after all, primarily in the business of selling, whether it be to the new or the used market.

3.4. Retail Policies

I now consider retail policies when independent used markets are absent or beyond the reach of consumers in which the seller essentially assumes the role of the buyer or the seller on a self-initiated used market. Of course, the "As-is" approach is still available to consumers. But I show that the seller can do better.

In this section, I analyze (a) a seller buyback policy (which includes money-back returns as a special case), (b) a seller rental policy (with an option to buy), (c) the seller's choice from among these two retail policies, and (d) qualitative implications of seller buyback and rental policies. I maintain the assumptions of the model summarized in

Section 2, except that I assume that the transactions costs t_b and t_s are prohibitively high for consumers to utilize the used market. Our notation is summarized in Appendix 3-2.

3.4.1. Buyback Policy

I consider a seller offering to buy back any unwanted purchase after the learning phase.[32] This provides a learning environment similar to the starting-new approach, only the type l consumers return the product to the seller rather than selling it on the used market.

Specifically, the seller determines the price of the new product, p, and the percentage, r, of this price that the seller will refund to the buyer as the "buyback." The total refund is, thus, rp.[33] I assume the consumer's transactions cost for buying the new product is t_n, as before, and the transactions cost to return the product is t_r.

The seller accordingly chooses p and r to maximize its profit

$$\pi_{\mathrm{BB}} = (p - c) + (1 - \theta)((1 - \delta)p_{sv} - rp), \qquad (3\text{-}18)$$

where p_{sv} is the unit salvage value of the returned product. The first item $(p - c)$ describes the profit the seller obtains from sale of new products. The second item $(1 - \theta)((1 - \delta)p_{sv} - rp)$ is the net profit or loss due to the buyback business.

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[32] We differentiate buyback from money-back guarantees in that money-back guarantees involve the full refund of payment conational on the unused status of the products. Therefore, it is quite possible that the seller can offer both money-back guarantees and buyback to consumers. If a product is returned without any usage, then money-back guarantees are feasible. When the product is returned after usage and with some tear and wear, the buyback policy applies here. (Heiman, *et al.* 2002).

[33] Choosing a refund amount instead of the refund percentage does not change my results.

For a viable buyback policy, three properties must be true: (a) all consumers must derive non-negative expected surplus; (b) type l consumers must be better off by returning the product to the seller than holding onto it; and (c) type h consumers must be better off keeping the new product rather than returning it to the seller (possibly to buy another new product). This gives rise to one participation constraint and two incentive compatibility constraints for this problem.

The participation constraint is given by nonnegative expected surplus:

$$ES_{BB} = \theta(1-\delta)v + (1-\theta)\max(rp - t_r, 0) - e - p - t_n \geq 0. \tag{3-19}$$

The first incentive compatibility constraint is

$$rp - t_r \geq 0. \tag{3-20}$$

This constraint assures that it is attractive for type l consumers to return the product. When it does not hold, the buyback policy will collapse to "As-is."

The second incentive compatibility constraint is

$$(1-\delta)v \geq rp - t_r - p - t_n + (1-\delta)v + \delta p. \tag{3-21}$$

This inequality safeguards against the possibility of opportunistic behavior where the type h consumer returns the product for what it perceives as a good deal and just buys another new product.[34] In particular, the left-hand side is the net surplus that type h consumers derive from keeping and consuming the product throughout the game horizon. Note that δv of the product value was "used up" during the learning stage. The right-

[34] Actually, I assume that the buyback policy allows consumers to only do one buyback during the game horizon, which rules out the possibility of repeated, or infinite, arbitrage possibilities.

hand side is the net surplus that type h consumers derive by returning the product at an advantageous rate and buying a new product for consumption for the rest of the game horizon. Here, the consumer received back rp, incurs a buyback transactions costs t_r, pays p for a new product, incurs transactions costs for the new product of t_n , derives utility during the consumption stage of $(1 - \delta)v$, and retains in his or her possession the product with remaining value δp at the end of the game horizon.

As in analysis of the starting-new approach, the seller should set the highest price which makes (3-19) an equality. In the case where (3-20) holds, I solve (3-19) for p, and substitute p^*_{AsIs} from Equation **Error! Reference source not found.** to yield

$$p = \frac{\theta(1-\delta)v - e - t_n - (1-\theta)t_r}{1-(1-\theta)r} = \frac{p^*_{AsIs} - (1-\theta)t_r}{1-(1-\theta)r}. \qquad (3\text{-}22)$$

Substituting this into (3-18) I find

$$\pi^*_{BB} = \pi^*_{AsIs} + (1-\theta)(1-\delta)p_{sv} - (1-\theta)\, t_{r}. \qquad (3\text{-}23)$$

From Equation (3-22), I see that consumers are willing to pay higher price, p, if the refund percentage, r, increases (provided that $r \geq t_r/p$). Equation (3-23) indicates that the profit from the buyback policy is only greater than the "As-is" profit when the total salvage value of the returned products is sufficient to cover type l consumers' transactions cost of returning the product, $(1 - \delta)p_{sv} > t_r$. It is interesting, when this is true, that the profit does not change for different combinations (p, r). I summarize this now:

Lemma 4. *Suppose (3-19), (3-20), and (3-21) are all satisfied under a buyback policy.*

(a) The seller's optimal profit is the same for any choice of p and r that satisfy (3-22). Any such policy (p, r) yields profit $\pi = \pi^*_{AsIs} + (1-\theta)(1-\delta)p_{sv} - (1-\theta) t_r$.

(b) There is a set of profit maximizing buyback policies (p^*, r^*):

$$(p^*,r^*)\in \{(p, r)|\ p=\frac{p^*_{AsIs}-(1-\theta)t_r}{1-(1-\theta)r}\ \ and\ \ \frac{t_r}{p^*_{AsIs}}\le r\le r_a\}, \tag{3-24}$$

$$where\ \ r_a=(1-\delta)+\frac{t_n+t_r}{p_a},\ \ p_a=\frac{(1-\delta)\theta v-\theta t_n-e}{\theta+\delta-\theta\delta}.$$

(c) The seller uses a buyback policy rather than an the "As-is" policy when $p_{sv} \geq (1-\theta)t_r/(1-\theta)(1-\delta)$*; otherwise, the seller sells the "As-is".*

Several interpretive comments are relevant here. First, Equation (3-24) indicates that consumers ultimately pay a higher price p for a high buyback rate r. Second, the seller is engaged in two related businesses, new product sales and buyback/salvage, with a dollar-for-dollar tradeoff between these two businesses within a particular range. Third, the seller is willing to take losses in the salvage business to facilitate learning and profit in the new product sales business. Fourth, the seller is only willing to offer a buyback policy (rather than sell "As-is") if the salvage value is sufficiently high, $p_{sv} \geq (1-\theta)t_r/(1-\theta)(1-\delta)$.

3.4.2. Rent-to-own Policy

I now consider the seller offering a rent-to-own policy, with an option to buy, as a mechanism to facilitate consumer learning. Specifically, the seller rents a product at a rate k to consumers only for the learning period. If consumers would like to own the product at the end of the learning stage, they can pay a buyout price equal to f to keep the product. Consumers incur a one-time transactions cost t_k to rent a new product from the seller, and if they decide to buy the product, they incur another transactions cost that is the same as for buying a new product, which is t_n. The seller determines the rental rate k and the subsequent purchase price f. Alternately, sellers can also use the "As-is" approach.

If a rent-to-own policy is offered, the seller seeks (k, f) to maximize

$$\pi_{RTO} = \delta k + \theta f + (1 - \theta)(1 - \delta)p_{sv} - c. \qquad (3\text{-}25)$$

In this equation, θf is the revenue from product sales to the type h consumers; $(1 - \theta)(1 - \delta)p_{sv}$ is the salvage value from the remaining product that is returned (after renting) by the type l consumers; and p_{sv} is the unit salvage value of returned product as defined earlier.

For viability of the rent-to-own policy, all consumers must derive non-negative expected surplus, the type l consumers must be better off discontinuing renting the product, and type h consumers must choose to rent to own rather than not to. This gives rise to one participation constraint (nonnegative expected surplus) and two incentive compatibility constraints. In addition, the seller must get at least as much profit as from the "As-is" release.

The participation constraint (non-negative expected surplus) is

$$ES_{RTO} = \theta(\max((1 - \delta)v - f - t_n, 0)) - e - \delta k - t_k \geq 0. \qquad (3\text{-}26)$$

The term $\theta((1 - \delta)v - f - t_n)$ is the expected surplus from the type h consumers who exercise the option to buy the rented product (including the transactions costs).

Subtracted from this are the rental fee δk, the transactions cost of renting t_k, and the learning cost e.

The first incentive compatibility constraint is that type h consumers should be better off purchasing after renting, rather than not purchasing:

$$(1-\delta)v \geq f + t_n \text{ or } f \leq (1-\delta)v - t_n. \quad (3\text{-}27)$$

The second incentive compatibility constraint requires that low-type consumers not buy, which is satisfied trivially for any positive price or rental fee (since these consumers derive no utility from the product).

The seller will raise the rental rate k to a level where the consumers' expected surplus is zero. I therefore take (3-26) as an equality, and substitute p^*_{AsIs} into it to yield

$$f = \frac{\theta(1-\delta)v - t_k - \theta t_n - e - \delta k}{\theta} = \frac{P^*_{AsIs} - t_k + (1-\theta)t_n - \delta k}{\theta}. \quad (3\text{-}28)$$

I, therefore, observe a trade-off such that increases in k lead to decreases in f. Similar to the buyback policy, the seller finds itself balancing the profitability between three businesses: the rental business (intended for learning), product sales (intended for consumption), and salvage.

Substituting this into (3-25), as an equality, and substituting p^*_{AsIs} from Equation **Error! Reference source not found.**, yields

$$\pi^*_{RTO} = \pi^*_{AsIs} + (1-\theta)(1-\delta)p_{sv} + (1-\theta)\, t_n - t_k. \quad (3\text{-}29)$$

Equation (3-29) indicates that the profit from the rent-to-own policy is only greater than the "As-is" profit when the salvage value is sufficient to cover the incremental consumer transactions costs of using the rent-to-own approach rather than buying the "As-is":

$$(1-\theta)(1-\delta)p_{sv} \geq t_k + (\theta - 1)\, t_n \,. \qquad (3\text{-}30)$$

Furthermore, similar to the buyback policy, the profit does not change for different combinations (k, f) that satisfy Equation (3-28). I summarize these considerations more completely below:

Lemma 5. *Suppose (3-26) and (3-27) are satisfied under a rent-to-own policy.*
(a) The seller's optimal profit is the same for any choice of k and f that satisfy (3-28).
Any such policy (k, f) yields profit $\pi = \pi^*_{AsIs} + (1-\theta)(1-\delta)p_{sv} + (1-\theta)\, t_n - t_k$.
(b) There is a set of profit maximizing rent-to-own policies $(k^*, f^*,)$:

$$(k^*, f^*) \in \{(k,f) |\ k = \frac{P^*_{AsIs} - t_k + (1-\theta)t_n - \theta f}{\delta},\ and\ 0 \leq f \leq (1-\delta)v - t_n\}. \qquad (3\text{-}31)$$

(c) The seller uses a rent-to-own policy rather than an the "As-is" policy when $p_{sv} \geq t_k - (1-\theta)t_n / (1-\theta)(1-\delta)$*; otherwise, the seller sells the "As-is".*

Several interpretive comments are relevant here. First, Equation (3-31) indicates that consumers are willing to pay a high rental rate, k, if the subsequent buyout price, f, is low. Second, the seller here is engaged in several related businesses: product sales, rental, and salvage (with a dollar-for dollar-tradeoff between lower profits from product sales when f is low and higher profit from rental and salvage activities when the rental rate, k, is high). Third, the seller is willing to take losses in the rental/salvage businesses to facilitate learning and profit in the subsequent product sales business. Fourth, the seller is only willing to engage in rental (rather than sell "As-is") if the salvage value is sufficiently high, $p_{sv} \geq t_k-(1-\theta)t_n/(1-\theta)(1-\delta)$.

3.4.3. Choice of Selling Policy

I can combine Lemmas (5) and (6) to determine when a seller should use buyback, rent-to-own, or sell "As-is".

Proposition 5. *Under the following conditions, the seller will choose the following retail policies:*

(a) When $t_n + (1-\theta)t_r < \min(t_k + \theta t_n,\ t_n + (1-\theta)(1-\delta)p_{sv})$*, the seller will choose a buyback policy specified in Lemma 4, Equation (3-24);*
(b) When $t_k + \theta t_n < \min(t_n + (1-\theta)t_r,\ t_n + (1-\theta)(1-\delta)p_{sv})$*, the seller will choose a rental policy specified in Equation (3-31);*
(c) When $t_n + (1-\theta)(1-\delta)p_{sv} < \min(t_n + (1-\theta)t_r,\ t_k + \theta t_n)$*, the seller will choose the "As-is" release:* $p^* = p^*_{AsIs}$*, where* $p^*_{AsIs} = (1-\delta)\theta v - e - t_n$.
(d) The profit relationships are as follows:
$\pi^*_{BB} = \pi^*_{AsIs} + (1-\theta)(1-\delta)p_{sv} - (1-\theta)\, t_r$,
$\pi^*_{RTO} = \pi^*_{AsIs} + (1-\theta)(1-\delta)p_{sv} + (1-\theta)\, t_n - t_k$, and $\pi^*_{BB} + (1-\theta)t_r + t_n = \pi^*_{RTO} + t_k + \theta t_n$..

This result has several interesting implications. First, the seller chooses the regime that leads to the lowest expected cost for consumers: $t_n+(1-\theta)t_r$ under buyback, $t_k+\theta t_n$ under rent-to-own, or $t_n+(1-\theta)(1-\delta)p_{sv}$ under "As-is" (this includes the wasted product that type l consumers can not get rid of, valued at the salvage value).

Second, if the salvage value under buyback, p_{sv}^{BB}, is different from under rent-to-own, p_{sv}^{RTO}, then I have

$$\pi^*_{BB} + (1-\theta)t_r + t_n - (1-\theta)(1-\delta)\, p_{sv}^{BB} = \pi^*_{RTO} + t_k + \theta t_n - (1-\theta)(1-\delta)\, p_{sv}^{RTO}. \qquad (3\text{-}32)$$

Thus, if $p_{sv}^{BB} > p_{sv}^{RTO}$ (because of moral hazard problems for rentals), then buyback would be more profitable and the seller choose it.

Third, the seller still has a fair amount of latitude in choosing the particular form of buyback or rental policy due to the range of feasible solutions arising in Equations (3-24) and (3-31). In both cases, all feasible solutions keep the *ex ante* expected utility the same, but the exact solution that the seller picks determines the relative *ex post* benefits to the high and low-type consumers. As I discuss in more detail below, the seller effectively determines whether the buyback or rental policy is strategically designed to provide the maximum inducement for consumers to try the product (limiting the losses of low-type consumers) or the maximum utility to consumer who end up liking the product (maximizing the gain for high-type consumers).

3.4.4. Interpretations of Feasible Buyback and Rental Policies

As I indicated there are ranges for both the feasible buyback and rental policies. I discuss these in turn.

Range of Buyback Solutions. For buyback solutions, higher price and sales income are positively related to higher buyback rates and lower salvage income, according to Equation (3-22).

One extreme buyback solution is $(r^*,p^*) = (t_r / p^*_{AsIs}, p^*_{AsIs})$. The seller pays a nominal fee – just enough to get a consumer to bring the product in (to cover the consumers' transactions cost) and the price is the same as the "As-is" price. The consumer obtains no net benefit from the buyback (other than the satisfaction of avoiding waste), and no learning is facilitated by positive utility provided from the buyback. Then the seller salvages, or recirculates, the product at a profit, which is closer to what consumers think of as a *for-profit recycling or salvage* business. The seller is effectively capitalizing on a salvage opportunity under the "As-is" regime. The key beneficiary of this policy is type h consumers since they do not take the buyback, and benefit from the lower new product price.

The other extreme buyback solution is $r^* = r_a = (1-\delta) + \frac{t_n + t_r}{p_a}$ and $p^* = p_a = \frac{(1-\delta)\theta v - \theta t_n - e}{\theta + \delta - \theta\delta}$. The seller effectively provides a *money-back guarantee*, consisting of a full refund of the remaining value of the product plus all transactions cost of the low-type consumer (i.e., $r_a p_a = (1-\delta)p_a + t_n + t_r$). Price is comparable to the starting-price (except that it is higher because the numerator does not include the expected transactions costs of the type l consumer, which are covered in the buyback rate). From the seller's perspective, the strategic purpose of such a buyback policy is to facilitate learning. The key beneficiary of such a policy is the type l consumers because they get most of their money back.

In all cases, perhaps the best advice for sellers is to attend to their strategic need. If there is need for consumer learning about a product and if the seller can raise its price for the value created by facilitating consumer learning, then the seller should use a money-back guarantee (a high buyback rate). If there is a need for salvaging used products, and if such activity can be profitable, then the seller should use something that consumers will view as a recycling policy (a low buyback rate).[35]

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[35] Our model formally has the seller indifferent between choosing these very different forms of buyback policies, but one can obtain guidance as to which version of this a seller should use in a

Range of Rental Solutions. For rental solutions, higher rental rates and income leads to lower buyout prices and sales income, according to Equation (3-28).

One extreme rental solution is $(k^*, f^*) = (\frac{P^*_{AsIs} - t_k + (1-\theta)t_n}{\delta}, 0)$. Here, a greater portion of the total revenues are borne by the type *l* consumers and the type *h* consumers have the lowest feasible combined price for the learning and consumption stages.

The other extreme rental solution is $(k^*, f^*) = (0, \frac{P^*_{AsIs} - t_k + (1-\theta)t_n}{\theta})$ (and if I allow negative prices, I could even have $(-(e+t_n), (1-\delta)v - t_n)$). Here, the seller is effectively providing a *free sample* to people to try the product (and in the most extreme case the low-type consumers effectively have their learning and transactions costs covered). This policy is best for the type *l* consumers and worse for the type *h* consumers.

Which to choose depends on the strategic objective, whether it to harvest revenues from existing customers or to induce trial of new customers. If there is a potentially large untapped customer base, then it is desirable to use a low rental rate and a high buyout price. If there is little untapped customer base, but repurchase depends on

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particular instance based on which of the assumptions of the above model might be suitably relaxed in a particular application. On the one hand, if the new product is truly novel or if the nature of the product is such that consumers can not initially know his or her idiosyncratic value or ultimate level of skill, then there is a need for facilitating consumer learning. Suppose, in addition, that I relax the model assumptions to include the possibility that the learning by some consumers leads to word-of-mouth and "free" consumer learning for other consumers. Then, this suggests that the seller might have greater reason to use a money-back guaranty type of buyback policy. The type *l* consumer is the key beneficiary. On the other hand, if the product is such that learning is not critical, and there is a lot of surplus of used product without a readily available used market, then there is a market need for a salvage business. Suppose, in addition, I relax the model assumptions that make it such that the seller is able to fully expropriate the amount of any customer value increased by a buyback policy to facilitate consumer learning. In particular, the seller might have difficulty charging a high price to fully expropriate such customer value due to (a) competition between different sellers, possibly on the Internet, (b) difficulty of assessing or measuring the amount of product "wear out.", or (c) government regulation of the price. Then, in such cases the seller might have greater incentives to use a buyback policy which provides the

the satisfaction of existing customers, then the best approach would be to have a low buyout price. Thus the seller should pick one or another of these rental policies based on this strategic objective.[36]

3.5. General Discussion

I explore a used market learning game in which the consumer can "start new," "start used," or buy the product the "As-is." In steady state, consumers will start new if the probability of being type h is high and the transactions costs for buying new and selling used are low. Consumers will use start used if the probability of being type h is low and the transactions costs of buying used and buying new are low. Consumers will buy "As-is" if the probability of being type h is high, the depreciation rate is high, and the transactions costs of buying and selling used are high. The used markets approaches yield higher profits for the seller than the "As-is" approach, when consumers use these approaches. So everybody "wins" when used markets are utilized to recirculate product.

In terms of long-term product flows, when θ is small, the starting-used approach

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consumer with what would be perceived more as recycling service (or at least avoid overly generous and costly buyback rates). Here the type h consumer benefits.

[36] Formally, the seller would be indifferent between these outcomes in the model. But in practice, I would recommend that the seller pick the one that fits best with the seller's strategic objectives. On the one hand, if the goal is to educate consumers about a radically novel product, with the hopes of increasing the success rate with the product over time, or that the number of latent consumers who will turn out to benefit from the product is large, then the seller should pick the lowest possible rental rate. The seller is providing a free sample with the hopes of inducing as much learning as possible. This will induce the maximum possible trial, which will be made up for when the type h consumers later come to paying a high price for the remaining product. On the other hand, if the goal is to help out the loyal customers, thinking that satisfied customers are strategically desirable, then the model suggests choosing the highest feasible rental rate, and the lowest feasible price for the remaining product. In this case, type h consumers bear the lowest combined price.

has some qualitative advantages. The starting-used approach involves less churn from new to used markets, as well as within the used market, and requires less absorption of used product by the seller to keep the used market in balance. Hence the starting-used market may be considered by some to be easier to manage and more ecological.

When used markets are not accessible to consumers, the seller can analogously help consumers reduce their exposure to loss by providing a self-initiated used market, in the form of seller buybacks or rent-to-own policies. To choose between buyback and rent-to-own, the seller should examine the various transactions costs of renting and purchasing, and of returning purchased or rented product. One may also wish to consider the impact of relaxing the modeling assumptions. For example, one may wish to consider whether the salvage values are the same for product returns for buybacks and rentals. Moral hazard arguments suggest that the salvage value from a buyback may be higher than from a rent-to-own policy.

Lastly, looking beyond the model, the outcome would be influenced if consumers derive additional utility from consuming a new, rather than a used, products. The preoccupation in society with conspicuous consumption reflects such values. A market which reflects such values would give rise to more buyback activities. On the other hand, consumers might have a preference for learning with a used product if they are uncertain (and risk-averse) about what the buyback rate will be; if there is an additional penalty for product "wear and tear"; or if they are environmentally conscious.

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Appendix 3-1: Proof of Propositions and Lemmas

Proof of Proposition 1.

The proposition is a restatement of Equation (3-6).

Proof of Lemma 1.

(a) *When $t_b - t_n > 0$, (3-11) is satisfied. Thus, any used products with durability greater than δ is also a waste for type h consumer ex post, For type l consumers, buying any used products with durability greater than δ also leads to waste of money.*

(b) *When $t_b - t_n > 0$, (3-12) is satisfied. Thus, at the end of the learning stage, type h consumers will not buy a used product after learning their preference.*

Proof of Lemma 2.

(a) *Condition (i) arises as necessary by substituting p_N^* from (3-8) and (3-9) into $t_s \leq p_N(1-\delta)$, which directly results from $ES_N - ES_{Asis} \geq 0$.*
Condition (ii) arises as necessary when $p_N^* - c \geq 0$.
For sufficiency, note that when $t_s \leq t_1$, Equation (3-8) defines p_N^* and then (ii) implies $p_N^* - c = ((1-\delta)\theta v - e - (\theta + \delta - \delta\theta)\, c - t_n - (1-\theta)\, t_s)/(\theta + \delta - \delta\theta) = ((1-\delta)\theta v - e - c - t_n + (1-\theta)(1-\delta)c - (1-\theta)\, t_s)/(\theta + \delta - \delta\theta) = ((1-\delta)\theta v - e - c - t_n + \Delta_1)/(\theta + \delta - \delta\theta)$, which is nonnegative when $e \leq (1-\delta)\theta v - t_n - c + \Delta_1$, where $\Delta_1 = (1-\theta)(1-\delta)c - (1-\theta)\, t_s$.

(b) *Condition (i) arises as necessary by substituting p_U^* from* (3-13) into *$t_b \leq (1-\theta)(1-\delta)p + (1-\theta)t_n$, which directly results from $ES_U - ES_{Asis} \geq 0$.*
Condition (ii) arises as necessary when $p_U^* - c \geq 0$.
For sufficiency, note that Equation (3-13) defines *p_U^* and then (ii) implies $p_U^* - c = ((1-\delta)\theta v - e - (\theta + \delta - \delta\theta)\, c - \theta t_n - t_b)/(\theta + \delta - \delta\theta) = ((1-\delta)\theta v - e - c - t_n + (1-\theta)(1-\delta)c - t_b + (1-\theta)\, t_n)/(\theta + \delta - \delta\theta) = ((1-\delta)\theta v - e - c - t_n + \Delta_2)/(\theta + \delta - \delta\theta)$, which is nonnegative when $e \leq (1-\delta)\theta v - t_n - c + \Delta_2$, where $\Delta_2 = (1-\theta)(1-\delta)c - t_b + (1-\theta)\, t_n$.*

Proof of Proposition 2.

(a) *The first inequality in (3-14) establishes market failure under the "As is" approach. The second inequality establishes Condition (ii) in Lemma 2, which together with Condition (i) is sufficient for the starting-new approach to be feasible.*

(b) *The first inequality in (3-15) establishes market failure under the "As is" approach. The second inequality establishes Condition (iii) from Lemma 2, which is sufficient for the starting-used approach to be feasible.*

Proof of Proposition 3.

(a) (i) *Note that the condition* $t_n+(1-\theta)t_s \leq t_n+(1-\theta)(1-\delta)p$ *restricts attention to* $p \geq t_s/(1-\delta)$. *The condition also implies* $ES_N - ES_{Asis} \geq 0$ *(from (3-7) and (3-4)). So the incentive compatibility constraint of choosing starting-new over "As-is" is met. In addition,* $t_n+(1-\theta)t_s \leq t_b+\theta t_n$ *implies* $ES_N - ES_U \geq 0$ *(from (3-7) and (3-10)). So the incentive compatibility constraint of choosing starting-new over starting-used is met. Now,* $p \leq p_N^*$ *implies that the participation constraint (3-7)) holds. So the consumer will choose the starting-new approach.*

(ii) When $p > p_N^*$, *the participation constraint (3-7)) does not hold, and the consumer will choose not to purchase at all.*

(b) (i) *Note that the condition* $t_b+\theta t_n \leq t_n+(1-\theta)(1-\delta)p$ *restricts attention to* $p \geq (t_b-(1-\theta)t_n)/(1-\theta)(1-\delta)$. *The condition also implies* $ES_U - ES_{Asis} \geq 0$ *(from (3-10) and (3-4)). So the incentive compatibility constraint of choosing starting-used over "As-is" is met. In addition,* $t_b+\theta t_n \leq t_n+(1-\theta)t_s$ *implies* $ES_U - ES_N \geq 0$ *(from (3-10) and (3-7)). So the incentive compatibility constraint of choosing starting-used over starting-new is met.* $p \leq p_U^*$ *implies that the participation constraint (3-10) holds. So the consumer will choose the starting-new approach.*

(ii) When $p > p_U^*$, *the participation constraint (3-10) does not hold, and the consumer will choose not to purchase at all.*

(c) (i) $t_n+(1-\theta)(1-\delta)p < t_n+(1-\theta)t_s$ *implies* $ES_{Asis} - ES_N > 0$ *(from (3-4) and (3-7))). So the incentive compatibility constraint of choosing "As-is" over starting-new is met.* $t_n+(1-\theta)(1-\delta)p < t_b+\theta t_n$ *implies* $ES_{Asis} - ES_U > 0$ *(from, (3-4) and (3-10)). So the incentive compatibility constraint of choosing "As-is" over starting-used is met. The condition when* $p \leq p_{AsIs}^*$ *implies that the participation constraint (3-4) holds. So the consumer will choose the "As-is" approach.*

(ii) When $p > p_{AsIs}^*$, *the participation constraint (3-4) does not hold, so the consumer will choose not to purchase at all.*

Proof of Lemma 3.

Follows directly from definition of long-term used-market steady state. To keep the total stock of used profit the same at the end of the time horizon as it was at the beginning, the seller's net sales of new and used product life must equal the total amount that consumers "use up" in the time horizon.

Proof of Proposition 4.

(1) From Proposition 3, the firm should restrict its attention p_N^*, p_U^*, *or* p_{AsIs}^* *depending on which case applies.*

(a) *From Proposition 3 (a),* $t_n+(1-\theta)t_s < t_b+\theta t_n$ *implies that consumers will not use the starting-used approach.* $t_n+(1-\theta)t_s < t_n+t_1$ *implies that* $t_s/(1-\delta) < p_N^*$ *(using (3-7) and rearranging terms). This means there will be a range of prices p between* $t_s/(1-\delta)$ *and* p_N^* *for which consumers will choose the starting-new approach (again from Proposition 3 (a)).*

Noting that $\theta + (1-\theta)\delta$ *units need to be supplied under the starting-new approach, the profit is* $\pi_N^* = (\theta + \delta - \delta\theta)(p_N^* - c) = (1-\delta)\theta v - e - (\theta + \delta - \delta\theta)c - t_n - (1-\theta)t_s = (1-\delta)\theta v - e - c - t_n + (1-\theta)(1-\delta)c - (1-\theta)t_s = (1-\delta)\theta v - e - c - t_n + \Delta_1$ *(from (3-7) and rearranging terms). When* $\Delta_1 \geq 0$, $\pi_N^* \geq (1-\delta)\theta v - e - c - t_n = p_{Asis}^* - c = \pi_{AsIs}^*$ *(from (3-4) and noting that quantity supplied under "As-is" is one). Also by Lemma 2 (a),* $e \leq (1-\delta)\theta v - c - t_n + \Delta_1$ *implies* $\pi_N^* \geq 0$.

So the firm will choose consumer will choose $p = p_N^*$ *because, for this price, consumers will choose starting-new (rather than not purchase),* $\pi_N^* \geq \pi_{AsIs}^*$, *and* $\pi_N^* \geq 0$.

(b) *From Proposition 3 (b),* $t_b + \theta t_n < t_n + (1-\theta)t_s$ *implies that consumers will not use the starting-new approach. Thus, the seller chooses between* p_U^* *or* p_{AsIs}^* *by comparing* π_U^* *and* π_{AsIs}^*. $t_b + \theta t_n < t_n + t_1$ *implies that* $(t_b - (1-\theta)t_n)/(1-\theta)(1-\delta) < p_U^*$ *(using (3-10) and rearranging terms). This means there will be a range of price p between* $(t_b - (1-\theta)t_n)/(1-\theta)(1-\delta)$ *and* p_U^* *for which consumers will choose the starting-used approach (again from Proposition 3 (b)).*
Noting that $\theta + (1-\theta)\delta$ *units need to be supplied under the starting-used approach, the profit is* $\pi_U^* = (\theta + \delta - \delta\theta)(p_U^* - c) = (1-\delta)\theta v - e - (\theta + \delta - \delta\theta)c - t_b - \theta t_n = (1-\delta)\theta v - e - c - t_n + (1-\theta)(1-\delta)c - t_b + (1-\theta)t_n = (1-\delta)\theta v - e - c - t_n + \Delta_2$ *(from (3-10) and rearranging terms). When* $\Delta_2 \geq 0$, $\pi_U^* \geq (1-\delta)\theta v - e - c - t_n = p_{Asis}^* - c = \pi_{AsIs}^*$ *(from (3-4) and noting that quantity supplied under "As-is" is one). Also by Lemma 2 (b), when* $e \leq (1-\delta)\theta v - c - t_n + \Delta_2$, $\pi_U^* \geq 0$.

So the firm will choose consumer will choose $p = p_U^*$ *because, for this price, consumers will choose starting-used (rather than not purchase),* $\pi_U^* \geq \pi_{AsIs}^*$, *and* $\pi_U^* \geq 0$.

(c) *From parts (a) and (c) above,* $t_n + t_1 < \min(t_n + (1-\theta)t_s,\ t_b + \theta t_n)$ *implies* $p_N^* < t_s/(1-\delta)$ *and* $p_U^* < (t_b - (1-\theta)t_n)/(1-\theta)(1-\delta)$. *Examination of Cases (a) and (b) of Proposition 3 indicates that there does not exist a starting-new or starting-new solution. Therefore the only possible solution is* $p = p_{AsIs}^*$.
Now note that $t_n + t_1 < t_n + (1-\theta)t_s$ *implies that* $p_{AsIs}^* < t_s/(1-\delta)$ *(using (3-4) and rearranging terms). Also,* $t_n + t_1 < t_b + \theta t_n$ *also implies* $p_{AsIs}^* < (t_b - (1-\theta)t_n)/(1-\theta)(1-\delta)$ *(using (3-4) and rearranging terms). So for for* $p = p_{AsIs}^*$, *the consumers prefer the "As is" release. The seller participates because* $e \leq (1-\delta)\theta v - c - t_n$ *implies that* $\pi_{AsIs}^* \geq 0$. *The seller also prefers this "As-is price" to any other possible As-is Price.*

So p^*_{AsIs} is a solution because consumers will use the "As-is" approach at this price and the firm will sell at this price because $\pi^*_{AsIs} \geq 0$. Furthermore it is the only solution because p^*_N and p^*_U are not feasible in this case.

(2) By Proposition 3 and Proposition 4(1).

(3) Directly from the result of comparison among π^*_N, π^*_U and π^*_{AsIs}.

Proof of Lemma 4.

(a) *Implied by Equation (3-23).*

(b) *Based on (3-19) I can solve for the profit maximizing buyback policies (p*, r*). Analysis indicates that there is no single interior solution, and according to I may have a range of indeterminacy. When Lemma 4 applies, there is a locus of combinations (p, r) that yield equal profit. When r is too low, the incentive compatibility constraint (3-20) is not satisfied, the type l does not return product, and the seller effectively uses an "As is" approach. When r is too high, the incentive compatibility constraint (20) is not satisfied, the type h consumer does not keep the product, and buyback is not feasible.*

(c) *Follows from (a).*

Proof of Lemma 5.

(a) *is implied by Equation (3-29).*

(b) *I can solve for the profit maximizing rent-to-own policies (k*, f*). Since Lemma 6 indicates a locus of combinations (k, f) that yield equal profit, it is no surprise that further analysis shows that that there is no interior solution. At the boundary, when if p is too high, the incentive compatibility constraint (3-27) is not satisfied and the type h consumer does not buy the product after the learning stage. When k is too high, given f, the participation constraint will be violated, and consumers will not rent-to-buy.*

(c) *Follows from (a).*

Proof of Proposition 5.

Based on Lemma 4 and Lemma 6, and the comparison of Equation (3-23) and (3-29).

Appendix 3-2: Model Notation

Notation	Interpretation and values
v	*Product valuation of type h consumers,* $v_h = v$. *The product valuation for type l consumers is* $v_l = 0$.
d	*Product life or durability,* $0 < d < 1$.
$u_i(d) = v_i d$	*The valuation of consumer type i for a product with durability d, where* $i \in \{l, h\}$.
p	*The price of a new product.*
$s(d, p) = dp$	*The used market price for a used product with the durability d, given the associated new product price, p.*
θ	*The proportion of type h consumers. The proportion of type l consumers is* $1-\theta$.
e	*The learning cost for the consumer to discover his or her type.*
δ	*Product depreciation due to learning,* $0 \leq \delta \leq 1$.
c	*The marginal cost of supplying a new product.* $0 < c < v$.
t_j	*Transaction cost of activity j, where j = b (buying on the used market), s (selling on the used market), n (buying on the new market), r (returning a product under a buyback policy), k (renting a product), and e (expected total transactions cost).*
ES_j	*Expected surplus for the* j^{th} *approach or policy, where j = AsIs ("As-is" approach), N (the starting-new approach), U (the starting-used approach, BB (the buyback policy), RTO (the rent-to-own policy).*
π_j	*Profit from the* j^{th} *approach or policy, where j = AsIs ("As-is" approach), N (the starting-new approach), U (the starting-used approach, BB (the buyback policy), RTO (the rent-to-own policy).* π_j^* *denotes the optimal profit under the* j^{th} *approach or policy.*
p_{AsIs}^*	*The seller's optimal price for the "As-is" approach.*
p_N^*	*The seller's optimal price under the starting-new approach.*
p_U^*	*The seller's optimal price under the starting-used approach.*
r	*The buyback rate (after the learning stage). The buyback price is rp.*
k	*The lease rate. The cost of leasing for d periods is dk.*
f	*The price paid by a consumer to acquire the ownership of a rented new product after the learning stage.*

Appendix 3-3: Endogenous Supply and Demand on the Used Market

We extend the second essay to discuss a case where the supply and the demand on the used market are endogenous and make the following new assumptions.

1. A unit mass of consumers come to the market at the beginning of every period; they simultaneously decide whether to buy a new or used product.
2. Consumers are heterogeneous in their ability to utilize used market. This is captured by their individual transaction cost τ to buy or sell on the used market.
3. Consumers are evenly distributed in a continuum of τ, ranging from zero to T, i.e., $\tau \sim \text{Uniform}(0, T)$.
4. The used products, once purchased, cannot be sold again.
5. Used products are for learning purpose only and they do not have any consumption values.
6. It takes every consumer one period to learn their valuation through the usage of either a new or a used product.
7. The market is developed into a steady state such that the game repeats itself in every period.

Consumer Decision Making

We write the expected surplus of the starting-new approach and the starting-used approach, respectively, as

$$E(S^{SN}) = \rho\theta v + \rho(1-\theta)(\max(p_S^U - \tau, 0)) - p_S^N; \tag{A33}$$

$$E(S^{SU}) = \rho\theta(v - p_S^N) - p_S^U - \tau, \tag{A34}$$

where ρ is the discount factor, the subscript "S" stands for "steady state", and τ is the transaction cost.

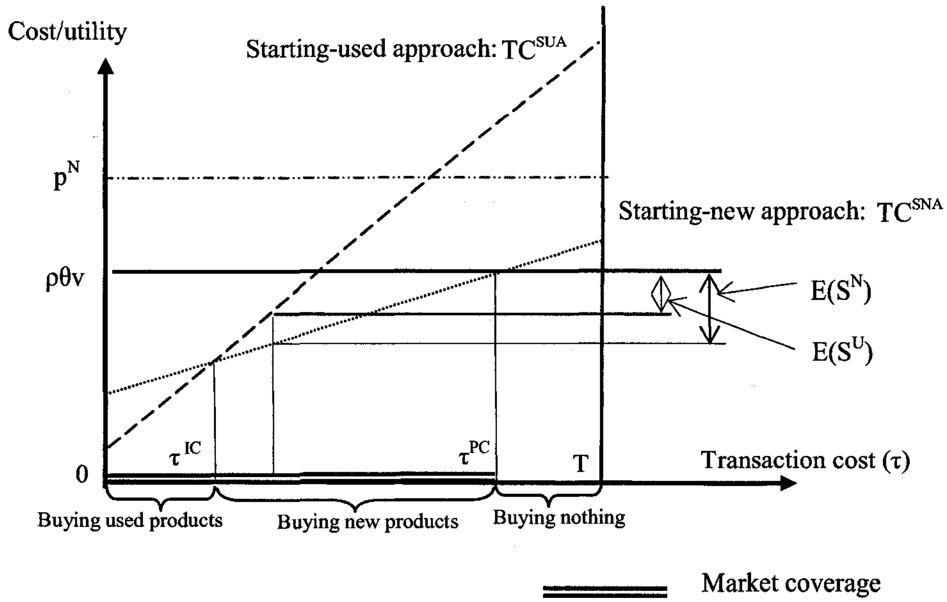
(A33) and (A34) imply that whichever approaches consumers adopt, their expected surplus goes down as τ increases; however, consumers with a larger τ have a higher expected surplus by adopting the starting-new approach than by adopting the starting-used approach. Thus, we can write down the participation constraint and the incentive compatibility constraint, based on which we further derive consumers' demands for new or for used products.

As stated above, consumers with a large τ have a higher expected surplus when adopting the starting-new approach. We define the marginal consumer who adopts the starting-new approach as the one whose transaction cost is the highest along the continuum of τ conditional on a non-negative $E(S^{SN})$. The associated transaction cost, τ_S^{PC}, is equal to $\max\{\tau \mid E(S^{SN}) \geq 0\}$. τ_S^{PC} specifies the participation constraint on the continuum of τ: any consumer with τ lower than τ_S^{PC} will engage in either the starting-new or the starting-used approach.

Consumers with τ lower than τ_S^{PC} obtain a positive expected surplus from adopting either approach. Define τ_S^{IC} as the transaction cost for the marginal consumer who is indifferent between adopting these two approaches: $\tau_S^{IC} = \{\tau \mid E(S^{SN}) = E(S^{SU}) \geq 0\}$. Any consumer with τ higher than τ_S^{IC} (and lower than τ_S^{PC}) will adopt the starting-new approach, and any consumer with τ lower than τ_S^{IC} will adopt the starting-used approach.

Figure A1 demonstrates how τ_S^{PC} and τ_S^{IC} are determined in a dimension of the total costs of purchase and the transaction cost τ.

Figure A1: Comparison of Costs of Different Approaches



In Figure A1, we plot the total expenditure of purchase against the τ for different approaches. The total costs of adopting the starting-new approach are $TC^{SNA} = p_S^N - \rho(1-\theta)(p_S^U - \tau)$; TC^{SNA} is increasing in τ with a slope equal to $\rho(1-\theta) < 1$. The total costs of adopting the starting-used approach are $TC^{SUA} = \rho\theta p_S^N + \tau + p_S^U$; TC^{SUA} is also increasing in τ with a slope equal to one. The threshold of the transaction cost of the participation constraint, τ_S^{PC}, is determined at the intersection of TC^{SNA} and $\rho\theta v$. The threshold of the transaction cost of the incentive compatibility constraint, τ_S^{IC}, is determined by the intersection of TC^{SNA} and TC^{SUA}.

Determination of τ_S^{PC}

There are various cases for τ_S^{PC} due the sequential decision of reselling used products under the starting-new approach. First, consumers should have positive expected surplus for participation. Denote $\tau_A = \{\tau \mid E(S^{SN}) = 0\}$; $\tau_A = p_S^U + \frac{\theta v - p_S^N}{1-\theta}$. $\tau_S^{PC} \leq \tau_A$. Second, consumers will not resell a used product if the used-market price is not enough to compensate for their transaction cost even if the total expected surplus ($E(S^{SN})$) for doing so is positive. This is captured by the maximum function that compares $p_S^U - \tau$ with zero in (A33): i.e., $\tau_S^{PC} \leq p_S^U$. Combining the inherent constraint imposed on τ_S^{PC}, i.e., $0 \leq \tau_S^{PC} \leq T$, we have $\tau_S^{PC} \leq \min\{\tau_A, p_S^U, T\}$. We further characterize τ_S^{PC} into three scenarios which are summarized in (A35).

$$\tau_S^{PC} = \begin{cases} p_S^U + \frac{\theta v - p_S^N}{1-\theta}, & \text{when } p_S^N > \rho\theta v \text{ and } p_S^U + \frac{\theta v - p_S^N}{1-\theta} < T; \\ T, & \text{when } p_S^N > \rho\theta v \text{ and } p_S^U > T; \\ p_S^U & \text{when } p_S^N \leq \rho\theta v \text{ and } p_S^U \leq T. \end{cases} \quad \text{(A35)}$$

When $p_S^N > \rho\theta v$, consumers receive a negative expected surplus from buying a new product alone. Thus, no consumers will buy new product "as is". If consumers buy a new product, they anticipate selling it when their valuation is learnt to be low. By (A33), in order for consumers to adopt the starting-new approach in the first place, they must receive a positive expected surplus as a compensation when reselling it on the used market, i.e., $p_S^U - \tau > 0$. Consequently, τ_S^{PC} is either equal to T when the market is fully covered or equal to a threshold value of τ under which the marginal consumer receives zero expected surplus. Denote $\tau_A = \{\tau \mid E(S^{SN}) = 0\}$; $\tau_A = p_S^U + \frac{\theta v - p_S^N}{1-\theta}$. Thus, $\tau_S^{PC} = \min\{\tau_A, T\}$.

When $p_S^N \le \rho\theta v$, consumers receive a non–negative expected surplus from buying a new product alone. Such low p_S^N could make some low-valuation consumers receive a positive aggregate expected surplus from both transactions (buying new and selling used) even if they resell for a loss. However, due to sequential decision process, low–valuation consumers will resell their purchase if and only if their transaction cost τ is lower than the used market price, p_S^U, which is the revenue of resale. Thus, we have $\tau_S^{PC} = \min\{p_S^U, T\}$.

Demand and Supply

Based on the above discussions, we can write the demands and supplies for new and used products in the steady state.

The demand for used products in any period in the steady state is from consumers whose transaction cost is lower than τ_S^{IC}: $D_S^U = \tau_S^{IC}/T$. The demand for new products in the steady state is from three subgroups of consumers: consumers who adopt the starting-used approach in the previous period and whose valuation turns out to be high, consumers who adopt the starting-new approach, and consumers buying new products "as is". We denote their demands for new products as ${}^{SN}D_S^N$, ${}^{SU}D_S^N$, and ${}^{AS}D_S^N$, respectively. We have

$$D_S^N = {}^{SN}D_S^N + {}^{SU}D_S^N + {}^{AS}D_S^N. \quad \text{(A36)}$$

By the definition of τ_S^{PC}, ${}^{SN}D_S^N = (\tau_S^{PC} - \tau_S^{IC})/T$; ${}^{SU}D_S^N$ is θ portion of the consumers who buy used products: ${}^{SU}D_S^N = \theta D_S^U$; ${}^{AS}D_S^N$ is only greater than zero when $p_S^N \leq \rho\theta v$. In that case, consumers with transaction cost between p_S^U and T adopt "as is" provided $p_S^U < T$, i.e., ${}^{AS}D_S^N = \max\{T - p_S^U, 0\}$.

The supply of new products, as assumed in our paper, is infinite with a constant marginal production cost c. The supply of used products, S_S^U, is decided by the equilibrium quantity of new products purchased by consumers who adopt the starting-new approach in the previous period. In the steady state, S_S^U is equal to (1− θ) portion of ${}^{SN}D_S^N$: $S_S^U = (1-\theta)\,{}^{SN}D_S^N$.

Market Equilibrium Analysis

In the steady state the firm chooses p_S^N to maximize a per-period profit $\pi_S = D_S^N(p_S^N - c)$, subject to the following constraints:

(C1) $\tau_S^{PC} \leq \min\{\tau_A, p_S^U, T\}$, and

(C2) $D_S^U = S_S^U$.

We seek the solution in terms of a price vector $\mathbf{p}_S = \{p_S^N, p_S^U\}$ that maximizes the firm's profit π_S. We also define the support in the parametric space {v, θ, ρ, c, T} in which the solution satisfies all the required constraints.

Scenario one

We first consider the case $\tau_S^{PC} = \tau_A$. This indicates that $p_S^N > \rho\theta v$ and $p_S^U + \frac{\theta v - p_S^N}{1-\theta} < T$ in the equilibrium. Since $p_S^N > \rho\theta v$, the demand for new products from consumers who adopt "as is" is zero, i.e., $D_S^N = {}^{SN}D_S^N + {}^{SU}D_S^N$. And because $p_S^U + \frac{\theta v - p_S^N}{1-\theta} < T$, the market is partly covered and we seek an inner solution.

We compose a Lagrangian function

$$L = D_S^N(p_S^N - c) + \lambda_s(D_S^U - S_S^U). \tag{A37}$$

where $D_S^N = (\tau_S^{PC} - \tau_S^{IC})/T + \theta\tau_S^{IC}/T$, $D_S^U = \tau_S^{IC}/T$, and $S_S^U = (1-\theta)(\tau_S^{PC} - \tau_S^{IC})/T$.

Differentiate L w.r.t. p_S^N, p_S^U and λ_s; we have $\begin{bmatrix} \frac{\partial L}{\partial p_S^N} & \frac{\partial L}{\partial p_S^U} & \frac{\partial L}{\partial \lambda_S} \end{bmatrix}^T = \mathbf{0}.$

In matrices, we have

$$\begin{bmatrix} \frac{2(-\rho^2\theta^3+2\rho^2\theta^2+\rho\theta^2-\rho^2\theta-\rho\theta+1)}{\rho(\theta-1)(\rho\theta-\rho+1)} & \frac{\rho\theta^2-\rho\theta-\theta+2}{\rho\theta-\rho+1} & \frac{-\rho^2\theta^2+2\rho^2\theta-\rho-1}{\rho(\rho\theta-\rho+1)} \\ \frac{\rho\theta^2-\rho\theta-\theta+2}{\rho\theta-\rho+1} & 0 & \frac{-\rho\theta-2\theta+\rho+3}{\rho(\rho\theta-\rho+1)} \\ \frac{-\rho^2\theta^2+2\rho^2\theta-\rho-1}{\rho(\rho\theta-\rho+1)} & \frac{-\rho\theta-2\theta+\rho+2}{(\rho\theta-\rho+1)} & 0 \end{bmatrix} \begin{bmatrix} p_S^N \\ p_S^U \\ \lambda_S \end{bmatrix} = \begin{bmatrix} \frac{-\theta v}{(\theta-1)} - \frac{(\rho^2\theta^3-2\rho^2\theta^2-\rho\theta^2+\rho^2\theta+\rho\theta-1)c}{\rho(\theta-1)(\rho\theta-\rho+1)} \\ \frac{(\rho\theta^2-\rho\theta-\theta+2)c}{(\rho\theta-\rho+1)} \\ -\theta v \end{bmatrix}. \tag{A38}$$

Denote $\hat{\mathbf{p}}_S$ the optimal solution in scenario one: $\hat{\mathbf{p}}_S = \begin{bmatrix} \hat{p}_S^N \\ \hat{p}_S^U \end{bmatrix}$. $\hat{\mathbf{p}}_S$ and $\hat{\lambda}_S$ can be solved from the matrices above.

When $\rho = 1$, the solution is

$$\begin{bmatrix}\hat{p}_S^N\\ \hat{p}_S^U\end{bmatrix}_{\rho=1} = \begin{bmatrix}\dfrac{2\theta v-\theta^2 v+c+\theta c-\theta^2 c}{2(1+\theta-\theta^2)}\\ \dfrac{4\theta v-8\theta^2 v+2\theta^3 v+\theta^4 v+2c-3\theta^2 c+3\theta^3 c-\theta^4 c}{2(4-3\theta)(1+\theta-\theta^2)}\end{bmatrix},$$

$$\hat{\lambda}_S = \frac{(2-2\theta+\theta^2)(-2\theta v+\theta^2 v+c+\theta c-\theta^2 c)}{2(4-3\theta)(1+\theta-\theta^2)}.$$

We can compute the steady-state optimal profit $\hat{\pi}_S$ for scenario one.

Denote $v_a = \{v|\ \hat{p}_S^U + \frac{\theta v-\hat{p}_S^N}{1-\theta} = T\}$, $v_b = \{v|\ \hat{p}_S^N = \rho\theta v\}$, and $v_c = \{v|\ \hat{\pi}_S = 0\}$. v_a, v_b and v_c are given in (A39).

$$v_a = \frac{(2\rho^2\theta^2+4\rho\theta^2-4\rho^2\theta-10\rho\theta+6\rho)T+(\rho^2\theta^3-3\rho^2\theta^2+2\rho^2\theta-\theta+2)c}{\rho\theta(\theta-2)(\rho\theta-\rho-1)},$$

$$v_b = \frac{(\rho^2\theta^2-\rho^2\theta-1)c}{\rho\theta(2\rho^2\theta^2-2\rho^2\theta-\rho\theta+\rho+1)}, \text{ and } v_c = \frac{(\rho^2\theta^2-\rho^2\theta-1)c}{\rho\theta(\rho\theta-\rho-1)}. \qquad \text{(A39)}$$

Lemma A1: $v_a > v_c$, and $v_b > v_c$.

Proof: This can be proved by directly comparing v_a and v_c, v_b and v_c.

Based on Lemma A1, we have the following proposition.

Proposition A6: The optimal solution $\hat{\mathbf{p}}_S$ is only feasible in a parametric space defined as

$\{v, \theta, \rho, c, T \mid v_c < v < \min\{v_a, v_b\}\}$, where v_a, v_b and v_c are given in (A39).

Proof: By assuming $\hat{p}_S^N > \rho\theta v$, we have $0 < \tau_S^{PC} = \tau_A = \hat{p}_S^U + \frac{\theta v-\hat{p}_S^N}{1-\theta} < \hat{p}_S^U$; in order to satisfy C1, we only need $0 < \hat{p}_S^U + \frac{\theta v-\hat{p}_S^N}{1-\theta} < T$. This is satisfied when $v < v_a$. Then we require $\hat{p}_S^N > \rho\theta v$; this is satisfied when $v < v_b$. In addition, that $\hat{\pi}_S > 0$ is satisfied when $v > v_c$. *Q.E.D.*

Proposition A6 defines a feasible region in which the firm can charge $\hat{p}_S^N$ for new products. The used market price will be $\hat{p}_S^U$, and the firm obtains the maximized profit $\hat{\pi}_S$.

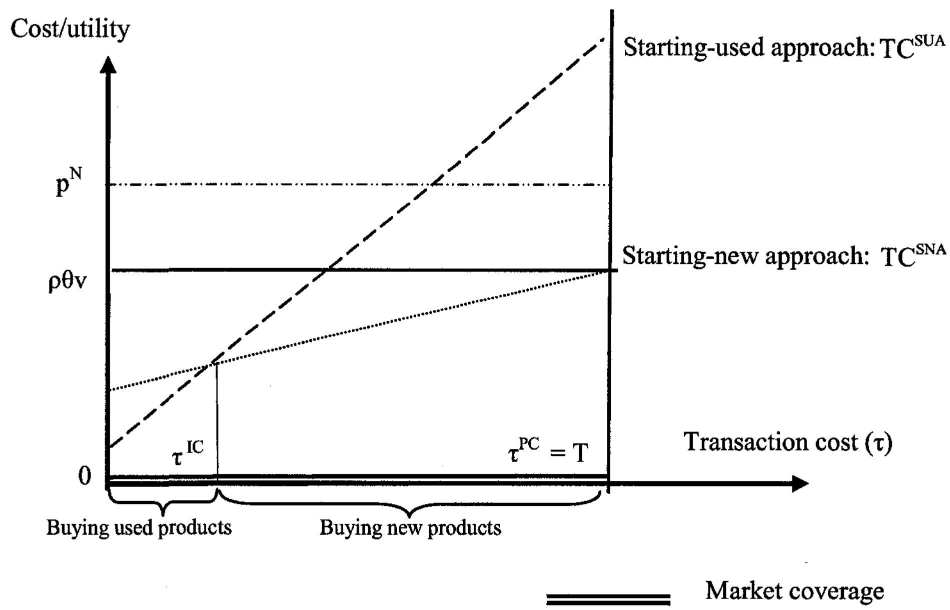
Scenario two

The next we relax one constraint imposed on v to allow $v \geq v_a$ but maintain $p_S^N > \rho\theta v$. When $v \geq v_a$, $\hat{p}_S^U + \frac{\theta v - \hat{p}_S^N}{1-\theta} \geq T$ and the market is fully covered. Thus, $\tau_S^{PC} = T$. Consequently, the inner solution derived in scenario one, $\hat{\mathbf{p}}_S$, is not feasible. Instead, we have a corner solution by bounding $p_S^U + \frac{\theta v - p_S^N}{1-\theta} = T$. That $p_S^U + \frac{\theta v - p_S^N}{1-\theta} = T$ let the consumer with the transaction cost equal to T have a zero expected surplus ($E(S^N) = 0$) to adopt the starting-new approach, and thus, that consumer will do so. As the result, any price that allows that particular consumer to have a positive expected surplus is not optimal.

Since $p_S^N > \rho\theta v$ is still required in scenario two, consumers will adopt either the starting-new approach or the starting-used approach; no consumers will buy a new product "as is".

In Figure A2 we plot the demand for new products in the plane of total costs and transaction cost. The market is fully covered as shown. Since $\tau_S^{PC} = T = p_S^U + \frac{\theta v - p_S^N}{1-\theta}$, the three lines, TC^{SNA}, $c = \rho\theta v$ and $\tau = T$, intersect at one point with the coordinates (T, $\rho\theta v$).

Figure A2: Demand for New Products in Scenario Two



We solve $\{(p_S^N, p_S^U) \mid p_S^U + \frac{\theta v - p_S^N}{1-\theta} = T,\ D_S^U = S_S^U\}$.

Denote the optimal solution in scenario two $\begin{bmatrix} \tilde{p}_S^N \\ \tilde{p}_S^U \end{bmatrix}$ as $\tilde{\mathbf{p}}_S$. In matrices, we have

$$\begin{bmatrix} -1 & \rho(1-\theta) \\ \frac{(\theta-2)(\rho\theta-1)}{\rho\theta-\rho+1} & \frac{(2-\theta)(\rho\theta-\rho-1)}{\rho\theta-\rho+1} \end{bmatrix} \begin{bmatrix} p_S^N \\ p_S^U \end{bmatrix} = \begin{bmatrix} -\rho(\theta v+\theta T-T) \\ (1-\theta)T \end{bmatrix}. \qquad \text{(A40)}$$

$\tilde{\mathbf{p}}_S$ can be solved from the matrices above.

When $\rho = 1$, the results can be simplified as

$$\begin{bmatrix} \tilde{p}_S^N \\ \tilde{p}_S^U \end{bmatrix}_{\rho=1} = \begin{bmatrix} \dfrac{4\theta v - 4\theta^2 v + \theta^3 v - 4T + 7\theta T - 3\theta^2 T}{(2-\theta)(1+\theta-\theta^2)} \\ \dfrac{2\theta v - 3\theta^2 v + \theta^3 v - 2T + 4\theta T - 3\theta^2 T + \theta^3 T}{(2-\theta)(1+\theta-\theta^2)} \end{bmatrix}.$$

We then can compute the steady-state optimal profit $\tilde{\pi}_S$ for scenario two using $\tilde{\mathbf{p}}_S$.

Define $v_d = \{v \mid \tilde{p}_S^N = \rho\theta v\}$, then $v_d = \dfrac{(-\rho\theta-2\theta+\rho+3)T}{\rho\theta(\theta-2)(\rho\theta-1)}$. $\tilde{p}_S^N > \rho\theta v$ if $v > v_d$. We have following proposition regarding the applicability of scenario two.

Proposition A7:

(1) The optimal solution $\tilde{\mathbf{p}}_S$ is feasible in the parametric space $\{v, \theta, \rho, c, T \mid v > \max\{v_a, v_d\}\}$;

(2) When $v = v_a$, $\tilde{\mathbf{p}}_S = \hat{\mathbf{p}}_S$, i.e., scenario one and scenario two are identical.

Proof: (1) We require $\tilde{p}_S^N > \rho\theta v$. This is satisfied if and only if $v > v_d$. In addition, since we relax the constraint such that $v > v_a$, jointly we have $v > \max\{v_a, v_d\}$.

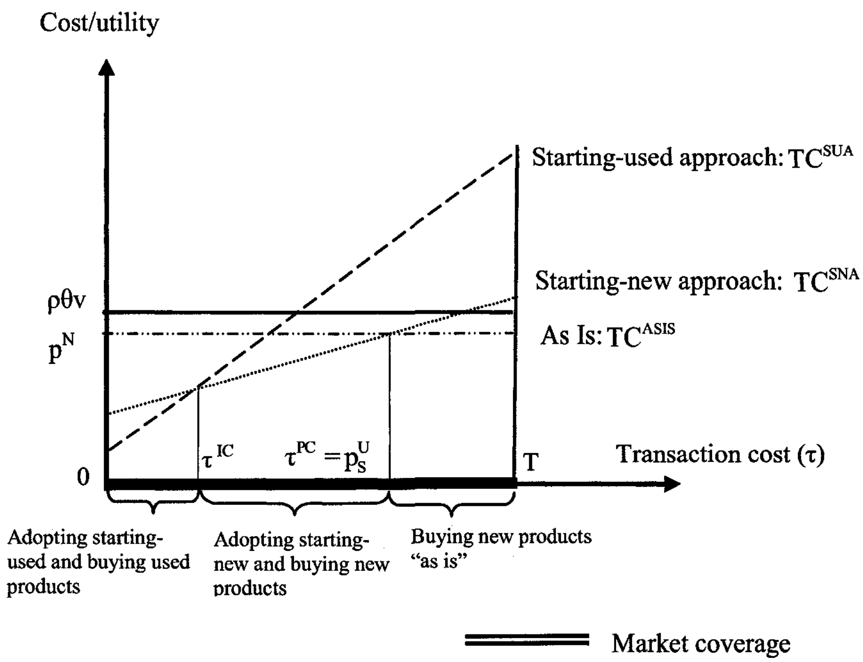
(2) $v = v_a$ implies that the inner solution is obtained on the boundary of $p_S^U + \dfrac{\theta v - p_S^N}{1-\theta} = T$. This can be shown by substituting $v = v_a$ into $\tilde{\mathbf{p}}_S = \hat{\mathbf{p}}_S$. *Q.E.D.*

Proposition A7 provides a feasible parametric region in which the firm charges the optimal price for new products which is $\tilde{p}_S^N$. It also states that the relationship between scenario two and scenario one in the parametric space.

Scenario three

We relax the other constraint on v in scenario one: we allow $v \geq v_b$. When $v \geq v_b$, $\hat{p}_S^N \leq \rho\theta v$. This indicates that when those consumers who do not purchase any products due to a high transaction cost (i.e., $\tau > \tau_S^{PC}$) will now purchase a new product "as is", and thus, the market is fully covered. Consequently,, $\hat{p}_S^N$ is no longer the optimal solution.

Figure A3: Demand for New Products in Scenario Three



In this scenario, the transaction cost of the marginal consumer who is indifferent between adopting the starting-new approach and buying "as is" is p_S^U subject to $p_S^U < T$, i.e., $\tau_S^{PC} = \min\{p_S^U, T\}$. When $p_S^U < T$, consumers whose transaction cost is greater than p_S^U will buy a new product "as is".

In Figure A3 we plot the demand for new products in the plane of the total costs of purchase and the transaction cost τ. The total costs of buying a new product "as is" is simply the new-product price: $TC^{ASIS} = p_S^N$ which is a horizontal line. The expected utility derived from consumption is always $\rho\theta v$. From Figure A3, we can see that consumers whose transaction cost is higher than p_S^U buy a new product "as is".

By (A36), the demand for new products consists of three parts: $D_S^N = {}^{SN}D_S^N + {}^{SU}D_S^N + {}^{AS}D_S^N$, where ${}^{SN}D_S^N = (\tau_S^{PC} - \tau_S^{IC})/T$, ${}^{SU}D_S^N = \theta\tau_S^{IC}/T$, and ${}^{AS}D_S^N$ $= \max\{1 - \tau_S^{PC}/T, 0\}$.

Since the market is fully covered, lowering the price below $\rho\theta v$ will not increase the demand for new products. Thus, the optimal p_S^N is $\rho\theta v$.

Substitute $p_S^N = \rho\theta v$ into $D_S^U = D_S^U$ and solve for p_S^U, we have

$$\breve{\mathbf{p}}_S = \begin{bmatrix} \breve{p}_S^N \\ \breve{p}_S^U \end{bmatrix} = \begin{bmatrix} \rho\theta v \\ \dfrac{(2-\theta-2\rho\theta+\rho\theta^2)\rho\theta v}{3+\rho-\rho\theta-2\theta} \end{bmatrix}.$$

We then can compute the steady-state optimal profit $\breve{\pi}_S$ for scenario two using $\breve{\mathbf{p}}_S$.

Proposition A8:

(1) The solution $\breve{\mathbf{p}}_S$ is feasible only in a parametric space defined as $\{ v, \theta, \rho, c, T \mid v_b < v < v_d \}$, where $v_d = \dfrac{(-\rho\theta-2\theta+\rho+3)T}{\rho\theta(\theta-2)(\rho\theta-1)}$.

(2) When $v = v_d$, $\breve{\mathbf{p}}_S = \tilde{\mathbf{p}}_S$, i.e., scenario two and scenario three are identical.

(3) $\breve{\pi}_S$ is smaller than $\rho\theta v - c$ if $\rho\theta v > c$.

Proof: (1) we require $\breve{p}_S^U \leq T$ in scenario three. This is satisfied if and only if $v < v_d$. In addition, since we let $v > v_b$, jointly, we have $v_b < v < v_d$.

(2) $v = v_d$ implies that $\tau_S^{PC} = p_S^U = T$ and from Proposition A2, this also implies that $\breve{p}_S^N = \rho\theta v$. Substitute $v = v_a$ into $\tilde{\mathbf{p}}_S = \hat{\mathbf{p}}_S$ and the results are identical.

(3) is from the directly comparison of $\breve{\pi}_S$ and $\rho\theta v - c$. *Q.E.D.*

Proposition A8 states a feasible region in which the firm can charge $\breve{p}_S^N$ for new products. In addition, it explains the relationship between scenario three and scenario two. From Proposition A8, when v is large and c is small, the used market creates competition for the new products and the firm receives fewer profits than when there is no used market.

Decision Map

Given the parametric values of $\{\theta, \rho, c, T\}$, the threshold values for v (i.e., v_a, v_b, v_c, and v_d) are also determined. We then can decide which scenario the market fits into and apply the corresponding optimal solution in the parametric space of v.

Lemma A2: $\min\{v_b, v_d\} \le v_a \le \max\{v_b, v_d\}$.

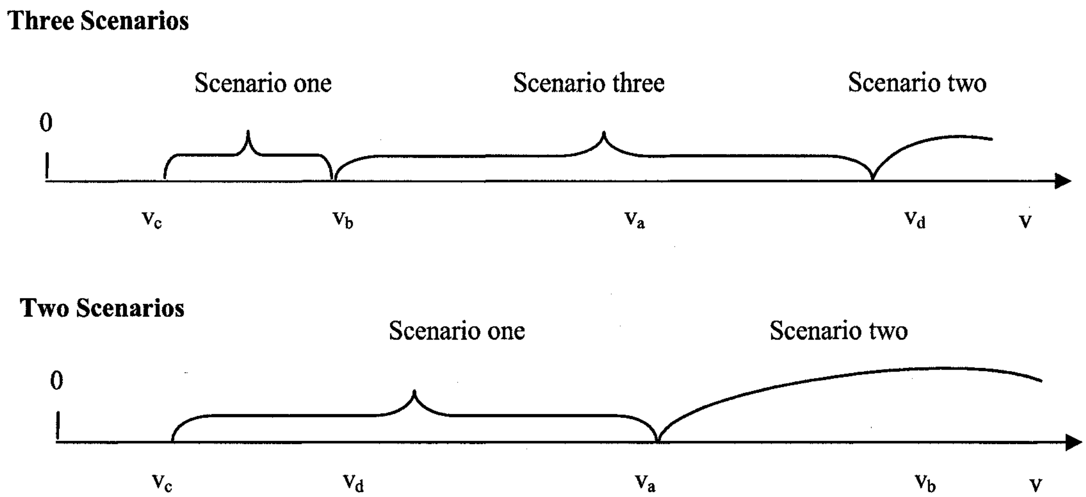
Proof: let $x = v_b - v_a$, and let $y = v_a - v_d$. Define $c_a = \{c| x=0\}$, and

$$c_a = \frac{(2\rho^2\theta^2-2\rho^2\theta-\rho\theta+\rho-1)(-\rho\theta-2\theta+\rho+3)}{(\theta-2)(\rho\theta-1)(\rho^2\theta^2-\rho^2\theta-1)}T.$$ When $c = c_a$, y also equals to zero. Then

when $c > c_a$, $x > 0$ and $y > 0$; when $0 < c < c_a$, $x < 0$ and $y < 0$; when $c = c_a$, $x = 0$, $y = 0$. *Q.E.D.*

By Lemma A2, there are two different possible situations. When $0 < c < c_a$, we have $v_b < v_a < v_d$, and all three scenarios are possible candidates given the particular range of the parametric value of v; when $c > c_a$, we have $v_b > v_a > v_d$, and the firm never applies scenario three regardless the parametric value of v, i.e., there are not consumers buying "as is". Figure A4 depict the two situations, respectively.

Figure A4: Scenario Decisions



Next we consider the impacts of the production cost c and the maximum transaction cost T on the application of optimal scenarios. Denote $c = sv$ $(s > 0)$ and $T = rv$ $(r > 0)$. s measures the relative marginal production cost to v, and r measures the maximum transaction cost to v. A large s implies a large production cost; a large r implies a large transaction cost for consumers on average.

Lemma A3:

(1) There is an upper boundary s_c on s: the firm makes a positive profit when $s < s_c$.

(2) $s_c > \theta\rho$.

Proof: (1). s_c is derived by substitute $c = sv$ in to v_c given in (A39): $s_c = \frac{\rho\theta(\rho\theta-\rho-1)}{\rho^2\theta^2-\rho^2\theta-1}$.

$\tau_S^{PC} < 0$ when $s > s_c$. (2) $s_c - \theta\rho = \frac{\rho^2\theta(1-\theta)(\rho\theta-1)}{\rho^2\theta^2-\rho^2\theta-1} > 0$. *Q.E.D.*

Lemma A3 indicates the upper boundary of the production cost. In addition, it says that in the presence of used market, the firm can make a positive profit even if the production cost is relatively large.

Lemma A4: There exist the following equivalent relationships:

$v < v_a \Leftrightarrow s > s_a$, $v < v_b \Leftrightarrow s > s_b$, $v < v_c \Leftrightarrow s > s_c$, and $v < v_d \Leftrightarrow r > r_a$.

The relationships for the equal signs are also maintained.

Proof: We substitute s and r into v_a, v_b, v_c and v_d, and Lemma A4 is proved.

We discuss the applicability of different scenarios in the new parametric space {θ, ρ, v, s, r} and have the following proposition.

Proposition A9:

Scenario one is applicable in the parametric space $\{\theta, \rho, v, s, r \mid \max\{s_a, s_b\} < s < s_c\}$; scenario two is applicable in the parametric space $\{\theta, \rho, v, s, r \mid 0 < r < r_a, 0 < s < s_a\}$; scenario three is applicable in the parametric space $\{\theta, \rho, v, s, r \mid r > r_a, 0 < s < s_b\}$, where $s_a = \frac{2\rho(\theta-1)(-\rho\theta-2\theta+\rho+3)}{(\theta-2)(\rho^2\theta^2-\rho^2\theta-1)} r + \frac{\rho\theta(\rho\theta-\rho-1)}{\rho^2\theta^2-\rho^2\theta-1}$,

$s_b = \frac{\rho\theta(2\rho^2\theta^2-2\rho^2\theta-\rho\theta+\rho-1)}{\rho^2\theta^2-\rho^2\theta-1}$, $s_c = \frac{\rho\theta(\rho\theta-\rho-1)}{\rho^2\theta^2-\rho^2\theta-1}$, and $r_a = \frac{\rho\theta(\rho\theta-1)(\theta-2)}{-\rho\theta-2\theta+\rho+3}$.

Proof: By Lemma A4, we rewrite the supports in parametric space in Proposition A1 to A3 in terms of s and r. *Q.E.D.*

Proposition A9 indicates that v being constant, the relative production cost and the relative transaction cost both affect the applicability of the three scenarios. However, they affect the new-product price p_S^N differently, and thus, affect the applicability of each of the three scenarios.

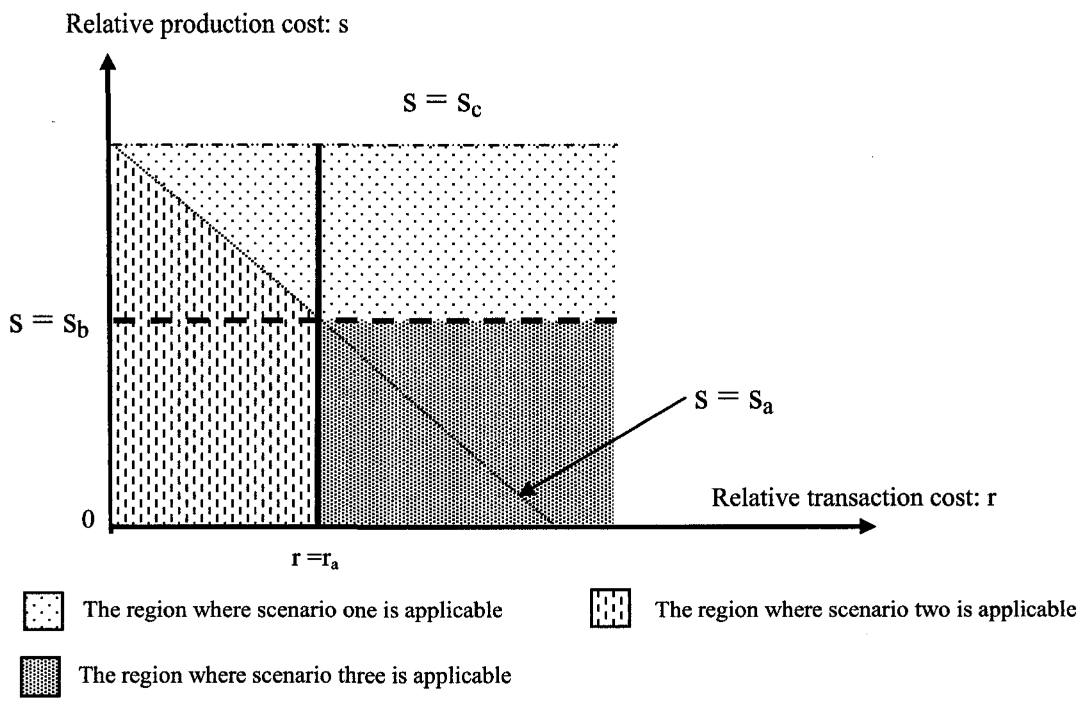
Specifically, scenario one can sustain a large production cost and a large transaction cost. This is because in scenario one the market is partly covered and only consumers with a low transaction cost participate. When the production cost increases, the firm can increase p_S^N accordingly. Though the demand shrinks, the firm still makes a positive profit as long as the relative production cost is below s_c. On the other hand, since the market is partly covered, consumers with a high transaction cost do not purchase. When the transaction cost increases, only the quantity sold is affected but not the optimal new product price p_S^N; the firm still makes a positive profit.

Scenario two is only feasible when both costs are small. This is because in scenario two the market is fully covered, and by (A33), consumers with a high transaction cost do not have much expected surplus for the firm to extract. When the relative production cost exceeds s_a, the firm has to raise p_S^N such that the consumers with a high transaction cost cannot afford a new product anymore, and thus, start to withdraw. Consequently, the market is no longer fully covered and scenario two becomes scenario one. On the other hand, when the transaction cost goes up, the same consumers mentioned above cannot afford to resell their purchase on the used market. In order to let scenario two to work, the firm has to reduce p_S^N. When the relative transaction cost r rises to r_a, the firm has to lower p_S^N to $\rho\theta v$; then scenario two collapses to scenario three.

Scenario three can sustain a large transaction cost but not a large production cost. In scenario three the firm has to bring down the new-product price p_S^N to $\rho\theta v$. Due to this low price, consumers with a high transaction cost can purchase a new product "as is"; they will receive zero expected surplus without reselling their purchase. Consequently, the market is fully covered. When the relative production cost increases to s_b, the firm has to raise p_S^N above $\rho\theta v$. As a result, “as is” purchase is not a choice anymore. This hinders consumers with a high transaction cost from participating, and thus, scenario three collapses to scenario two. In comparison, when the transaction cost increases, those consumers with a high transaction cost are not affected. This is because they purchase “as is" and will not incur any transaction cost because they will not resell their purchase regardless of their learning outcome.

We illustrate Proposition A9 in Figure A5.

Figure A5: Decision Map in r-s Plane



Profit Comparison with "As is"

Finally, we compare the profit generated by the firm under the three scenarios with the case when the firm releases the new product "as is" in the absence of a used market. The firm's profit when selling new products "as is" is $\pi^{as\text{-}is} = \rho\theta v - c$. We have the following proposition regarding $\pi^{as\text{-}is}$.

Proposition A10:

In the presence of a used market, there exists a region in the parametric space {v, θ, ρ, c, T} where the firm makes a positive profit that is greater than $\rho\theta v - c$.

Proof: Denote $x = \hat{\pi}_S - \pi^{as\text{-}is}$. Substitute $s = s_c$ into x. By Lemma A3, $\hat{\pi}_S = 0$. We have

$x_{s=s_c} = -\frac{v\rho^2\theta(-1+\theta)(-1+\rho\theta)}{\rho^2\theta^2-\rho^2\theta-1}$ >0. This implies that $\pi^{as\text{-}is}$ is negative when $s = s_c$.

In addition, when s= ρθ, $\pi^{as\text{-}is} = 0$. S ubstitute s= ρθ into x, we have

$x_{s=\rho\theta} = \frac{1}{4}\frac{v\rho^3\theta^2(-1+\theta)(-1+\rho\theta)^2(-1-\theta+\theta^2)}{(-\rho+\rho\theta-3+2\theta)r(\rho^2\theta^2-\rho^2\theta-1)} > 0$. This indicate that in a region where $\rho\theta < s < s_c$, $\hat{\pi}_S > 0 > \pi^{as\text{-}is}$. *Q.E.D.*

Proposition A10 implies that the used market successfully remedies the information problem which could otherwise lead to a market failure. When the production cost is above ρθv, the firm cannot sell anything in the absence of a used market. Nevertheless, when there is one, the firm can sell new products at a price higher than ρθv. Even though the market is partially covered, the firm is making a strictly positive profit. This shows that a used market can facilitate consumers to learn their valuations and eventually, cures the information problem.

4. Conclusion

In this thesis, I discuss how firms (sellers) facilitate consumer's purchase of products under limited information in two different marketplaces: Internet auction and the market for slow-to-evaluate experience products.

4.1. Summary of Findings

In the first essay, I provide support based on empirical results from three studies for my main hypothesis that BNPs can be used by retailers as reference prices, thereby increasing bidders' valuations. Study 1, a controlled field experiment, shows the existence of the reference price effect for different types of goods, while ruling out alternative motives for BNPs. A strong reference price effect is observed, resulting in an increase in bidders' WTPs by 23.05 percent. The reference price effect is stronger when the value of a product is more difficult to assess. Results of Study 2, a laboratory experiment, provide further support for my hypotheses regarding two moderating factors, the product category and product class, and indicate that the reference price effect of BNPs exists only for high-end products that are difficult to assess. Finally, Study 3 reports results consistent with a reference price effect under real-world competitive market conditions. Data from eBay auctions reveal that BNPs have a significant reference price effect, which diminishes in the magnitude of the BNP.

Most previous research on BNPs has focused solely on the behavior of bidders in auctions; in contrast, this essay considers the retailer's decision-making process as well. It proposes that BNPs function as external reference prices, and that retailers may benefit by using BNPs in auctions even though bidders seldom take them. When visiting an auction to determine the value of an item, bidders assimilate the BNP as useful information for forming their valuations. Thus, by setting a sufficiently high BNP, retailers can positively affect bidders' valuations in auctions, leading to higher ending prices.

Our findings are consistent with the growing literature that suggests people participating in Internet auctions construct the valuation of an auctioned product during the bidding process (Ariely and Simonson 2003; Häubl and Popkowski Leszczyc 2003) and their valuations may be influenced by different pieces of information revealed in the auction. This may include the bids submitted by other bidders (Milgrom and Weber 1982), the number of bids (Dholakia et al. 2002), and starting bids (Suter and Hardesty 2005; Kamins et al. 2004; Häubl and Popkowski Leszczyc 2003).

In the second essay, I examined a stylized model with several features. *Ex ante*, consumers do not know whether they will like a novel product, and, *ex post*, some consumers end up with a product they do not like. This information asymmetry gives rise to potential market failure, even though some consumers value the product more than the product cost. The problem is that consumers do not know whether they are the ones with high valuations and no consumer is willing to take the risk to find out. Used markets, seller buybacks, and rental policies circumvent this market failure by recirculating used product, helping consumers partially recoup or minimize the initial outlay. This reduces the penalty for making purchase "mistakes" and the exposure risk.

When used market is present, consumers will start new if the probability of being type h is high and the transactions costs for buying new and selling used are low. Consumers will start used if the probability of being type h is low and the transactions costs of buying used and buying new are low. Consumers will buy "As-is" if the probability of being type h is high, the depreciation rate is high, and the transactions costs of buying and selling used are high. In general, the used-markets approaches yield higher profits for the seller than the "As-is" approach, when consumers use these approaches. So everybody "wins" when used markets are utilized to recirculate product.

When used markets are not accessible to consumers, the seller can analogously help consumers reduce their exposure to loss by providing a self-initiated used market, in the form of seller buybacks or rent-to-own policies. For both retail policies, the seller will earn greater profits than under the "As-is" approach when the salvage value of returned product exceeds the expected total consumer transactions costs of using these polices (as compared to selling "As-is"). However, for both approaches, the seller is in multiple businesses: selling new product, buying back/salvaging or renting/salvaging.

Both of these two policies involve some indeterminacy regarding optimal policies. If the seller chooses the highest feasible buyback rate or the lowest feasible rental rate, then, when their types are revealed, the type l customers incur the smallest loss and the type h consumers have the smallest gain (because they initially paid the highest feasible product price). In the extreme, this type of buyback policy is effectively a *full refund*, or *money-back guarantee*; and this type of a low rental rate has the properties of a *free sample*. Both induce the greatest amount of product trial, but both end up benefiting the type h consumers (the ultimate clients) the least. (The opposite is true if the seller picks the lowest feasible buyback rate or the highest feasible rental rate.)

4.2. Managerial Relevance

The first essay provides useful managerial relevance to online retailers who use Internet auctions as an alternative distribution outlet. First, it demonstrates how consumers behave in Internet auctions given BNPs, as well as how they are influenced by BNPs that are under the control of the retailer. I find that consumers, regardless of taking BNPs or not, are influenced by BNPs.

Second, my conceptual model shows how retailers can strategically use BNPs. I suggest that a retailer's decision to set a BNP depends on the product type and the retailer's specific objective. Such decisions will vary depending on whether retailers want to provide insurance to risk-averse bidders, segment time-sensitive consumers, or set external reference prices for auctioned items. When BNPs are used as external reference prices, retailers can positively influence auction outcomes.

Finally, I find that the reference price effect diminishes as the BNP increases, and maximum bids may even be negatively affected by very high BNPs. As a result, retailers must take care not to set BNPs too high. Clearly, my findings empirically reveal a pertinent explanation as to why retailers avoid setting high BNPs in their auctions.

The second essay provides important insights for sellers of slow-to-evaluate products such as pianos, sporting equipment, cars, and cameras. First, the analysis demonstrates how used markets can be utilized to facilitate learning about the products using the starting-new and starting-used approaches. Each example is perhaps debatable, because different people use these markets in different ways. Nevertheless, the authors are aware of parents who started their children on used pianos or other musical instruments, and purchased more expensive, new instruments when their children showed greater interest, which is an example of the starting-used approach. Also some purchasers of new cars have justified their purchase of a particular brand because it "retains its value" and thereby reduces its risk in the presence of a used market, which is an example of the starting-new approach. Recognition is due to used markets, which play a key role in facilitating consumer learning about slow-to-evaluate experience products. This is certainly not the only role of used markets, but an important one.

Second, the analysis reveals that sellers can create a used market by offering sales policies such as buyback and rent-to-own policies. For example, IKEA gives a three-week full buyback guarantee, which allows consumers to assess whether the product fits with their decor. The Home Depot and other home improvement stores provide two- to four-week return policies to allow the do-it-yourselfer or contractor to determine whether a hardware part fits a need. Car leases may constitute an example of a retail-initiated rental policy. Such leases may reduce the consumer's exposure by letting the consumer rent the car for a limited period of time while the consumer learns his or her tastes, with an option to buy at the end. For these examples, I believe sellers are conscious of their desire to facilitate consumer learning.

Finally, the analysis recommends that managers adopt a basic philosophical approach to facilitating consumer learning about slow-to-evaluate products. Most marketing texts highlight the importance of educating the customer. That is certainly true.[37] But it is also important for sellers to let consumers know there are used markets available to backstop customer decisions, or even to suggest that customers first go through a trial period with a used product. If used markets do not exist or do not function perfectly, the seller could set up a used market as a section of a store, a website, or other form of e-commerce activity. For example, Nikon, a professional camera manufacturer, has established a well-organized "Nikon Club" through which customers exchange used Nikon SLR cameras and lenses. If the seller wishes to retain more control, the seller may offer some form of buyback or rental policies. The choice of which policy to offer depends on an examination of the various transactions costs, the proportion of consumers that will ultimately like the product, and the salvage values, as described in this essay. The seller can also use independent online used markets to help efficiently dispose of used product to obtain a suitable salvage value. Then, given that the seller has chosen to pursue either buybacks or rentals, the subsequent choice between a generous or stingy buyback and rental policy depends on whether the underlying strategic objective is to induce product trial on the part of as many consumers as possible or to provide the greatest satisfaction for the seller's long-term customers.

A more local example of this approach can be witnessed in sports stores in Edmonton, Alberta. They sell both used and new items. Alternatively, a store may organize a special weekend when consumers can sell their own used items. In this case, the store facilitates the second-hand market, and at the same time attracts potentially new

[37] In particular, I suggest renewed focus on customer service, including answering consumer inquiries, providing in-person purchase guidance, and offering training programs, online training manuals, tutorials, and discussion boards.

customers to its store. Finally, Sport Mart (part of the Forzani group) has a program whereby kids can trade in sporting equipment purchased at the store to get x percent of the paid price when they purchase new items. Sporting equipment is of course a prime example of a market where many parents buy either used items or items that will have resale value (as rapidly growing children only use sports items for a limited period of time). The Sport Mart example is a nice strategy of providing some insurance to customers (if the item is not good you can always purchase another and still get a substantial amount for the old item back) to keep them loyal in the long run.

4.3. Future Research

The first essay raises an interesting question for future research: given various factors affecting the usage of BNPs, how should one determine the optimum level of a BNP? In other words, at what level may a high BNP have a negative impact? This issue is related to consumers' perceptions of price fairness, as Suter and Hardesty (2005) suggest that setting a high reference point in the form of a starting bid may have a negative impact on long-term profits. Some research findings suggest that even exaggerated reference prices may have a positive influence on consumers' internal reference prices (Urbany et al. 1988), while others suggest that BNPs at moderate levels have a stronger impact on internal reference prices (Kopalle et al. 2003). This suggests that the relationship between BNPs and auction outcomes may be non-linear.

In addition, research is needed to consider different forms of reference price information, since retailers have alternative ways of setting reference points for consumers. They can use a reference price in the form of a starting bid, appraisal, or other price information in the product description, as well as a BNP. I observed that both the BNP and the starting bid are significant; however, the effect of the BNP on auction outcomes is stronger. Our results from eBay auctions for diamond stud earrings indicate that BNPs and starting bids do influence auction outcomes but appraisals do not. This is consistent with the findings reported by Park and Bradlow (2005) that the positive effect of a starting bid becomes insignificant once a BNP variable is included. However, more research is needed to determine which reference points have the greatest impact under different market conditions.

Another relevant question of interest is: what is the joint impact of BNPs and starting bids on bidders' valuations? Will the joint reference price effect be stronger or weaker? If the effect is stronger, what is the optimal BNP and starting bid for maximizing auction outcomes? Finally, the strategy of combining a BNP with a secret reserve may be fruitful, since in that instance the BNP remains until the auction reaches the secret reserve.

Research is also required to further investigate the process through which BNPs influence consumer valuations. What is the psychological process that underlies the effect of BNPs on auction outcomes? This may either be (i) a relatively low-level, possibly unconscious mental process, consistent with either priming or anchoring and adjustment, or (ii) a deliberate inference about the value of the auctioned product based on the retailer-specified BNP. The results of my research suggest that this is more of a deliberate process, since I have not observed reference price effects for low-end products.

Finally, the results of the first essay also have implications for consumer welfare. Consumers bidding in an auction should be careful not to rely too much on BNPs as an information source when determining the value of an item in an auction.

The second essay illustrates how consumer learning about durables is facilitated by used markets, buybacks, and rentals in a simple, stylized model. A next step would be to examine how results change when the model is made more general. In particular, it would be desirable to include (a) product quality (recognizing that more experienced users often trade up), (b) other marketing mix variables (particularly advertising, customer service, or training programs), (c) more complex leasing contracts (including upgrade options), (d) discounting for time value, (e) competition from other sellers of new and used products and from new entrants, (f) more explicit modeling of supply and demand conditions in the used market, and (g) explicit modeling of general equilibrium considerations.

Looking forward, I think there are several related phenomena worth studying:

1. *It would be desirable to study how product line design affects consumer learning and skill development.* Firms offer basic, entry-level products at a lower price, and encourage consumers to trade in for expensive, advanced versions after consumer learning. This will greatly reduce the risk of learning to consumers.

2. *It would be desirable to study how firm-supplied training influences consumer learning and purchase decisions.* In this case, firms bundle service (training) with products (hardware) and benefit from two aspects: first, training reduces consumers' perceived risk of buying; second, training can bring in additional revenue. When the training is critical and the cost of hardware is low, firms can actually give away free hardware and profit from the bundle.

3. *It would be desirable to study the extent to which secondhand information communicated by the media and word-of-mouth helps customers learn their*

valuation for novel products. What kinds of people require direct interaction with a product and what kinds of people can learn from secondhand information such as chat rooms, expert recommendation systems, blogs, wikis, personal web-spaces, immersive avatar-based systems, and other forms of social computing?

4. *It would be desirable to understand how peer-to-peer trading influences the markets for music, movies, software, games, books, and other copyrightable products.* There are complex copyright and property right considerations. Since there is virtually no depreciation from use or costs of replicating such products, the solutions of this essay involving starting-used, starting-new, buybacks, and rentals are no longer feasible.

5. *It would be desirable to measure and assess the business and social implications of consumers' behavioral orientation toward used markets, consumerism and ecology.*

In conclusion, a subtext of the second essay involves the growing tension in modern markets between values for newness and ecology. The paper suggests a partial resolution of this tension by recognizing (and encouraging) the role of used markets, buybacks, and rentals to facilitate learning about products novel to the consumer. Nevertheless, noting the list of related research topics described above, the content of this essay is only a small part of the picture. I look forward to future research that addresses the larger picture.

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