**The effect of brand loyalty and loss aversion on competitive trade-in strategies**

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**Abstract**

Trade-in promotions allow consumers to turn in old products and receive a discount for purchasing a new item. Firms usually price discriminate consumers based on their purchase history (i.e., new or existing customers). However, behavioral research has shown that consumers exhibit loss aversion and brand loyalty after consuming a product that may influence economic outcomes. This paper examines the impact of consumers’ loss aversion and brand loyalty behavior on firms’ trade-in promotion pricing strategy, profits, consumer surplus, and social welfare. Contrary to prior game theory research that generally shows that price discrimination based on purchase histories eventually results in lower profits for all firms, we find that firms’ profits from conducting price discrimination can increase with consumers’ loss aversion behavior. We consider two scenarios where firms recognize and do not recognize consumers’ loss aversion and brand loyalty behavior. We find that the profit with behavior recognition is higher than that without behavior recognition under the condition that consumers’ loss aversion concerns are sufficiently strong. However, both loss aversion and brand loyalty decrease consumer surplus. Besides, consumers’ loss aversion and brand loyalty behavior can increase social welfare because they can reduce inefficient switching.

*Keywords*: trade-in promotions; price discrimination; dynamic pricing; loss aversion; brand loyalty

## 1. Introduction

Consumers have the opportunity to use better-quality products because of technological progress. Apple, Samsung, Huawei and other companies release a new version of products almost every year. As high-tech markets mature, trade-in has become a common industry practice, and replacement purchases represent an ever-increasing proportion of the sales, for consumer durables, nondurables and industrial products (Kim et al., 2011). For example, over 60% of mobile phone (cell and smartphones) sales are replacement sales (Wilhelm et al., 2011), and the percentage of replacement purchases even amounts to 70%-80% of annual sales for products in highly saturated markets (Fernandez, 2001). By offering trade-ins or inducing replacement purchases, firms can create switching costs (Klemperer, 1987, 1988), increase the purchasing frequency (Ackere and Reyniers, 1993), alleviate the psychological cost (Ackere and Reyniers, 1995; Park et al., 2007; Okada, 2001; Zhu et al., 2008), or achieve better price discrimination outcomes (Agrawal et al., 2016).

Trade-in programs have evolved from exchanging old products of the same brands to any brands (Desai et al., 2016). For instance, Apple’s initial reuse and recycling program only accepts IOS trade-in devices, but it has now expanded to all non-IOS devices (Swanner, 2015). Not only can companies encourage consumers to make repeated purchases, they can also attract potential new consumers to buy their products. Behavior-based pricing (BBP) is a prevalent industry practice whereby firms charge different prices to existing and new consumers. Firms can easily recognize whether the consumers have or have not purchased from them by using a trade-in program. Generally, consumers can be grouped according to their purchase history as firms’ existing consumers and competitor’s consumers. Accordingly, firms could offer different rebates to the two groups when they participate in a trade-in program. In this regard, two important questions that are pertinent to a firm arise. Which group should receive more trade-in rebates, and which group should receive a lower price for the new product?

The growing popularity of trade-in promotions has raised significant concerns about loss aversion and brand loyalty because consumers’ buying experiences play a vital role in their current decisions (Anninou et al., 2019). Regarding loss aversion, consumers engage in trade-in transactions by buying a new product and selling an old product (Kim et al., 2011). Consumers tend to perceive losses to be more substantial than gains (Kahneman et al., 1979; Thaler, 1985; Su, 2009; Okada, 2001). However, in trade-in transactions, gain and loss can be explained from two different perspectives. On the one hand, some scholars believe that selling used product is a loss, whereas obtaining a new product is a gain which causes consumers to emphasize on trade-in rebates rather than on purchasing new products (Okada, 2001 and Okada, 2006). Therefore, consumers will demand more rebates when they sell a used item compared to their willingness to pay for the same item (Thaler, 1980). On the other hand, some scholars argue that monetary payout is a loss, whereas the trade-in rebate is a gain (Kim et al., 2011). Consumers would be more sensitive to the prices of new products than the trade-in rebates of used products. They may become loyal to the current brand while become less willing to accept trade-in offers from other brands. Existing research does not consider such consumers’ behaviors.

The loss aversion and brand loyalty behaviors of consumers have imperative implications for firms because these behaviors directly affect firms’ pricing strategy and profitability. Traditional BBP literature suggests that firms should attract new consumers rather than the repeated ones, and offer lower prices to new consumers. However, consumers may exhibit different purchasing behavior when they have loss aversion and brand loyalty concerns. In this paper, we use a standard dynamic game model to investigate the loss aversion and brand loyalty behaviors of consumers, and how they affect the overall profit of the firm through pricing. Specifically, we address the following questions: How should firms offering trade-in programs alter their BBP strategies based on consumers’ loss aversion and brand loyalty behavior? How would consumers’ loss aversion and brand loyalty behavior affect firms’ profits? From the perspective of public policymakers, how would consumers’ loss aversion and brand loyalty behavior affect consumer surplus and social welfare? Existing research on trade-in strategies or BBP did not jointly considered consumers’ loss aversion and brand loyalty behaviors in their analysis even though such behavior would significantly affect firms’ pricing strategy.

We will address the aforementioned research gap in this paper. In particular, we build a two-period model with two horizontally differentiated firms, where firms can offer trade-in rebates in the second period that depend on the brand of the old product each consumer hold. Consumers with heterogeneous valuations are uniformly distributed on a Hotelling line. Consumers make direct purchase decisions between the two firms in the first period, while in the second period, they make purchase decisions by participating in a firm’s trade-in program. In the second period, some consumers will remain loyal to a brand. In this paper, we define loyal consumers as individuals who would not consider other brands even if they were offered a switching discount or were not paid a trade-in rebate from the brand they are loyal to (Shaffer et al., 1995; Shaffer et al., 2002). As for the other consumers, firms can price-discriminate and offer different trade-in rebates to them depending on whether they are their existing or the rival’s consumers. Consequently, firms can encourage consumers to upgrade and make a purchase and also fully exploit consumers’ surplus. As explained earlier, consumers’ loss aversion behavior is derived from consumers’ uneven valuation of loss and gain in trade-in transactions. Such uneven valuation is caused by consumers’ emphasis either towards paying the price of a new product or receiving trade-in rebates. We assume that consumers would perceive more losses from paying more for a new product than receiving fewer trade-in rebates. We analyze how the loss aversion degree affects consumers’ replacement decisions and firms’ trade-in strategy. We also investigate the effects of loss aversion and brand loyalty behavior on firms’ profits, consumer surplus, and social welfare.

The remainder of this paper is organized as follows. The following section briefly reviews the previous work. In Section 3, we introduce the model description and setting. In Section 4, we present the benchmark and main model. We investigate how loss aversion and brand loyalty behavior impact firms’ price-discriminate trade-in strategy in a duopoly in this section. In Section 5, we extend the main model in several ways. Contributions and managerial implications are provided in Section 6. Section 7 concludes the paper, and all proofs are provided in the Appendix.

## 2. Literature review

This section respectively reviews five distinguishing streams of literature that are related to our research: (a) trade-in transaction, (b) BBP, (c) loss aversion, (d) brand loyalty, and (e) switching cost.

As the practice of trade-in transactions become popular, a growing number of researchers show their interest in whether the firms should implement trade-in options as well as a variety of optimal decisions of firms for offering trade-in options. For instance, Ray et al. (2005) investigate the optimal pricing and trade-in strategies for selling durable, remanufactured products. Yin et al. (2014) and Yin et al. (2015) respectively examine whether firms facing strategic consumers can benefit from offering trade-in programs with up-front fees and for two successive-generation products. Zhu et al. (2016) consider a duopoly supply chain structure wherein the implementation of trade-ins creates competitive advantages for the firm. Miao et al. (2017) extend trade-in options to supply chain channels and identify the conditions under which trade-ins can benefit channel members. Ma et al. (2017) investigate the combined optimal decisions of two kinds of trade-in transactions, i.e., old-for-new and old-for-remanufactured. Zhang et al. (2018) show the effect of consumers’ purchasing behavior and remanufacturing efficiency on the economic and environmental utility of trade-in remanufacturing. Hu et al. (2019) further consider strategic consumers and limited trade-in duration in their optimal pricing decisions. Trade-in is also widely believed as a method of promotion. Currie et al. (2016) study how firms sell products by using different rebate promotions. Desai et al. (2016) find that multicategory (i.e., within-category and cross-category) exchange programs can increase both replacement and new purchases when consumers are waste aversive. Genc et al. (2018) examine fixed and variable rebate regimes and show how different game solutions are affected by the consumer return behavior. Cao et al. (2019) compare a B2C platform’s offering two forms of rebates, i.e., gift card or cash coupon, with dual-format retailing. Sheu et al. (2019) adopt a multi-methodological approach to characterize the trade-in-for-upgrade programs with generalized solutions of prices and trade-in rebates. However, the decisive effect of consumers’ behaviors towards the pricing strategies of trade-in campaigns has not been sufficiently characterized in the previous studies. Our contribution to this body of literature lies in us showing how consumers’ loss aversion and brand loyalty behaviors would affect the optimal trade-in strategy, rebates and prices of the firms.

In practice, price discrimination usually works when firms categorize the consumer groups according to purchase history. Thus, our work is closely related to the stream of BBP. Two critical problems commonly studied in BBP literature are: (1) how to offer different prices to new and repeat consumers, and (2) whether the firms can benefit from performing BBP (we refer interested readers to Fudenberg and Villas-Boas (2006) for a comprehensive review). Shin and Sudhir (2010) find that a firm should reward his repeat consumers under symmetric competition and exhibit forward-looking behavior with consumers to make BBP practice beneficial. Zhang (2011) considers the BBP with product design and finds that firms should offer lower prices and less differentiated designs to poach new consumers. The author uses a two-period dynamic game and finds that BBP can hurt firms’ profits in each period. Li and Jain (2016) estimate the impact of peer-induced fairness concerns on BBP implementation and find that the profit of the firms with BBP recognition increases with consumers’ fairness concerns. Rhee and Thomadsen (2017) study the BBP strategy for vertically differentiated products and find that the quality-adjusted costs between high- and low-quality firms play an important role in whether the firm should reward his repeat consumers or new consumers. Amaldoss and He (2019) find that firms can benefit from implementing BBP when consumers are loss aversive towards quality when the practice of BBP is applied on a horizontally differentiated market. We extend this stream of research by incorporating consumers’ loss aversion behavior into BBP analysis, and investigate how such behavior affects firms’ BBP strategy for new and repeat consumers. We also show that firms can benefit from performing BBP under particular conditions when consumers’ loss aversion and brand loyalty behavior are analyzed. Additionally, our study also extends previous research that focuses on forward sales by considering closed-loop, trade-in transactions that occur afterward.

Consumers’ loss-averse preferences in trade-in transactions has been studied by many scholars in behavioral research (Okada, 2001; Okada, 2006; Zhu et al.,2008; Srivastava et al., 2011; Kim et al., 2011) and even in neuroscience (Knutson et al., 2007). Loss aversion behavior arises in trade-in transactions mainly because these transactions are upgrade decisions, and some researchers try to understand such behavior by examining the differences of purchase decisions between upgrade and new products (Okada, 2011; Okada, 2006). Okada (2001) theoretically explains why a replacement purchase decision is more price-sensitive and concludes that trade-ins reduce consumers’ loss aversion behavior through mitigating the write-off of the book value. Okada (2006) argues that upgrade decisions differ from new purchase decisions. The author also develops approaches to alleviate the psychological costs associated with used products and to facilitate upgrade purchases by enhancing the new products. Consumers weighing greater importance of experiencing a better value from used products (i.e., overpaid) than being offered a better price from new products (i.e., underpaid) explains the core issues associated with the loss aversion behavior in trade-in transactions. Zhu et al. (2008) conduct a series of laboratory experiments to systematically support that loss-averse consumer tends to overpay when performing trade-in transactions. Contrary to Zhu et al. (2008), Srivastava et al. (2011) find that consumer evaluations and choices are equivalently influenced by the payment and receipt. Kim et al. (2011) characterize the loss aversion behavior of consumers by using the prospect theory value function to evaluate consumers’ preferences for overpayment and underpayment. Zha et al. (2021) show that loss-averse consumers would compare the current prices with historical prices when they make purchase decisions. Kallio et al. (2020) find that the loss aversion of value does not necessarily lead to loss-averse market demand and can benefit the firm under some conditions. Simpson et al. (2019) explore how consumers’ disposal of reusable products is influenced by psychological factors (i.e., loss-averse preference), and find that emotional reward could encourage consumers to dispose reusable products. Xu et al. (2019) investigate how the firms promote sales in trade-in transactions when consumers have loss aversion and waste aversion concerns. In this paper, we also incorporate consumers’ loss aversion behavior in the trade-in transaction models to investigate the impact of such behavior on trade-in pricing strategies.

Brand loyalty is always an important topic in the marketing literature since it was introduced by Brown in 1952. Brand loyalty was first identified as a biased choice behavior concerning branded merchandise (Tucker, 1964). Subsequently, conceptual definitions of brand loyalty were gradually formed (Jacoby et al., 1973; Wernerfelt, 1991). Henry (1987) defines brand loyalty as a commitment due to favorable attitudes learned from past purchases. Wernerfelt (1991) states that consumers’ brand loyalty behavior depends on the last brand purchased. Brand loyalty has been measured in several ways in the literature. One is the probability of buying the same brand of products as previously owned, namely, the repeated purchase probability. It has been studied by Colombo et al. (1989) and Bayus (1992), and is commonly used in empirical studies. Alternatively, brand loyalty is measured as the minimum price differential needed to influence consumers to switch their purchase decisions (Raju et al., 1990; Agrawal, 1996; Shaffer et al., 2000). Firms can benefit from consumers’ brand loyalty behavior; wherein various factors that influence such behavior are studied. Gönül et al. (1997) position the group of loyal consumers and investigate how firms retain and attract consumers. He and Lai (2014) study the impact of corporate social responsibility on brand loyalty and find that legally responsible behavior helps to enhance consumers’ brand loyalty. Lin (2016) finds that the profits of channel members increase with consumers’ loyalty. Miller et al. (2019) show the effects of trade-in characteristics and brand loyalty on upgrades and downgrades using mental accounting theory. Hua et al. (2019) find that consumers’ loyalty can be increased when a reverse logistic system is introduced. Chen et al. (2020) extend the measurement of consumers’ brand loyalty to green purchase behavior and examine the impact of firms’ greenwashing behavior on the brand loyalty of consumers. Consistent with these studies, we define brand loyalty as the strong preferences for a particular brand despite trade-in offer from other brands and the absence of trade-in offer from the particular brand. Besides, our model also considers consumers having a strong preference for a brand could switch to other brands when offered high rebates, and how firms can retain and attract brand-loyal consumers. Our primary goal is to understand the implication of brand loyalty in the trade-in strategy and the trade-in rebates offered by two competing firms.

Another stream of related research focuses on switching costs (see Klemperer 1995 for a comprehensive review, and Farrell and Klemperer 2007 for extended surveys). A switching cost comes from the desire for compatibility when making different purchase decisions. Such compatibility might be physical, informational, artificially-created, and even psychological (Klemperer, 1995). Chen (1997) finds that firms would charge higher prices to their old consumers by using a two-period, two-firm model. Taylor (2003) extends Chen’s models to multiple periods and firms. Arbatskaya (2000) shows that a firm’s old and new consumers are irrelated when products are functionally differentiated. Fudenberg et al. (2000) also find that loyal consumers should be charged with higher prices than switchers concerning functional product differentiation. Acquisti et al. (2005) study a related two-period monopoly model when consumers consider switching cost. Tsao et al. (2009) use the Markov brand-switching model to examine the impact of loyalty and promotion effect on retention rate. Nan et al. (2019) analyze a cloud service provider’s optimal pricing strategy in an incumbent entrant setting when users facing upgrade and switching cost. We investigate the joint effect of consumers’ loss aversion and brand loyalty behavior on the trade-in pricing strategy of firms. We incorporate switching costs in the extensions because it affects purchase decisions and firms’ profits.

## 3. Model Setting

We consider a two-period model of a duopoly. The market consists of two firms, labeled A and B, are located at the opposite ends of a linear city of unit length (Hotelling, 1929). Firms sell horizontally differentiated products in each period, while at most one-unit product is consumed by each consumer. The base value of the product is , and  is sufficiently high so that all consumers buy the product and the market is fully covered. The firms are symmetric with zero marginal production cost.

Consumers are uniformly distributed on a Hotelling line. A consumer’s location on the line represents the ideal product for the consumer. Let  represents the transportation cost when the consumer incurs a mismatch dis-utility. Without considering consumers’ loss aversion and brand loyalty behavior, a consumer at  who buys product A at price  has the utility. Similarly, the utility that a consumer at  consumes product B at price  is . We assume that firms and consumers do not discount the second-period payoff, namely, firms’ and consumers’ discount factors are one. This assumption is plausible when the time distance between the periods is short (Li, 2019).

We use the linear utility function to capture consumers’ loss aversion behavior; this allows us to model consumers’ weighing losses more heavily than gains. Therefore, we use the following utility function proposed by Kahneman and Tversky (1979), Kivetz (2003) and Su et al., (2009):

   (1)

where  is the coefficient of loss aversion. In this paper, we view the monetary payout of a new item as a loss, and the trade-in rebate received from an old product is a gain. Since losses loom larger than gains, consumers prefer to pay less for the new products than receive more rebates from the old ones. Following Kim et al. (2011), we assume in this paper.

We consider two scenarios: (1) the firms recognize the loss aversion and brand loyalty behaviors of consumers, namely, with behavior recognition, and (2) the firms do not recognize any consumer behavior, namely, without behavior recognition. In the benchmark model, we consider the scenario without behavior recognition, whereas behavior recognition is characterized in the main model. It is practical and common to study trade-in transactions without behavior recognition (Kwon et al., 2015; Genc et al., 2017; Genc et al., 2018; Cao et al., 2019). In the first period, the two firms simultaneously set sales prices denoted by  and . In the second period, the two firms offer trade-in programs which allow consumers to trade-in their old product for a new product, regardless of the brand. Since the two firms can recognize their own consumers or their rival’s consumers when consumers turn in their old product, they can set prices for past consumers as  and , and prices for new consumers as  and . In the baseline, firms do not recognize consumer behaviors. Therefore, the prices are the net prices that consumers need to pay for the new product, including trade-in rebates. Figure 1 depicts the choice patterns of consumers in the pure strategy equilibrium. Let denote consumers’ indifference to trading A for A and trading A for B, denote consumers’ indifference to trading B for A and trading B for B, and  denote consumers’ indifference to buying product A and buying product B in the first period.

Figure 1 Consumer choices in periods 1 and 2 without behavior recognition

For simplicity, we assume that the firms’ salvage value and disposal costs associated with used items are zero (Desai et al., 2016). In Section 5, we discuss situations in which firms’ salvage value and disposal costs are not zero to verify the robustness of our model.

## 4. Model analysis

In this section, we first characterize the benchmark model when the firms do not consider the effects of consumer behaviors. We then analyze the main model with behavior recognition.

### *4.1. Benchmark model: No behavior recognition*

When firms do not recognize consumer behaviors, we solve the two-period problem using backward induction. In this case, firms’ price discrimination is customized, according to their own and the rival’s consumers. The equilibrium results are similar to price discrimination based on behavior; Lemma 1 summarizes the equilibrium outcomes.

**Lemma 1.** Without behavior recognition, the first-period sales prices are , past-consumer sales prices are , and new-consumer sales prices are . The two firms’ total profits are . The marginal consumers are at , , and .

These results are based on the standard finding in the BBP literature that new-consumers always pay a lower price than past-consumer (Villas-Boas, 1999, Fudenberg and Tirole 2000).

## *4.2. Main model: Behavior recognition*

We also use the backward induction method to solve the symmetric pure-strategy equilibrium of firms’ recognition of the loss aversion and brand loyalty behaviors of consumers.

*The second period*. Firms take consumers’ loss aversion and brand loyalty behavior into consideration, in which consumers weigh losses more heavily than gains or can remain loyal to a firm despite trade-in offers from the competing brand. Let and denote the prices firm A and firm B charges, where index the prices in the first period, in the second period, and trade-in rebates offered to old consumers and new consumers by both brands respectively. In equilibrium, loyal consumers are located nearer to their selected firms, whereas those nearer to the center of the line switch (see Figure 2).



Figure 2 Consumer choices in periods 1 and 2 with behavior recognition

Consumers loyal to brand A will prefer buying from firm A even if they receive B’s trade-in offer and do not have A’s trade-in offer, let denote the location of the marginal consumer who is loyal to brand A. We have the following:

  (2)

  (3)

The left-hand side (LHS) is the utility of buying from firm A at the price , the parameter  represents the degree of consumers’ loss aversion behavior which ranges from . If , loss aversion behavior does not exist and consumers’ utility is not affected by that behavior. The higher the , the more consumers put on losses when making replacement decisions. The right-hand side (RHS) is the utility of buying from firm B at the price , is the new-consumer trade-in rebate received from firm B for trading in an old product from A. Similarly, let denotes the location of the marginal consumer who is loyal to brand B. Thus, we have

  (4)

  (5)

The LHS is the utility of buying from firm A at the price with the new-consumer trade-in rebate . The RHS is the utility of buying from firm B at price .

The consumer located at is indifferent to trading A for A and trading A for B, and the consumer locate at is indifferent to trading B for A and trading B for B. We can write that

  (6)

  (7)

Similarly, we can write the consumer located at as

  (8)

  (9)

The two firms’ profits consist of profits generated by selling to loyal consumers, the firm’s past consumers who make a replacement purchase decision without switching brand, and the competitor’s consumers whom the firm poaches from the competitor. Hence, the profit functions for firm A and firm B in the second period are

  (10)

  (11)

The second-period sales prices are ,,, ,,.

*The first period.* The marginal consumer located at  makes a first-period purchase to maximize total utilities over two periods; there exists such that all consumers buy from firm A in the first period and all consumers whose buy from firm B. Letand denote consumers’ expectation about firms’ prices in the second period. We can write that

  (12)

By rational-expectation conditions, i.e., ,,and , we have

  (13)

The two firms set first-period prices to maximize their profits over two periods. The total profit functions for firm A and B are

  (14)

  (15)

Lemma 2 summarizes the pure-strategy equilibrium outcomes when the two firms can recognize consumers’ loss aversion and brand loyalty behavior.

**Lemma 2.** When the two firms recognize consumers’ loss aversion and brand loyalty behavior, the first-period sales prices are , the second-period sales prices are , past-consumer trade-in rebates are , and new-consumer trade-in rebates are . The net sales prices to past-consumer are , the net sales prices to new-consumer are . The two firms’ total profits are . The marginal consumers are at , ,,, and .

 To avoid trivial discussion, we restrictto (i.e., to ensure ). When, loss aversion behavior does not exist, and consumers’ utility is only affected by brand loyalty behavior. Lemma 3 summarizes the pure-strategy equilibrium outcomes when the firms only recognize consumers’ brand loyalty behavior.

**Lemma 3.** When the two firms only recognize consumers’ brand loyalty behavior, the first-period sales prices are , the second-period sales prices are , past-consumer trade-in rebates are , and new-consumer trade-in rebates are . The net sales prices to past-consumer are , the net sales prices to new-consumer are . The two firms’ total profits are . The marginal consumers are at , ,,, and .

 When , consumers are loss averse. In the following, we show how the loss aversion degree (i.e., ) affects the pricing strategy of the firms in each period.

**Proposition 1.** As consumers become increasingly loss-averse to the prices they pay than the rebates they receive (i.e.,  increases), the first-period prices increase, while the second-period prices decrease. As  increases, fewer consumers choose to switch.

 By intuition, we expect that consumers’ loss aversion behavior limits the degree of firm’s price charge in the second period. Proposition 1 shows that this intuition is reasonable. Any high price charged to the consumer increases the consumer’s loss aversion concerns. Firms have to decrease the prices charged to consumers and commensurately decrease trade-in rebates offered to consumers in the second period to mitigate the negative impact of consumers’ such concerns. To offset profit losses in the second period, firms raise their first-period prices. Besides, consumers’ loss aversion concerns affect the first-period prices by directly influencing the marginal impact of first-period prices on firms’ total profits. An increase in will increase the impact of the first-period prices on firms’ total profits. Therefore, prices in the first-period increase.

The equilibrium outcomes suggest that firms offer higher trade-in rebates to new consumers than to their old consumers; the net prices new consumers paid for new products are lower than those paid by the old consumers. The direct impact of this pricing strategy is to encourage switching options. But a coin has two sides. If consumers are loss-averse, they put more weight on losses than gains, which implies that they favor a better price for the new product than a simple update of the used product. As  increases, the trade-in rebates for both new and old consumers decrease, the net price differences between new and old consumers for the new product decrease, and fewer consumers choose to switch. As a result, the stronger the loss aversion behavior exhibits, the more consumers prefer to stay than switch.

We will now examine the implications of consumers’ loss aversion behavior on consumer surplus and social welfare.

**Proposition 2.** As  increases, consumer surplus decreases.

When consumers concern about the prices they pay more than the trade-in rebates they receive, they perform loss aversion behaviors. Once firms recognize such behaviors of consumers, they optimally adjust their pricing strategies according to consumers’ behavior. We find that consumer surplus decreases with the loss aversion degree of consumers if all firms adjust their pricing strategies. The loss aversion behavior affects consumer surplus two-sided. Positively, the loss aversion behavior mitigates inefficient switching and lowers the prices paid in the second period which increases consumer surplus. Whereas negatively, loss aversion behavior increases the first-period prices. Also, fewer consumers choose to switch (as shown in Proposition 1) as the loss aversion degree upgrades. Hence, consumers who previously favor a switch would stay as repeated consumers and pay a higher price. The reduced price differences of old and new consumers paying for a new product make the switching options less attractive. In sum, the negative effect dominates the positive effect, leading to decreasing consumer surplus as loss aversion increases.

**Proposition 3.** As consumers concern more about the prices they pay than the rebates they receive (i.e.,  increases), social welfare increases.

We assume that firms and consumers do not discount the second-period payoff. Therefore, in this case, social welfare is not affected by the changing pricing strategies of the firms. Proposition 1 shows that in equilibrium, fewer consumers choose to switch to other brands if they are loss averse. In fact, the switching preference of consumers undermines social welfare because consumers have to comply with a suboptimal choice of brand. Hence, as  increases, social welfare increases.

### *4.3. Model comparison*

After discussing the two models where both firms can recognize consumer behavior and where two firms can only recognize consumers’ brand loyalty behavior, we compare the models with behavior recognition and no behavior recognition. We obtain several interesting findings by comparing these models (see Table 1).

Table 1 Summary of equilibrium outcomes

|  |  |  |  |
| --- | --- | --- | --- |
|  | Benchmark modelCase 1 | Main modelCase 2 | Only recognize brand loyalty()Case 3 |
|  |  |  |  |
|  | N/A |  |  |
|  |  |  |  |
|  |  |  |  |
|  | N/A |  |  |
|  |  |  |  |
|  |  |  |  |
|  | N/A |  |  |
|  |  |  |  |
|  |  |  |  |

**Proposition 4.** Without the recognition of consumer behavior, the net prices of the new and old consumers paid in the second period are higher than that when firms recognize the loss aversion and brand loyalty behavior of consumers. The first-period prices are higher with behavior recognition when  is sufficiently strong.

 Consumers with a strong preference for a brand will prefer buying the brand without trade-in rebates even if they receive trade-in rebates from the rival firm. As the price difference between the sales prices of the firm and the trade-in rebates of the rival firm decrease, even loyal consumers will switch. To avoid such occurrence, firms will lower their sales prices and trade-in rebates offered in the second period. As a result, the second-period price would be lower with behavior recognition than that without behavior recognition. Consumers are willing to pay a higher price in the first period when they anticipate receiving a better deal in the second period. Hence, firms can strategically raise the first-period prices to offset profits loss in the second period by anticipating this effect. The proposition shows that the first-period prices increase as consumers become more averse to the loss. As a result, prices in the first period with behavior recognition are higher than prices without behavior recognition when  is sufficiently strong.

**Proposition 5.** The profit of firms without recognition of consumer behaviors is higher than that of firms that solely recognize the brand loyalty behavior of consumers. Facing sufficiently strong loss aversion concerns of consumers, the firms with recognition of loss aversion and brand loyalty behaviors achieve higher profits than those without behavior recognition.

Consumers exhibit their loyalty by buying from their preferred firms even when they do not offer trade-in rebates or when the competitor offers trade-in rebates. However, as the competitor increases his trade-in rebates, loyal consumers could switch their brand. Firms have to decrease prices to make consumers stay, which weakens firms’ ability to extract surplus from their old consumers. Further, the lower prices and trade-in rebates also hamper the entrance of the competitor’s consumers who have lower preferences for a particular brand. As a result, the profits of firms with brand loyalty recognition are lower than those without behavior recognition. Consumers’ loss aversion behavior can also cause firms to decrease their second-period prices, but firms’ first-period prices increase with . As increases, fewer consumers choose to switch, which improves firms’ ability to extract surplus from their old consumers, even though consumers’ brand loyalty may weaken that ability. The effect of consumers’ loss aversion on firms’ profits dominates that of brand loyalty. Therefore, the profits achieved with both behavior recognition are higher than those achieved without behavior recognition, on condition that consumers’ loss aversion concerns are sufficiently strong.

We also show that when consumers exhibit both loss aversion and brand loyalty behavior, the pricing strategy considering the two behaviors is beneficial to the firms over the pricing strategy without behavior recognition. This is because the loss aversion and brand loyalty behaviors of consumers limit the pricing of firms in the second period, reducing the profits, whereas the first-period prices increase with the recognition of both behaviors. However, the profits increase in the first period exceed the decrease in the second period, and the total profits over two periods increase.

Furthermore, the total profits are higher than profits in firms without behavior recognition when consumers’ loss aversion concerns are sufficiently strong (see Figure 3), i.e., . The threshold is such that satisfies the conditions .



Figure 3 Profits vary with loss aversion concerns

## 5. Model extensions

The main model assumes that the salvage value and disposal costs associated with used items are zero. In Sections 5.1 and 5.2, we relax this assumption by incorporating the salvage value of used items and consumers’ switching costs into the main model. In Section 5.3, we allow firms and consumers to discount their future payoff. We summarize the findings and show detailed analyses in the Appendix.

### *5.1. Salvage value and disposal costs*

Collecting old products has the potential to generate revenues, either through remanufacturing (i.e., refurbishing) operations (Ray et al., 2005; Rao, 2009; Zhu et al.,2016) or through the reuse of old parts and materials (Ginsburg, 2001; Savaskan et al., 2004; Souza, 2013). For instance, Xerox saves 40%-65% in manufacturing costs through collecting used copiers and reusing old parts and materials. Hewlett Packard Corporation and Canon have undertaken similar activities to save costs. Salvage value and disposal costs have the opposite effect on firms’ pricing strategies. A positive salvage value imposes lower costs of a trade-in promotion, higher reuse value, and the firm passes some of these savings to consumers in terms of a higher discount or a lower sales price; similarly, positive disposal cost results in a smaller discount or higher sales price. Let denote the net value of the collected used product, that is, its salvage value minus all associated costs such as disposal costs and transportation costs. If , we expect that sales price would decrease with net value. While if , we expect that sales prices would increase with net value. This intuition is verified when we compute the main models. The equilibrium outcomes are presented in Appendix.

**Proposition 6**. With behavior recognition, the net value of used products decreases the trade-in rebates offered to old consumers in the second period but increases the first-period prices. When the loss aversion concerns of consumers are sufficiently strong, the second-period prices decrease with , while the trade-in rebates offered to new consumers increase with . Therefore, the overall profit of the firm is U-shaped to .

Our analysis shows that the net value of used products enhances the key results that we present in the main model. Thus, firms would also decrease their second-period prices and increase the first-period prices in the presence of . However, several distinctions exist between the effects of the net value of used product and consumer behavior (i.e., loss aversion and brand loyalty). The collection of used product induces firms to transfer some of the revenue to consumers. In a similar vein, firms offset their profit loss by offering a lower discount when they incur costs (i.e., ). It is interesting to note that trade-in rebates offered to old consumers always decrease, while those offered to new consumers may increase conditional with sufficiently large . It implies that firms would always transfer some revenue obtained from the collection to new consumers to induce them to switch, and consumers’ loss aversion behavior would further strengthen such firm’s strategy. Furthermore, the price difference between old consumers and new consumers for a new product would increase as increases, as long as consumers’ loss aversion behavior remains sufficiently strong.

The current research finds that BBP can increase the total profits when consumers exhibit fairness concerns (Li et al., 2016) or products are vertically differentiated (Rhee et al., 2017). Here, we show that the firms’ profit functions are U-shaped or unimodal (i.e., first decreasing, and then increasing) concerning the net value of used product when consumers are loyal to a brand and loss-averse with net value of used product. The increase of profits with can be explained by the first and second period prices which are consistent with the main model. The reason why the profits may decrease with is that when , a net cost would be incurred for undertaking the collection tasks. On the other hand, firms always offer lower prices and higher trade-in rebates to attract the competitor’s consumers less loyal to a particular brand in the first period, and offer higher prices and lower trade-in rebates to their old consumers. Poaching weakens firms’ ability to extract surplus from their own consumers and the competitor’s consumers. As a result, profits decrease with (see Figure 4).



Figure 4 Profits varying with net value of used product

### *5.2. Switching cost*

Switching costs could be the physical, informational, artificially created, and even psychological costs incurred when consumers switch to another firm (Klemperer, 1995). Let denote consumers’ switching cost. We solve the main models and document the equilibrium outcomes in Appendix. Our analysis shows that when consumers exhibit loss aversion and brand loyalty behaviors that affect the switching cost, the main results show in the main models continue to hold. Thus, firms also charge higher prices to their old consumers than to the rival’s consumers. With increasing switching costs, fewer consumers would switch from one firm to another in the second period.

However, it is also useful to identify some differences between the effects of loss aversion behavior and switching costs on pricing strategies. Firms increase the price for past consumers and decrease the price for the competitor’s consumers. Specifically, switching cost increases the price difference between old and new consumers paid for the new product in the second period, while consumers’ loss aversion behavior decreases such difference. In addition, switching costs force firms to decrease prices in the first period, which encourages consumers to stay as repeated consumers. Firms can exploit repeated consumers by raising the second-period prices and earn more profits. No consumers would switch to other brands in the first period when switching costs are sufficiently high. However, consumers’ loss aversion behavior induces firms to increase their first-period prices to compensate for the profit loss in the second period.

Firms’ profit is also U-shaped to the switching cost, which is similar to the model on salvage value and disposal costs. When consumers with loss aversion and brand loyalty also pay for the switching cost, firms have to decrease prices in the first period to compensate the consumers for such losses. On the other hand, if consumers are loyal to their preferred firm as repeat consumers, firms would consequently increase the second-period prices. Also, switching costs reduce consumers’ switching willingness which also offset firms’ profit loss in the first period. Therefore, firms’ profits are not monotone to the switching costs.

### *5.3. Patience of firms and consumers*

In our main model, we assumed that the firms and consumers did not discount payoff in the second period. We relax this assumption by considering the patience of firms and consumers (i.e., their discount rate) may affect our results. We use to denote the discount rate of firms and consumers respectively. When , firms and consumers are myopic, the game reduces to a replication of a static game. A higher suggests that firms and consumers are more strategic or patient so that the utility in the second period would enhance. Such behavior only affects the first-period decisions. Therefore, the results in Lemma 2 retain to hold.

**Proposition 7**. With consumer behavior recognition, the patience of firms and consumers increases the first-period prices and the total discounted profits. However, the firms’ patience is either unmonotone or unimodal (first decreasing, and then increasing) to the first-period prices.

Consistent with the literature (Li et al., 2016; Li, 2019), firms raise their first-period prices as consumers become more patient. When consumers are strategic, they have a higher willingness to pay in the first period from anticipating a better deal in the second period. Firms can exploit strategic consumers by raising the first-period prices to compensate for the profit loss in the second period. However, the first-period prices decrease as firms become more patient with slighter loss aversion concerns of consumers. The second period prices and prices charged to old and new consumers increase as the loss aversion concerns of consumers are not sufficiently strong, which increase the profit of firms in the second period. The more patient the firms are, the more they weigh the second-period profits when making the first-period decisions. As a result, the first-period prices decrease as firms become more patient.

## 6. Contributions and managerial insights

This study sheds light on how consumer behavior (i.e., brand loyalty and loss aversion) affects the trade-in strategies of firms in the competition. Price discrimination with the recognition of consumer behavior is critical for the trade-in pricing strategy because consumers’ preferences alter transactions when buying and selling are involved simultaneously. Our observations provide a new framework for firms to develop the BBP strategy of trade-in promotions. Specifically, the contributions are summarized as follows:

1. We extend the traditional research stream of BBP focused on a forward supply chain to a closed-loop supply chain involving trade-in transactions and used product collections. Traditionally, the price-discrimination strategy is commonly observed when similar products are introduced into the market repeatedly for the existing consumers of the firm and the competitor. It concludes that the firm should always pay consumers to switch rather than pay consumers to stay. Here, we also show that offering more trade-in rebates to new consumers promotes their purchases. Thus, paying consumers to switch is also beneficial though the collection process of used products is considered.
2. We model consumers’ brand loyalty and loss aversion behavior in the trade-in transactions. Before consumers decide which brand to purchase, they evaluate the sales prices of new products and the possible trade-in rebates they may receive from alternative brand options. Consumers’ brand loyalty and loss aversion behaviors play a vital role in their purchasing decisions and consequently affect the firms’ pricing strategies. This results from consumers’ different weights put on the prices they pay and the rebates they receive.
3. We find that firms can benefit from behavior recognition and may suffer a profit loss if without such recognition. This is because loss aversion and brand loyalty behaviors limit pricing strategy in the second period. Firms have to charge lower prices in the second period to mitigate the negative impact of consumer behavior, which discourages firms to raise prices in the first period to offset the overall profit losses. Also, consumers’ loss aversion behavior reduces the price difference paid for a new product between old and new consumers, leading more consumers to stay and to pay higher prices as repeated consumers. First-period profit increases with the first-period prices. An increasing number of repeated consumers would achieve a higher profit in the model with behavior recognition than that without such behavior recognition.
4. We also find that consumer’s increasing sensitivity toward the prices over the rebates does not increase consumer surplus. Instead, consumer surplus decreases as they become more loss averse. Finally, social welfare increases with consumer’s loss aversion because insufficient switching is reduced. This finding is useful for both the firms and the policymakers. Even though behavior recognition may undermine the revenue of consumers as a whole, it brings benefits to the whole society.
5. We extend our base model in several ways to verify our results. First, we incorporate the salvage value and disposal cost of used items into the analysis. Second, we extend our base model by considering the switching cost. Third, we characterize the patience factors of firms and consumers. Our key results do not change in these extensions, which emphasize the importance of the recognition of the loss aversion and brand loyalty behaviors.

 Our observations provide some practical guidelines for firms offering BBP together with trade-in strategies. The models show that firms should recognize consumer behavior when offering trade-in promotions because consumers respond differently to rebates and prices, which ultimately affects the firms’ pricing and promotion strategies. Firms should increase their first-period price but decrease their second-period price when consumers become more loss-averse. For policymakers, encouraging firms to recognize consumer behavior and then price discriminate consumers is necessary because it reduces consumers’ inefficient switching and increases the overall social welfare. In contrast, policymakers should discourage the irrational behavior of consumers towards the uneven weights regarding the gain and loss in trade-in transactions in case of harming the consumers as a whole.

## 7. Conclusion

Many firms use trade-in campaigns to increase consumers’ purchasing frequency of goods when upgraded products are introduced into the market. Consumers may exhibit loss aversion and brand loyalty behavior during trade-in transactions, which involve purchasing a new product and selling an old product at the same time. In this paper, we investigate how firms should adjust BBP and trade-in promotion strategies according to consumers’ loss aversion and brand loyalty behavior. We build a two-period model with two competing firms with and without behavior recognition.

Firms offering lower prices to their self-owned consumers or to their competitors’ consumers incentivize existing consumers to stay or potential consumers to switch. This problem has been widely discussed in the marketing literature. In general, the literature suggests that firms should charge higher prices to their current consumers than to new consumers (Alsop, 1985; Neslin et al., 1990, Rossi et al., 1993; Chen, 1997; Fudenberg et al., 2000, Taylor, 2003; Li et al., 2016; Li, 2019). The reason is that when a consumer has a purchase history of a firm, they will develop a higher preference or willingness to pay for the firm’s product. Firms can take advantage of this by charging a higher price to their existing consumers whereas charging a lower price to attract the competitor’s consumers. Some research has examined the conditions under which firms should pay to retain their consumers (Shaffer et al., 2000; Pazgal et al., 2008; Rhee et al., 2017). For example, when both firms implement price discrimination and the demand is asymmetric (Shaffer et al., 2000), when firms can provide more benefits to old consumers (Pazgal et al., 2008), and when firms provide vertically differentiated products (Rhee et al., 2017). Our work extends the research of price discrimination between the existing and new consumers in the trade-in transactions, with a combination of new product sales and old product collections as closed-loop supply chains. This is very different from traditional behavior-based pricing focused solely on new product sales in the forward supply chains.

There are also some limitations which we need to address in the future. We have only considered one decision variable in our theoretical analysis. In practice, there are many decision variables such as customized quality (Li, 2019) or customized services for firms to discriminate against consumers. Therefore, it would be interesting to investigate how consumers’ loss aversion and brand loyalty behavior influence consumers’ purchasing decisions, firms’ pricing strategy, quality strategy, or services strategy. We also do not consider the quality of used products. In fact, the quality of used products varies with brands and usage, which would affect the salvage value and disposal costs of used products, and consequently affect firms’ pricing and trade-in strategy. Finally, researchers can empirically test consumers’ behavior influence in various contexts. For instance, they can empirically assess the impact of consumers’ loss behavior on firms’ profits.

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## Appendix A

*Proof of Lemma 1*

*Proof.* With no behavior recognition, we solve the two periods backwards.

*The Second Period*. In the second period, let denote consumers indifferent between trading A for A and trading A for B, and denote consumers indifferent between trading B for A and trading B for B . We can write that





Similarly, we can write consumer located at as





The profit functions of the two firms in the second period are





The second period sales prices are ,,,.

*The first period.* The marginal consumer located at makes a first-period purchase to maximize total utilities over two periods. This consumer rationally anticipates that he will switch firm in the second period. Therefore, his choice in period 1 is determined by prices in period 1 as well as the switching prices he will face in period 2. We can write that



By rational-expectation conditions, i.e., ,, and , we have that



The profit functions of the two firms in the two periods are





First order conditions give the equilibrium outcomes: ,. Substituting ,, we have ,,,,.

*Proof of Proposition 1*

*Proof*. We analyze the impact of on first period prices and second period prices. Taking the partial derivative with respect to , we have







Hence, as increases, the prices charged in the first period increase, while the prices charged in the second period decrease.

*Proof of Proposition 2*

*Proof*. Here we prove that consumer surplus decrease with . Let denote the consumer surplus that includes the loss aversion and brand loyalty components. We have the following.



As increases, is impacted as follows.



Therefore, consumer surplus decreases with .

*Proof of Proposition 3*

*Proof*. Let denote the social welfare that includes the loss aversion and brand loyalty components. We have the following.



As increases, is impacted as follows.



Therefore, social welfare increases with .

*Proof of Proposition 4*

*Proof*. We use  and to denote benchmark and main model, respectively. To solve the prices difference of benchmark model and main model in the first period and second period, we have the following.







Because is increases with , when , ; when , . Therefore, The first period prices without behavior recognition may either higher or lower than the first period prices with behavior recognition, when  is sufficiently strong, prices with behavior recognition are higher than prices without behavior recognition.

*Proof of Proposition 5*

*Proof*. We use ,, and to denote benchmark, main model, and when firms only recognize consumers’ brand loyalty behavior, respectively. To solve the profits difference, we have the following.





The roots of satisfy the condition that.

Based on the factorization above, it is easy to prove Proposition 5.

## Appendix B: Analysis of Extensions

### B-5.1 Salvage value and disposal costs

From the perspective of consumers, if firms have salvage value and incur disposal costs when dealing with collected used products, the net value of used products only affects firms’ profits and does not affect consumers’ choice. In this case, the impact of salvage value and disposal costs on firms excludes its impact on consumers’ indifferent between the two firms. Therefore, the marginal consumers indifferent between the two firms in the two periods stay the same as in main model.

Firms’ profit functions in the second period are

 

The second period sales prices are ,,, ,,.

The profit functions for the two firms in the first period are





First order conditions give the equilibrium outcomes:, ,, ,.

The impact of on prices can be seen from below:









increases with , . It is easy to prove that

. if ; andif .

To investigate the impact of on profits, we have , and . Therefore, firms’ profit is a U-shape curve with respect to the net value of used product.

### B-5.2 Switching cost

When consumers who switch face a switching cost , where , the marginal loyal consumers in the second period are





and





The marginal disloyal consumers in the second period are





and





The second period profits are





The second-period sales prices are ,,, ,,.

The indifferent consumer at is





The total profits are





First order conditions give the equilibrium outcome: , ,,,. The marginal consumers are at , ,,, and .

The impact of on prices and profits can be seen from below:

,,,,,.

### B-5.3 Firm and consumer patience

Firm and consumer forward-looking behavior only affects its first period decisions, so outcomes pertaining to the second period in Lemma 2 continue to hold.

The indifferent consumer at is





The total profits are





First order conditions give the equilibrium outcome: , 

The impact of on first period prices and total profits can be seen from below:









To solve the roots of , we have . Therefore, if ; if . increases with , , so 

This completes the proof.