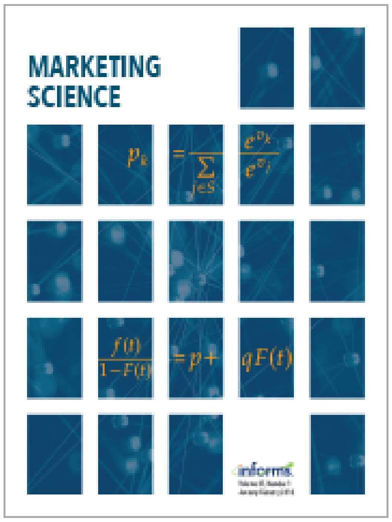

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Behavior-Based Pricing in Marketing Channels

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Abstract. With behavior-based pricing (BBP), firms use customers' purchase history data to price discriminate between past and new customers. Prior research has examined BBP in a non-channel setting. In this paper, we investigate BBP in a channel setting in which manufacturers sell to customers through exclusive retailers. We examine how channel members' adoption of BBP affects wholesale and retail prices, profits, consumer surplus, and social welfare. We find that BBP decreases channel members' profits when retailers use BBP and manufacturers use uniform pricing. However, BBP increases channel members' profits when manufacturers and retailers use BBP. In addition, BBP by retailers alone increases consumer surplus, whereas BBP by manufacturers and retailers decreases consumer surplus. When manufacturers also use BBP, BBP decreases social welfare to a greater degree than when only retailers use BBP. Furthermore, when manufacturers cannot use BBP, their profits are higher with long-term wholesale price contracts. When manufacturers can use BBP, short-term wholesale price contracts yield higher profits for manufacturers and retailers.

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Keywords: behavior-based pricing • dynamic pricing • marketing channels • game theory

1. Introduction

In 2015, when Volkswagen faced an emission-testing scandal, Fiat Chrysler offered its dealers incentives to convince Volkswagen customers to buy Chrysler's new models (Sylvers 2015, *The Business Journals* 2015). This type of manufacturer-to-dealer incentive reduces dealers' true cost, or wholesale price, to buy the vehicle from the manufacturer. Dealers are under no obligation to pass these incentives on to customers (Busse et al. 2006, Cars.com 2016, DMV.org 2017). "The Fiat Chrysler incentive, which ranges from €500 for a Fiat 500 to €1,500 for a Jeep Grand Cherokee, is paid to the dealer who can retain it or pass it along to buyers" (Sylvers 2015). Therefore, wholesale prices of new Chrysler vehicles are lower after incentives if dealers sell them to Volkswagen customers rather than to Chrysler's own customers.

This example entails a manufacturer (Chrysler) offering wholesale price discounts (incentives) to retailers (Chrysler dealers) to attract a competitor's (Volkswagen) customers. Documents such as the vehicle identification number (VIN) of trade-in cars, car insurance or registration reveal customers' purchase history (e.g., the type of car purchased previously). Dealers obtain these documents from customers who purchase a new car. Unless dealers can provide the documents as proof that customers own the competitor's car, they cannot receive the manufacturer-to-dealer incentives. Therefore, dealers are motivated to share customers' purchase history data with the manufacturer. The manufacturer conditions wholesale prices on whether its product (Chrysler) is ultimately sold to its past customers (who own a Chrysler) or to its competitor's customers (who own a Volkswagen).

Behavior-based pricing (BBP) by manufacturers, or the practice of charging different wholesale prices for retailers to sell to their own and competitor's customers, is common in the automobile industry. For example, General Motors offers bonus cash to dealers to help them close a conquest sale (LaReau 2007). Audi offers between $750 and $2,000 incentives for dealers to sell new models to current owners of an Acura, BMW, Infiniti, Lexus or Mercedes-Benz. Incentives are paid to dealers, and dealers have discretion on pass-through (AudiUSA 2015). When Chrysler struggled with bankruptcy, Ford offered dealers in New York, Denver, and Phoenix $1,000 "conquest cash" to lure Chrysler, Dodge, and Jeep owners into purchasing Ford crossovers, SUVs or trucks (Evans 2009). As one Ford spokesperson said, "from time to time around the world, we (Ford Manufacturer) and our dealers offer special offers to encourage customers not currently driving a Ford to consider making the switch" (Sylvers 2015).

The practice of BBP in channels becomes increasingly feasible and desirable for four reasons. First, given the advance of information technology and data science, collection of purchase history data is widespread. Optical scanning, cookies, loyalty cards, Wi-Fi, and other automatic data-gathering devices make it possible for retailers to track customers' purchase histories (Bread 2016). Second, processing and storage of purchase history data are cost-efficient. From 2009 to 2017, the cost per gigabyte of a hard drive decreased 75% from \$0.11 to \$0.028 (Klein 2017). With the recent emergence of cloud computing and Big Data technologies, data processing and storage costs continue to decline. Third, sharing purchase history data between retailers and manufacturers has become more common. For example, Kroger tracks the purchase history of its roughly 55 million loyalty-card members who shop at its more than 2,600 stores. It provides the data to Procter & Gamble, Nestlé, and other manufacturers of consumer products, ranging from cereals to sodas (Monga 2014, Pearson 2016). In 2013, the supermarket chain A&P launched the 1010 data Retailer Vendor Portal to share loyalty card data with manufacturers (RISN 2013). According to the recent Retailer/Supplier Shared Data Study, 27% of manufacturers have received loyalty card data from retailers (Retail Solutions 2015). The growing availability of purchase history data enables manufacturers to use BBP. Fourth, BBP is also feasible in channels of industries such as motorcycles, personal computers, appliances, and sporting goods. As long as manufacturers offer retailers a wholesale price discount for selling products to competitors' customers, retailers have incentives to share customers' proof of past purchase with manufacturers to receive the discount. For these reasons, we expect the practice of BBP to become increasingly prevalent in channels in the near future.

Extant theoretical research has analyzed BBP in a non-channel setting. Here we investigate the implications of BBP for channel members' profits, consumer surplus, and social welfare in a channel setting.[1] Our main contribution is showing how the practice of BBP in a channel setting overturns some basic results found in the BBP and channels literature streams. In particular, competitive BBP is typically a prisoner's dilemma without channels but is mutually beneficial with channels when manufacturers and retailers use BBP.

Specifically, we build a two-period game-theoretic model in which two horizontally differentiated manufacturers sell a repeatedly purchased product through exclusive retailers to customers in each period. As retailers handle sales transactions with customers, they have access to customers' purchase history data from the first period and can use these data for behavior-based price discrimination in the second period. Manufacturers may or may not have access to customers' purchase history data, depending on business context, data availability or data-sharing agreements with retailers. For this reason, we consider two cases. In the first case, only retailers offer behavior-based retail prices to customers, while manufacturers offer uniform wholesale prices to retailers. In the other case, retailers offer behavior-based retail prices to customers, and manufacturers offer behavior-based wholesale prices to retailers. We analyze the implications of the different BBP adoptions by manufacturers and retailers for profits, prices, consumer surplus, and social welfare. Furthermore, we extend the model to examine situations in which manufacturers can credibly commit to fixing wholesale prices over time by offering retailers long-term wholesale price contracts. We examine whether manufacturers have incentives to sign long- or short-term contracts with retailers. Our analysis yields several notable findings.

First, we find that when retailers use behavior-based retail prices and manufacturers use uniform wholesale prices, channel members' profits are *lower* than those in a channel without BBP. The reasons for this are twofold. First, BBP intensifies price competition in the second period, which reduces the second-period retail and wholesale prices. Second, by contrast to the findings in extant BBP literature, we find that first-period prices are also lower than those without BBP. This is because as a retailer reduces its first-period price, its first-period market share expands, which reduces its second-period demand. As a result, its manufacturer will reduce the second-period wholesale price, and the competing manufacturer will increase the second-period wholesale price. Both changes increase the retailer's second-period profit. Therefore, *a retailer's first-period market share has a positive impact on its second-period profit*. This second-period consideration gives incentives for retailers to strategically lower prices in the first period. The first-period competition between manufacturers is also intensified because retailers increase their pass-through rate in the first period. As a result, first-period wholesale prices are also lower than those without BBP. Because prices in both periods are lower, when only retailers use BBP, channel members' profits are lower than when they do not use BBP.

Second, we find that these negative results can flip if manufacturers also offer behavior-based wholesale prices for retailers to target past and new customers. When manufacturers also use BBP, the channel members' profits are *higher* than profits without BBP. The intuition is that when manufacturers also use BBP, a retailer's first-period market share no longer has an impact on its second-period profit. This is because when a retailer's market share increases, its manufacturer will reduce the wholesale price for new customers and increase it for past customers in the second period. At the same time, the competing manufacturer will increase the wholesale price for new customers and reduce it for past customers. The gain in one market segment cancels out the loss in the other segment, and the retailer's second-period profit does not change with its first-period market share. In addition, BBP reduces the price sensitivity of demand in the first period; therefore, retailers raise first-period prices to maximize profits from the first period. Similarly, manufacturers also raise first-period wholesale prices to leverage the reduction in price sensitivity of demand. Channel members' profits increase in the first period, which offsets the decrease in the second-period profits. Total channel members' profits over the two periods are higher with than without BBP.

Third, when only retailers use BBP, prices are lower in both periods than when retailers do not use BBP. These price reductions increase consumer surplus. However, when manufacturers also use BBP, the increase in first-period prices decreases consumer surplus from its level without BBP.

Fourth, BBP leads consumers to switch to less ideal products. The inefficient switching reduces social welfare. We find that manufacturers' use of BBP leads retailers to offer more attractive deals for customers to switch products. In equilibrium, more consumers switch products and social welfare is even lower than when only retailers use BBP.

Last, we examine the optimal wholesale price contracts for manufacturers to offer to retailers when they can offer long-term contracts and credibly commit to fixing wholesale prices over time. The optimal contract depends on whether manufacturers can access customers' purchase history data to offer behavior-based wholesale prices. Without customer data for BBP, fixing wholesale prices over time by offering a long-term contract is optimal for manufacturers. However, with customer data for BBP, letting wholesale prices change over time by offering short-term contracts yields higher profits for manufacturers.

In summary, these results reveal that the implications of BBP for equilibrium prices, channel member profits, consumer welfare, and wholesale pricing contracts in channels can be substantially different from those in non-channel settings. Furthermore, these implications can be positive or negative depending on whether manufacturers use BBP. These insights increase our knowledge and the theoretical research about BBP. They also provide important implications for manufacturers, retailers, and public policy makers. From a managerial standpoint, we highlight the opposite effects of BBP on channel members' profits when different channel members adopt BBP. Our analysis shows that profits increase when manufacturers and retailers use BBP but decrease when only retailers use BBP. Therefore, the main takeaway for managers is that retailers should share customer data with manufacturers, and both parties should set discriminatory wholesale and retail prices for past and new customers. From the perspective of public policy makers who strive to protect consumer privacy, this study shows that the impact of BBP on consumer surplus can be positive or negative. In situations when only retailers have access to customers' purchase history data, allowing retailers to use BBP improves consumer surplus. However, if manufacturers also condition wholesale prices on customers' purchase history, overall consumer surplus declines.

1.1. Related Literature

This paper is related to two streams of literature. The first is the literature on BBP (see Fudenberg and Villas-Boas 2006). Advancements in technology enable firms to keep track of customers' purchase history and set future prices based on customer types. If a customer has previously purchased from a firm, it reveals that the customer has a higher preference for the firm's product over the competitor's. Conversely, if a customer has not previously purchased from the firm, it reveals that the customer has purchased from the competitor and therefore has a higher preference for the competitor's product. Firms can exploit this partially revealed preference by charging a higher price to past customers and offering a discount to poach the competitor's customers. Fudenberg and Tirole (2000) formulate this phenomenon using a two-period model in which firms use purchase history data collected from the first period to price discriminate past customers and the competitor's customers in the second period. They show that BBP intensifies price competition and reduces profits in the second period. However, forward-looking customers are less price sensitive in the first period. Thus, firms can raise prices and reap higher profits at that time. Overall, firms' total profits are lower with than without BBP. Villas-Boas (1999, 2004) uses dynamic models with an infinite horizon to analyze situations in which firms serve overlapping generations of customers. Each customer lives for two periods and a new generation of customers enters the market in each period. As a result, firms recognize past customers but cannot distinguish between customers who bought from the competitor in the last period and those who just entered the market. Firms lower prices to attract the competitor's previous customers, and prices and profits are lower than those without behavior-based price discrimination. Zhang (2011) extends the above research by examining behavior-based product design decisions. She analyzes how symmetric and horizontally differentiated firms personalize product design and prices on the basis of customers' purchase history data. She shows that behavior-based personalization leads firms to design products that are similar. The decrease in design differentiation intensifies price competition and further decreases firm profits.

In general, these studies are pessimistic about the profitability of BBP. Other researchers have shown some conditions under which BBP can be profitable. For example, BBP can be profitable if firms actively pursue customer recognition to screen out price-sensitive customers (Chen and Zhang 2009), customers have heterogeneous demands and their preferences change over time (Shin and Sudhir 2010), customers have ex ante uncertainty about an experience good (Jing 2015), a firm has an advantage in adding benefits to past customers (Pazgal and Soberman 2008), customers of vertically differentiated firms sufficiently discount the future (Rhee and Thomadsen 2017) or customers are sufficiently concerned about price fairness (Li and Jain 2016). Our work extends the theoretical research on BBP by examining the implications of BBP in marketing channels: To our knowledge, this has not been examined previously. Moreover, we show that separating the pricing decisions of manufacturers and retailers brings important new insights. In particular, BBP is not profitable when only retailers set behavior-based retail prices; by contrast, BBP is profitable when manufacturers also set behavior-based wholesale prices.

Second, this paper is related to the literature on marketing channels with competing manufacturers (see Coughlan et al. 2014 and Sudhir and Datta 2009 for comprehensive reviews). McGuire and Staelin (1983) examine the profitability of vertical integration and decentralization when two manufacturers each sell through an exclusive retailer. They find that vertical decentralization is profitable if competing products are highly substitutable. Coughlan (1985) shows that decentralization dampens the competition between manufacturers and leads to higher channel profits. We use a similar framework as McGuire and Staelin (1983) and allow channel members to use BBP. In doing so, we show that the adoption of BBP by manufacturers and retailers softens competition in the first period (i.e., behavior-observation stage) and further improves profits.

In examining BBP, a practice of price discrimination, our paper is related to studies on price discrimination in channels. For example, Gerstner et al. (1994) assess how manufacturers use "pull" coupons to price discriminate customers, taking retailers' markup decisions into account. Gerstner and Hess (1991) show that manufacturers strategically use "push" wholesale price promotions and "pull" customer rebates to price discriminate customers and engage retailers in the promotion. Other researchers examine how a manufacturer issues discriminatory wholesale prices to different retailers (Inderst and Valletti 2009, Herweg and Müller 2012) or through opaque devices such as trade promotions (Agrawal et al. 2015, Cui et al. 2008). By contrast, we investigate a new form of price discrimination, that is, channel members' customization of prices based on customers' purchase history. We consider situations in which only retailers use behavior-based retail prices and situations in which manufacturers also use behavior-based wholesale prices. These two types of BBP exert opposite impacts on channel profits, welfare, and the optimal choice of (long- or short-term) wholesale pricing contracts.

The rest of the paper is organized as follows: In Section 2, we introduce the game-theoretic set-up and analyze the main models. In Section 3, we present the main results and explain our intuitions. In Section 4, we relax several assumptions from the main model to generalize our results and seek new insights. We conclude with managerial implications and directions for future research in Section 5.

2. Model and Analysis

2.1. Model Setup

We consider a two-period game in which horizontally differentiated manufacturers A and B each sell a repeatedly purchased product through an exclusive retailer to consumers in each period. The base value of the product is v. We assume that v is sufficiently high so that all consumers buy the product and the market is fully covered. In Section 4.2, we discuss situations in which v is low so that the market is partially covered. The marginal cost to produce the product is constant, and we normalize it to zero.

The market consists of a unit mass of consumers, each of whom has a unit demand for the product in each period. Consumers are uniformly distributed on a Hotelling line that ranges from 0 to 1, where product A is at 0 and product B is at 1. A consumer's location on the line represents the ideal product for the consumer. If a consumer purchases a product that is not ideal, the consumer incurs a mis-match dis-utility, which is a function of the distance from the consumer's location to the product's location. Specifically, the utility that a consumer at x consumes product A at price a is $v - tx - a$, where t represents the degree of the mismatch dis-utility. The utility that this consumer derives from consuming product B at price b is $v - t(1-x) - b$. We assume that firms' and consumers' discount factors are one.

In the main model, we focus on contexts in which manufacturers vary wholesale prices over time. Essentially, we assume that long-term contracts are not credible and manufacturers cannot commit to charging the same price over time (Hart and Tirole 1988, Fudenberg and Tirole 2000). This inability can be justified with the existence of potential noncontractible changes in the product specifications from period to period (Villas-Boas 1999). For example, in the automobile industry, car manufacturers introduce new models each year with technological and design changes. The changes can range from minor upgrades of exterior trim parts to complete redesigns (Weber 2009, pp. 1–2). For this reason, wholesale prices vary from year to year. In Section 4.1, we relax this assumption to consider contexts in which manufacturers can credibly commit to future prices by offering long-term contracts to retailers.

The timing of the game is as follows: The first period has three stages. In the first stage, manufacturers simultaneously set first-period wholesale prices denoted by w_{a1} and w_{b1}. In the second stage, retailers simultaneously set first-period retail prices denoted by a_1 and b_1. In the third stage, consumers observe first-period retail prices and decide from which retailer to buy the product. Similarly, the second period has three stages. In the first stage, if manufacturers use uniform wholesale pricing, they simultaneously set second-period wholesale prices denoted by w_{a2} and w_{b2}. If manufacturers use BBP, they simultaneously set wholesale prices for retailers to sell to past customers denoted by w_{ao} and w_{bo} and wholesale prices for retailers to sell to new customers denoted by w_{an} and w_{bn}. In the second stage, if retailers use uniform retail pricing, they simultaneously set second-period retail prices denoted by a_2 and b_2. If retailers use BBP, they set retail prices for past customers denoted by a_o and b_o and retail prices for new customers denoted by a_n and b_n. In the third stage, consumers observe the retail prices offered to them on the basis of their type (past customers or new customers) revealed from purchase history data. Consumers decide whether to buy the product from their past retailer or switch to the competing retailer. Table 1 summarizes the notations. Figure 1 depicts the channel structure and consumers' choice patterns in the pure-strategy equilibrium.

2.2. Main Models: Marketing Channels

When manufacturers sell to customers through exclusive and independent retailers, three scenarios emerge: First, because customers' purchase history data are not available for manufacturers or retailers, they cannot use BBP to price discriminate between past and new customers. We refer to this case as the case without BBP (Case 1). Second, because customers' purchase history data are stored in the retailer's database, retailers can issue behavior-based retail prices by offering different prices to past and new customers. However, manufacturers do not have access to the retailer's database to make use of customers' purchase history data and therefore cannot issue behavior-based wholesale prices. We refer to this as the case with retail BBP (Case 2). Third, manufacturers and retailers have access to customers' purchase history data. Retailers issue behavior-based retail prices to customers, and manufacturers issue behavior-based wholesale prices by offering different wholesale prices when retailers sell the product to past and new customers. We refer to this as the case with wholesale and retail BBP (Case 3). We discuss each case separately. Table 2 summarizes the equilibrium outcomes in all cases.

Table 1. Summary of Notations ($k \in \{a, b\}$)

Notation	Description
v	Base value of the product
x	Location of consumers on the Hotelling line
t	Degree of mis-match dis-utility or horizontal differentiation
k_1	Retailer k's first-period retail price
k_2	Retailer k's second-period retail price without BBP
k_o	Retailer k's past-customer retail price with BBP
k_n	Retailer k's new-customer retail price with BBP
w_{k1}	Manufacturer k's first-period wholesale price
w_{k2}	Manufacturer k's second-period wholesale price without BBP
w_{ko}	Manufacturer k's past-customer wholesale price with BBP
w_{kn}	Manufacturer k's new-customer wholesale price with BBP

Case 1: Without BBP

The two-period game without BBP is a replication of a static game. We solve the model in the first period, and the same analysis applies to the second period. The location of the marginal consumer who is indifferent between buying from retailer A and retailer B is x_1. We have $v - tx_1 - a_1 = v - t(1 - x_1) - b_1$ and $x_1 = (t + b_1 - a_1)/(2t)$. Retailers' profit functions are $\Pi_{ra1} = (a_1 - w_{a1})x_1$ and $\Pi_{rb1} = (b_1 - w_{b1})(1 - x_1)$. Using first-order conditions, we obtain the equilibrium retail prices: $a_1^* = t + (2w_{a1} + w_{b1})/3$ and $b_1^* = t + (2w_{b1} + w_{a1})/3$. The manufacturers' profit functions are $\Pi_{wa1} = w_{a1}x_1$ and $\Pi_{wb1} = w_{b1}(1 - x_1)$. Using first-order conditions, we obtain the equilibrium wholesale prices: $w_{a1}^* = w_{b1}^* = 3t$.

Case 2: With Retail BBP

When retailers use BBP and manufacturers do not, we solve the two periods backwards.

The Second Period. In the second period, let x_a indicate the location of the marginal consumer who is indifferent between staying with retailer A and switching to retailer B. We have the following:

$$v - tx_a - a_o = v - t(1 - x_a) - b_n, \tag{1}$$

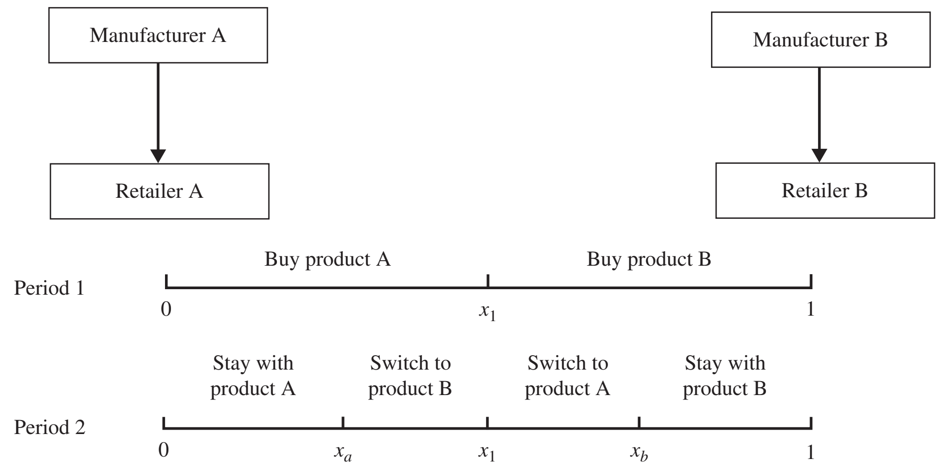
$$x_a = \frac{t + b_n - a_o}{2t}. \tag{2}$$

The left-hand side (LHS) of Equation (1) is the utility of buying from retailer A again at the past-customer price a_o, and the right-hand side (RHS) is the utility of buying from retailer B at the new-customer price b_n. Similarly, let x_b represent the location of the marginal consumer who is indifferent between staying with retailer B and switching to retailer A. Thus, we have

$$v - tx_b - a_n = v - t(1 - x_b) - b_o, \tag{3}$$

$$x_b = \frac{t + b_o - a_n}{2t}. \tag{4}$$

Figure 1. Channel Structure and Consumer Choices with BBP



The LHS of Equation (3) is the utility of buying from retailer A at the new-customer price a_n, and the RHS is the utility of buying from retailer B at the past-customer price b_o. Retailers' profit functions in the second period are

$$\Pi_{ra2} = (a_o - w_{a2})x_a + (a_n - w_{a2})(x_b - x_1), \quad (5)$$
$$\Pi_{rb2} = (b_o - w_{b2})(1 - x_b) + (b_n - w_{b2})(x_1 - x_a), \quad (6)$$

where w_{a2} and w_{b2} are the respective uniform wholesale prices that manufacturers A and B charge in the second period. Manufacturers' profit functions in the second period are

$$\Pi_{wa2} = w_{a2}(x_a + x_b - x_1), \quad (7)$$
$$\Pi_{wb2} = w_{b2}(1 - x_b + x_1 - x_a). \quad (8)$$

Because all consumers face the same price in the first period, there exists a $x_1 \in [0,1]$ such that all consumers whose $x < x_1$ buy from retailer A in the first period and all consumers whose $x > x_1$ buy from retailer B. In equilibrium, x_1 is at the center of the Hotelling line and the marginal consumer at x_1 switches firms in the second period. The second-period retail prices are $a^*_o(x_1) = (2x_1t + t + 2w_{a2} + w_{b2})/3$, $a^*_n(x_1) = (3t - 4x_1t + 2w_{a2} + w_{b2})/3$, $b^*_o(x_1) = (3t - 2x_1t + w_{a2} + 2w_{b2})/3$, and $b^*_n(x_1) = (4x_1t - t + w_{a2} + 2w_{b2})/3$. The second-period wholesale prices are $w^*_{a2}(x_1) = (5 - x_1)t/3$ and $w^*_{b2}(x_1) = (4 + x_1)t/3$ (see the detailed analysis in the appendix).

The First Period. The marginal consumer at x_1 makes a first-period purchase to maximize total utilities over two periods. This consumer is indifferent between two streams of consumption, i.e., (1) buying from retailer A in the first period and switching to retailer B in the second period at the expected new-customer price b^e_n and (2) buying from retailer B in the first period and switching to retailer A in the second period at the expected new-customer price a^e_n. We can write that

$$v - tx_1 - a_1 + [v - t(1 - x_1) - b^e_n]$$
$$= v - t(1 - x_1) - b_1 + (v - tx_1 - a^e_n). \quad (9)$$

Consistent with the BBP literature (e.g., Fudenberg and Tirole 2000, Chen and Zhang 2009, Shin and Sudhir 2010, Zhang 2011), we assume that consumers are strategic, that is, they recognize that the prices they face in the second period depend on their first-period decisions and have rational expectations about future prices (i.e., $a^e_n = a^*_n(x_1)$ and $b^e_n = b^*_n(x_1)$).[2] We relax this

Table 2. Summary of Equilibrium Outcomes

	Case 1	Case 2	Case 3
Retailers use BBP	No	Yes	Yes
Manufacturers use BBP	No	No	Yes
Total profits			
Channel (Π^*_{at})	$4.00t$	$2.96t$	$8.89t$
Manufacturer (Π^*_{wat})	$3.00t$	$2.07t$	$6.41t$
Retailer (Π^*_{rat})	$1.00t$	$0.89t$	$2.48t$
First-period prices			
Wholesale (w^*_{a1})	$3.00t$	$2.64t$	$11.31t$
Retail (a^*_1)	$4.00t$	$3.86t$	$15.75t$
Second-period prices			
Wholesale uniform price (w^*_{a2})	$3.00t$	$1.50t$	
Retail uniform price (a^*_2)	$4.00t$		
Wholesale past-customer price (w^*_{ao})			$1.67t$
Wholesale new-customer price (w^*_{an})			$1.33t$
Retail past-customer price (a^*_o)		$2.17t$	$2.22t$
Retail new-customer price (a^*_n)		$1.83t$	$1.78t$
Welfare			
Consumer surplus (CS^*)	$2v - 8.50t$	$2v - 6.48t$	$2v - 18.38t$
Social welfare (SW^*)	$2v - 0.50t$	$2v - 0.56t$	$2v - 0.60t$

Note. Because channel members A and B are symmetric, we report the equilibrium outcomes from A's perspective.

assumption in Section 4.2 by considering myopic consumers. Plugging in the values of $a_n^*(x_1)$ and $b_n^*(x_1)$ into Equation (9), we obtain

$$x_1 = \frac{1}{2} + \frac{9(b_1 - a_1)}{26t}. \tag{10}$$

Retailers set first-period prices to maximize their profits over two periods. The profit functions are

$$\Pi_{rat} = (a_1 - w_{a1})x_1 + \Pi^*_{ra2}(x_1), \tag{11}$$
$$\Pi_{rbt} = (b_1 - w_{b1})(1 - x_1) + \Pi^*_{rb2}(x_1). \tag{12}$$

Manufacturers set first-period wholesale prices to maximize their profits over two periods. The profit functions are

$$\Pi_{wat} = w_{a1}x_1 + \Pi^*_{wa2}(x_1), \tag{13}$$
$$\Pi_{wbt} = w_{b1}(1 - x_1) + \Pi^*_{wb2}(x_1). \tag{14}$$

Lemma 1 summarizes the pure-strategy equilibrium outcomes (for the detailed proof, see the appendix).

Lemma 1. *When only retailers use BBP, there is a pure-strategy equilibrium: The first-period wholesale prices are $w^*_{a1} = w^*_{b1} = 214t/81$, the second-period wholesale prices are $w^*_{a2} = w^*_{b2} = 3t/2$, the first-period retail prices are $a^*_1 = b^*_1 = 313t/81$, past-customer retail prices are $a^*_o = b^*_o = 13t/6$, and new-customer retail prices are $a^*_n = b^*_n = 11t/6$. Manufacturers' total profits are $\Pi^*_{wat} = \Pi^*_{wbt} = 671t/324$, retailers' total profits are $\Pi^*_{rat} = \Pi^*_{rbt} = 8t/9$, and channel total profits are $\Pi^*_{at} = \Pi^*_{bt} = 959t/324$. The marginal consumers are at $x^*_a = 1/3$, $x^*_1 = 1/2$, and $x^*_b = 2/3$.*

Case 3: With Wholesale and Retail BBP

How would the equilibrium outcomes change if manufacturers also have access to customers' purchase history data and can issue behavior-based wholesale prices for retailers to target past and new customers differently? We investigate this scenario next.

The Second Period. The locations of the marginal consumers in the second period take the same forms as in Case 2, that is, $x_a = (t + b_n - a_o)/(2t)$ and $x_b = (t + b_o - a_n)/(2t)$. With wholesale BBP, retailers' second-period profit functions become

$$\Pi_{ra2} = (a_o - w_{ao})x_a + (a_n - w_{an})(x_b - x_1), \tag{15}$$
$$\Pi_{rb2} = (b_o - w_{bo})(1 - x_b) + (b_n - w_{bn})(x_1 - x_a), \tag{16}$$

where w_{ao} and w_{bo} are wholesale prices if retailers sell the product to past customers and w_{an} and w_{bn} are wholesale prices if retailers sell the product to new customers. Manufacturers' second-period profit functions become

$$\Pi_{wa2} = w_{ao}x_a + w_{an}(x_b - x_1), \tag{17}$$
$$\Pi_{wb2} = w_{bo}(1 - x_b) + w_{bn}(x_1 - x_a). \tag{18}$$

As in Case 2, the marginal consumer at x_1 switches firms in the second period. The equilibrium retail prices in the second period are $a^*_o(x_1) = (2x_1t + t + 2w_{ao} + w_{bn})/3$, $a^*_n(x_1) = (3t - 4x_1t + 2w_{an} + w_{bo})/3$, $b^*_o(x_1) = (3t - 2x_1t + w_{an} + 2w_{bo})/3$, and $b^*_n(x_1) = (4x_1t - t + w_{ao} + 2w_{bn})/3$. The equilibrium wholesale prices in the second period are $w^*_{ao}(x_1) = (1 + 8x_1)t/3$, $w^*_{an}(x_1) = (9 - 10x_1)t/3$, $w^*_{bo}(x_1) = (9 - 8x_1)t/3$, and $w^*_{bn}(x_1) = (10x_1 - 1)t/3$ (for a detailed analysis of the second-period equilibrium prices, see the appendix).

The First Period. We analyze the first period using the same logic as in Case 2. The marginal consumer at x_1 makes a first-period purchase decision by taking the total utility from both periods into consideration and is indifferent between buying from retailer A and retailer B in the first period. We must have that

$$\begin{aligned} &v - tx_1 - a_1 + [v - t(1 - x_1) - b^e_n] \\ &\quad = v - t(1 - x_1) - b_1 + (v - tx_1 - a^e_n). \end{aligned} \tag{19}$$

By rational-expectation conditions, i.e., $a^e_n = a^*_n(x_1)$ and $b^e_n = b^*_n(x_1)$, we have that

$$x_1 = \frac{1}{2} + \frac{9(b_1 - a_1)}{80t}. \tag{20}$$

Retailers' profit functions are $\Pi_{rat} = (a_1 - w_{a1})x_1 + \Pi^*_{ra2}(x_1)$ and $\Pi_{rbt} = (b_1 - w_{b1})(1 - x_1) + \Pi^*_{rb2}(x_1)$. Manufacturers' profit functions are $\Pi_{wat} = w_{a1}x_1 + \Pi^*_{wa2}(x_1)$ and $\Pi_{wbt} = w_{b1}(1 - x_1) + \Pi^*_{wb2}(x_1)$. Lemma 2 summarizes the pure-strategy equilibrium outcomes (for the detailed proofs, see the appendix).

Lemma 2. *When manufacturers and retailers use BBP, there is a pure-strategy equilibrium: The first-period wholesale prices are $w^*_{a1} = w^*_{b1} = 916t/81$, past-customer wholesale prices are $w^*_{ao} = w^*_{bo} = 5t/3$, and new-customer wholesale prices are $w^*_{an} = w^*_{bn} = 4t/3$. The first-period retail prices are $a^*_1 = b^*_1 = 1{,}276t/81$, past-customer retail prices are $a^*_o = b^*_o = 20t/9$, and new-customer retail prices are $a^*_n = b^*_n = 16t/9$. Manufacturers' total profits are $\Pi^*_{wat} = \Pi^*_{wbt} = 1{,}039t/162$, retailers' total profits are $\Pi^*_{rat} = \Pi^*_{rbt} = 401t/162$, and channel total profits are $\Pi^*_{at} = \Pi^*_{bt} = 80t/9$. The marginal consumers are at $x^*_a = 5/18$, $x^*_1 = 1/2$, and $x^*_b = 13/18$.*

3. Main Results

By comparing the equilibrium outcomes across cases (see Table 2), we obtain several findings.

Proposition 1. *When only retailers use BBP, manufacturers' and retailers' profits are lower than when retailers do not use BBP.*

We obtain this result by comparing the equilibrium profits in Case 2 (with retail BBP) and Case 1 (without BBP). Given that symmetric retailers equally split the market, volume sales do not change with BBP. Manufacturers and retailers attain lower profits with retail

BBP because they charge lower prices in each period than their prices without BBP. In the second period, retail prices decline because customers' purchase history data categorize customers into two segments, i.e., a retailer's past customers and its competitor's past customers. Retailers set discriminatory prices to compete for customers in the two small segments. Specifically, the competitor's past customers have revealed from their first-period purchase that they prefer the competitor's product to the retailer's product. Therefore, retailers offer lower prices to poach the competitor's customers. As a result, neither retailer can extract a higher surplus from its past customers who have revealed a stronger preference for its product than the competitor's product, as the competitor offers them low poaching prices. When both retailers poach each other's customers, competition becomes more intense, and second-period retail prices are lower than those without BBP.

Manufacturers also reduce second-period wholesale prices, though they use uniform wholesale prices while retailers use BBP. The reason is that when retailers engage in BBP, the second-period competition between manufacturers also intensifies because the second-period demand becomes more sensitive to wholesale prices. To understand this intuition, we take manufacturer A's perspective. The second-period demand for A's product is $d_a^{C1} = x_1$ without BBP and $d_a^{C2} = x_a + x_b - x_1$ when only retailers use BBP, where d_a^{Cn} indicates the demand for product A and the superscript indicates the case number ($C1$ = Case 1 Without BBP, $C2$ = Case 2 With Retail BBP). The sensitivity of demand to manufacturer A's wholesale price is $\partial d_a^{C1}/\partial w_{a2} = -1/(6t)$ without BBP and decreases to $\partial d_a^{C2}/\partial w_{a2} = -1/(3t)$ when only retailers use BBP. In other words, when manufacturers reduce wholesale prices by Δ, the marginal increase in demand is $\Delta/(6t)$ without BBP and $\Delta/(3t)$ with BBP. The change in wholesale prices shifts demand more with BBP because it affects retail prices in two segments (past-customer segment and new-customer segment) with BBP, whereas without BBP, retailers compete in one segment, and the change in wholesale prices shifts demand in one segment. Therefore, wholesale price sensitivity with BBP is twice as high as it is without BBP, which induces manufacturers to reduce wholesale prices. As a result, equilibrium wholesale prices are lower than those without BBP in the second period.

Note that with retail BBP, the first-period prices are also lower than those without BBP. This result is opposite of the finding in the traditional BBP literature that BBP leads to higher prices in the first period than prices without BBP (Fudenberg and Tirole 2000). We state this finding in Proposition 2.

Proposition 2. *When only retailers use BBP, the first-period wholesale and retail prices are lower than when retailers do not use BBP.*

Fudenberg and Tirole (2000) examine two manufacturers competing in a non-channel setting. In this setting, BBP intensifies the second-period price competition but relaxes the first-period competition, i.e., the first-period prices are higher with than without BBP. By contrast, Proposition 2 reveals that in channels, BBP also intensifies the first-period competition, driving the first-period prices lower than prices without BBP.

In a non-channel setting, BBP increases firms' first-period prices from those without BBP because consumers become less price sensitive in the first period. Suppose that firm A increases its first-period price, and its first-period market share declines, leading firm B to reduce new-customer price and firm A to increase new-customer price in the second period. Anticipating better deals from firm B, consumers are more willing to buy from firm A in the first period to receive firm B's new-customer price when they switch firms in the second period. As a result, consumers become less sensitive to firm A's price increase in the first period than they are in the static case. This *price-sensitivity effect* induces firms to raise prices in the first period. Moreover, in the non-channel setting, when the first-period market share is in the neighborhood of the symmetric equilibrium (i.e., $x_1 = \frac{1}{2}$), a firm's first-period market share has no impact on its second-period profit (i.e., $\partial\Pi_{a2}^*(x_1)/\partial x_1|_{x_1=1/2} = 0$). This is because as x_1 increases, firm A attains higher profits from its past-customer segment and lower profits from its new-customer segment in the second period. These two effects cancel each other out, and the second-period profit does not change. Therefore, firms do not adjust first-period prices to improve their second-period profits. The price-sensitivity effect drives firms to raise first-period prices from the levels without BBP.

However, this is not true if we account for the role of independent manufacturers in channels (Case 2), even though manufacturers do not issue behavior-based wholesale prices. In the presence of independent manufacturers in channels, retailers reduce first-period retail prices from those without BBP (Case 1). This is because of retailers' strategic action to raise second-period profits by adjusting first-period retail prices. Specifically, *when retailers use BBP and manufacturers use uniform pricing, a retailer's first-period market share positively affects its second-period profit* (mathematically, $\partial\Pi_{ra2}^*(x_1)/\partial x_1|_{x_1=1/2} = 2t/9$, see Table 3).

To understand this result, suppose that retailer A's first-period market share (x_1) increases by Δ; then, the marginal increase in the locations of marginal consumers in the second period ($x_a^*(x_1, w_{a2}, w_{b2})$ and

Table 3. Summary of Key Effects

	Case 1	Case 2	Case 3
Retailers use BBP	No	Yes	Yes
Manufacturers use BBP	No	No	Yes
First-period price sensitivity			
Manufacturer ($\partial x_1/\partial w_{a1}$)	$-\dfrac{1}{6t}$	$-\dfrac{81}{374t}$	$-\dfrac{81}{1{,}832t}$
Retailer ($\partial x_1/\partial a_1$)	$-\dfrac{1}{2t}$	$-\dfrac{9}{26t}$	$-\dfrac{9}{80t}$
Effect of first-period market share on second-period profit			
Manufacturer ($\partial \Pi^*_{wa2}(x_1)/\partial x_1\|_{x_1=1/2}$)	0	$-\dfrac{t}{3}$	0
Retailer ($\partial \Pi^*_{ra2}(x_1)/\partial x_1\|_{x_1=1/2}$)	0	$\dfrac{2t}{9}$	0

Note. Because channel members A and B are symmetric, we report the effects from A's perspective.

$x_b^*(x_1, w_{a2}, w_{b2})$) is $\Delta/3$ when the second-period wholesale prices (w_{a2}, w_{b2}) are fixed. As a result, the second-period demand for product A $(x_a^*(x_1, w_{a2}, w_{b2}) + x_b^*(x_1, w_{a2}, w_{b2}) - x_1)$ decreases by $\Delta/3$. The decrease in demand depresses the pricing power of manufacturer A, and A's second-period wholesale prices decrease. At the same time, second-period demand for product B increases, and B's wholesale prices increase. The decrease in A's wholesale prices and the increase in B's wholesale prices improve retailer A's second-period profit. Therefore, retailer A's second-period profit increases with its first-period market share. For this reason, retailers have incentives to reduce their first-period prices to increase their first-period market share, thereby increasing their second-period profits. Although consumers in the first-period are less price sensitive than in the static case, retailers' incentives to reduce first-period prices to improve second-period profits dominate the price-sensitivity effect, and first-period retail prices are lower than those in the static case.

Wholesale prices in the first period are also lower than those without BBP. The underlying force that drives this result is that the first-period demand becomes more sensitive to wholesale prices when only retailers use BBP. Without BBP, the wholesale price sensitivity is $\partial x_1^*(w_1)/\partial w_{a1} = -1/(6t)$. With retail BBP, it becomes $-81/(374t) < -1/(6t)$. This is because with retail BBP, the retailer's pass-through (i.e., $\partial a_1^*(w_1)/\partial w_{a1}$) is higher and the competitor's cross pass-through (i.e., $\partial b_1^*(w_1)/\partial w_{a1}$) is lower. As a result, when a manufacturer reduces its price, its retailer passes a higher proportion of the price reduction to consumers, whereas the competing retailer does not respond by cutting prices as much as without BBP, and demand expands to a greater degree. Note also that manufacturers' second-period profits decrease with their first-period market share, i.e., $\partial \Pi^*_{wa2}(x_1)/\partial x_1|_{x_1=1/2} = -t/3 < 0$ (see Table 3). This is because a larger first-period market share reduces its second-period demand and wholesale prices. This second-period consideration encourages manufacturers to raise first-period wholesale prices to decrease first-period market share and improve second-period profits. However, this effect is dominated by the first price-sensitivity effect, which increases manufacturers' incentives to reduce first-period wholesale prices to expand first-period market share and profits. As a result, manufacturers and retailers reduce prices in both periods, and their total profits in the two periods are lower than those without BBP.

Now, consider the case when manufacturers and retailers use BBP. By comparing the equilibrium profits in Case 3 (with wholesale and retail BBP) and Case 1 (without BBP), we have the following finding.

Proposition 3. *When manufacturers and retailers use BBP, manufacturers' and retailers' profits are higher than when they do not use BBP.*

Note that when manufacturers and retailers use BBP, their second-period profits are still lower than when they do not use BBP (see Table 4) because of intensified price competition in the second period. Therefore, without the "behavior-observation stage" (i.e., the first period), the result in Proposition 3 does not hold. Manufacturers' and retailers' total profits over the two periods are higher with than without wholesale and retail BBP because both parties charge higher prices and earn greater profits in the first period than they do without BBP.

First-period profits increase because of the intertemporal trade-off that consumers, retailers, and manufacturers face. The marginal consumer in the first period switches firms in the second period. Consumers recognize that the second-period prices that retailers offer depend on their first-period purchase decisions, so they may pay a higher price in the first period to receive

Table 4. Equilibrium Profits by Period

	Case 1	Case 2	Case 3
Retailers use BBP	No	Yes	Yes
Manufacturers use BBP	No	No	Yes
Total profits			
Channel (Π^*_{at})	$4.00t$	$2.96t$	$8.89t$
Manufacturer (Π^*_{wat})	$3.00t$	$2.07t$	$6.41t$
Retailer (Π^*_{rat})	$1.00t$	$0.89t$	$2.48t$
First-period profits			
Channel (Π^*_{a1})	$2.00t$	$1.93t$	$7.88t$
Manufacturer (Π^*_{wa1})	$1.50t$	$1.32t$	$5.65t$
Retailer (Π^*_{ra1})	$0.50t$	$0.61t$	$2.22t$
Second-period profits			
Channel (Π^*_{a2})	$2.00t$	$1.03t$	$1.01t$
Manufacturer (Π^*_{wa2})	$1.50t$	$0.75t$	$0.76t$
Retailer (Π^*_{ra2})	$0.50t$	$0.28t$	$0.25t$

Note. Because channel members A and B are symmetric, we report the equilibrium outcomes from A's perspective.

a discount in the second period. When manufacturers and retailers use BBP, forward-looking behavior makes the marginal consumer less sensitive to first-period prices. We showed that when only retailers use BBP, first-period demand is less sensitive to retail prices ($\partial x_1/\partial a_1 = -9/(26t)$ in Case 2) than in the context without BBP ($\partial x_1/\partial a_1 = -1/(2t)$ in Case 1). Here, we find that when manufacturers and retailers use BBP, the first-period demand becomes even less sensitive to retail prices ($\partial x_1/\partial a_1 = -9/(80t)$ in Case 3) (see Table 3). The reason is as follows: Suppose that retailer A increases its first-period price a_1, then, its first-period demand x_1 decreases. As a result, the new-customer segment for retailer and manufacturer B to poach shrinks, and the new-customer segment for retailer and manufacturer A to poach expands. These changes in the size of the new-customer segment lead manufacturer B to reduce its wholesale prices for selling to new customers and manufacturer A to increase its wholesale prices for selling to new customers. This enables retailer B to offer a more attractive new-customer retail price than retailer A's than that it can offer without manufacturers' price discrimination. Anticipating the more attractive new-customer deals due to manufacturers' price discrimination, consumers in the first period are more willing to buy from retailer A to receive B's new-customer deal in the second period. Therefore, the first-period demand becomes even less price sensitive when manufacturers also use BBP, which enables retailers to raise prices and obtain higher profits in the first period.

In addition, manufacturers and retailers face an intertemporal trade-off. Manufacturers and retailers may set first-period prices in a way that reduces first-period profits but increases second-period profits to a greater degree, thereby maximizing total profits over the two periods. When only retailers use BBP (Case 2), forward-looking retailers reduce first-period prices to expand first-period market share to increase second-period profits. This incentive dominates the price-sensitivity effect and leads retailers to reduce first-period prices to be lower than when they do not use BBP. However, when manufacturers also use BBP, second-period profits are independent with first-period market share, as in the case without BBP (see Table 3). The reason is that when manufacturers also use BBP, the increase in a retailer's first-period market share increases its manufacturer's wholesale price for past customers and reduces its wholesale price for new customers. At the same time, the competing manufacturer increases its wholesale price for new customers and reduces its wholesale price for past customers. The retailer's profit from its past customers decreases, and its profit from its new customers increases. These counteracting changes in profits cancel out each other. As a result, the change in the first-period market share exerts no impact on retailers' second-period profit. Therefore, retailers will not reduce first-period prices to increase second-period profits. The decrease in consumers' price sensitivity in the first period (i.e., the price-sensitivity effect) leads retailers to raise first-period prices to be higher than those without BBP. This price increase causes retailers' total profits to exceed their profits without BBP.

For manufacturers, when only retailers use BBP, first-period demand is more sensitive to wholesale prices than without BBP ($\partial x_1^*/\partial w_{a1} = -81/(374t)$ with retail BBP versus $\partial x_1^*/\partial w_{a1} = -1/(6t)$ without BBP). However, with wholesale and retail BBP, first-period demand becomes less sensitive to wholesale prices than without BBP ($\partial x_1^*/\partial w_{a1} = -81/(1{,}832t)$ with wholesale and retail BBP, see Table 3). In addition, manufacturers' second-period profits are independent of first-period market share. Thus, manufacturers set first-period prices to maximize profits from the first period alone. Given that the first-period demand is less price sensitive, manufacturers charge higher wholesale prices in the first period than without BBP. The price increase causes manufacturers' total profits to be higher than their profits without BBP.[3]

The previous analysis demonstrates that BBP can have a significant impact on channel profits and that the impact is directionally opposite depending on which channel members adopt BBP. Next, we investigate the welfare implications of BBP by channel members.

Proposition 4. *When only retailers use BBP, consumer surplus is higher than when retailers do not use BBP. When manufacturers and retailers use BBP, consumer surplus is lower than when they do not use BBP.*

In a non-channel setting, BBP intensifies price competition in the second period, and prices decline. This price reduction improves consumer surplus. However, in a channel setting, the impact of BBP on consumer surplus is not monotonic; rather, the direction of this impact depends on which channel members use BBP. Our results show that when only retailers use BBP, retail prices in both periods are lower, and therefore consumer surplus is higher than it is without BBP. However, when manufacturers and retailers use BBP, retail prices in the first period increase substantially, which offsets the decrease in second-period retail prices. Thus, consumer surplus is lower than it is without BBP.

Proposition 5. *Social welfare is lower with than without BBP. When manufacturers and retailers use BBP, social welfare is lower than when only retailers use BBP.*

When we evaluate social welfare, price changes imply changes only in the allocation of welfare among consumers, retailers, and manufacturers, but not the overall level. With BBP, some consumers switch to buy products that are less ideal for them. For example, consumers in the region of (x_a, x_1) buy product B in the second period, though they prefer product A to product B at the same price. This inefficient switching reduces social welfare. Therefore, social welfare is lower with than without BBP. When manufacturers also use BBP, more consumers switch in the second period than when only retailers use BBP, resulting in a lower level of social welfare (see Table 2). This is because when manufacturers also use BBP, they set a higher wholesale price for past customers than for new customers, which induces retailers to charge an even higher retail price for past customers than for new customers. Therefore, consumers face more attractive prices when they switch firms in the second period and more consumers switch firms than when only retailers use BBP. As a result, manufacturers' adoption of BBP further reduces social welfare from its level when only retailers use BBP.

4. Extensions

We relax several assumptions made in the main model to show the robustness of the main results and provide new insights. In Section 4.1, we allow manufacturers to credibly commit to fixing wholesale prices over time by offering a long-term contract to retailers. We investigate whether manufacturers are better off by offering long-term contracts or by offering short-term contracts to retailers. In Section 4.2, we allow some consumers to be myopic about future prices, discuss the impact of consumers' switching costs on the equilibrium outcomes, and provide conjectural assessment of the model when the market is not fully covered.

4.1. Long-Term Wholesale Contracts

In the main model, we considered situations in which manufacturers charged different wholesale prices over time. Manufacturers offer retailers short-term contracts about wholesale prices in each period, and manufacturers can adjust short-term prices directly or through opaque devices such as trade promotions, off-invoice, and bill-back (Lal 1990, Lal and Villas-Boas 1998). Essentially, we assumed that manufacturers were unable to commit to future prices by offering long-term contracts (Hart and Tirole 1988, Fudenberg and Tirole 2000, Villas-Boas 1999). However, it could be argued that in some contexts wholesale prices do not always change over time and manufacturers can commit to fixed wholesale prices by signing long-term contracts with retailers. With possible commitment power, would manufacturers prefer long- to short-term wholesale contracts? The answer is not obvious; rather, it depends on whether manufacturers can access customers' purchase history data to use BBP (for the detailed proofs, see Section A-1.1 in the online appendix).

Proposition 6. *When manufacturers cannot use BBP, they prefer long-term contracts. When manufacturers can use BBP, they prefer short-term contracts.*

Manufacturers may be unable to use BBP if retailers do not share customer data with them. Our analysis shows that in this case, long-term contracts lead to higher profits for manufacturers. The intuition is that with short-term contracts, manufacturers have incentives to lower prices in the second period because retailers engage in competitive poaching with one another. The price reduction in the second period reduces the overall profits of manufacturers. However, with long-term contracts, manufacturers can sustain a high long-term wholesale price as the first-period demand becomes less sensitive to wholesale prices because of the long-term nature of the wholesale prices. To understand this intuition, suppose that manufacturer A raises its wholesale price. Because this wholesale price is long-term, it leads to a higher retail price (a_1) in the first period and a higher new-customer price (a_n) in the second period. This price increase negatively affects the marginal consumer at x_1 regardless of which product that customer chooses in the first period. If this consumer buys product A in the first period, she faces a higher retail price a_1 in the first period. If this consumer buys product B in the first period, she will face a higher new-customer price a_n when switching to buy product A in the second period. Therefore, this consumer's purchase decision in the first period is less affected by the wholesale price increase. Demand is inelastic to wholesale prices, allowing manufacturers to sustain high long-term wholesale prices. As a result, manufacturers prefer long-term contracts in this case. This finding suggests that when manufacturers cannot make a credible commitment about future prices, they are worse off than when they could commit to future prices.

By contrast, if manufacturers can access customers' purchase history data and use BBP, they prefer short-term contracts. With short-term contracts, manufacturers and retailers use BBP. The equilibrium outcome in Case 3 applies. Short-term contracts are more profitable because manufacturers can raise first-period wholesale prices much higher than they can with long-term contracts. Although second-period wholesale prices are lower because of intensified price competition, the increase in the first-period profit offsets the loss in the second-period profit for manufacturers. The reason that first-period wholesale prices increase is that first-period demand is even less price sensitive to wholesale prices. To illustrate this, suppose that manufacturer A raises its first-period wholesale price w_{a1}. Then, the first-period retail prices change accordingly, and A's market share x_1 decreases. The decrease in x_1 will have no impact on second-period wholesale prices under long-term contracts. With short-term contracts, the decrease in x_1 decreases the new-customer segment of product B and increases the new-customer segment of product A. As a result, manufacturer B's wholesale price for new customers decreases, and manufacturer A's wholesale price for new customers increases, which leads retailer A's new-customer retail price to increase and retailer B's new-customer price to decrease. As a result, consumers in the first period are more willing to buy from retailer A to receive retailer B's new-customer deal in the second period. Thus, first-period demand is much less sensitive to wholesale prices, and manufacturers can charge higher wholesale prices in the first period than that they can under long-term contracts.

Furthermore, our analysis suggests that retailers should share customers' purchase history data with manufacturers. With customers' purchase history data, manufacturers use short-term contracts and behavior-based wholesale pricing, leading to higher profits for manufacturers and retailers. If retailers do not share customers' purchase history data, manufacturers use long-term contracts, and the channel members' profits are lower than profits with data sharing.

4.2. Discussion

In the main model, we assume that consumers are strategic, i.e., they recognize that the second-period prices they face depend on their first-period purchase decisions and they rationally make a first-period purchase by taking second-period prices into account. However, research in behavioral economics shows that consumers may have bounded rationality and may not know or care about future prices (Ellison 2006). These myopic consumers make first-period purchases to maximize their first-period utilities (Taylor 2004, Acquisti and Varian 2005). We modify our model to allow for the presence of myopic consumers. Specifically, we let $\alpha \in (0,1)$ fraction of consumers be myopic and $1-\alpha$ fraction of consumers be strategic. We find that when channel members use BBP (i.e., Cases 2 and 3), as α increases (i.e., more consumers are myopic), first-period wholesale and retail prices decline. As a result, channel members' profits with BBP decrease with α. The reason is that when a retailer increases first-period prices, strategic consumers are less sensitive to this price increase as they anticipate receiving better deals when they switch retailers in the second period. This strategic anticipation reduces consumers' price sensitivity in the first period, inducing retailers and manufacturers to raise first-period prices. Thus, as α increases and more consumers are myopic, the first-period demand becomes more price sensitive, resulting in lower first-period prices and lower channel members' profits. Consequently, when only retailers use BBP, in the presence of myopic consumers, first-period prices and channel members' profits are lower than when retailers do not use BBP. Therefore, the results in Propositions 1 and 2 hold. When manufacturers and retailers use BBP, for a low value of α, channel members' profits are still higher than when they do not use BBP. We find that this main result in Proposition 3 holds as long as fewer than 53% of all consumers are myopic. In this case, the welfare implications of BBP that Propositions 4 and 5 state also hold (for the detailed analysis, see Section A-1.3 in the online appendix).[4]

To simplify analysis and focus on the main mechanisms, we assume that switching products is costless for consumers. This assumption may not be true as consumers may incur psychological barriers or physical learning costs when they switch products (Klemperer 1987). We relax the model to account for consumers' switching costs. We find the pure-strategy equilibrium in the models with BBP (Cases 2 and 3) when consumers' switching cost is not too high. However, if switching cost is sufficiently high, firms have incentives to reduce their first-period prices to expand their first-period market share, so that they do not poach the competitor's customers in the second period (for the detailed analysis, see Section A-1.4 in the online appendix).

Our main model also assumes that the base value (v) of the product is sufficiently high so that the market is fully covered in both periods. Would our results still hold for products that provide a low base value? To assess the robustness of our results, we relax this assumption and consider situations in which the market is partially covered (for the detailed analysis, see Section A-1.5 in the online appendix). When the base value of the product is sufficiently low, the two firms act as local monopolists in both periods without BBP. We consider two scenarios when firms use BBP, i.e., first, the market is fully covered in the first period and partially covered in the second period and, second, the market is partially covered in the first period and fully covered in the second period. We find that a symmetric pure-strategy equilibrium exists in the second scenario. In the second period, firms set new-customer prices to serve consumers who did not buy in the first period and set past-customer prices so that the first-period marginal consumers are indifferent between staying and switching. We compare equilibrium profits with and without BBP and find that BBP is not profitable for firms in non-channel settings. This is because BBP leads firms to reduce prices to build their customer base in the first period because they can charge these customers the high past-customer price in the second period. The decrease in first-period prices dominates, thus driving firms' total profits to be lower than profits without BBP. In channels, as the main model shows, BBP can be profitable when manufacturers and retailers use BBP (Case 3). Moreover, BBP also becomes profitable when only retailers use BBP (Case 2), which was not profitable under full market coverage in the main model. This is because BBP allows manufacturers to cater to consumers who did not buy in the first period. The market expansion effect increases profits in the second period. In addition, with independent manufacturers and retailers, the price competition is not as intense as that in non-channel settings because retailers do not pass all manufactures' price changes on to consumers. The decrease in first-period prices is dominated by the market expansion effect in the second period. As a result, manufacturers' and retailers' profits are higher with than without BBP.

5. Conclusions

In this paper, we extend the BBP literature by examining the implications of BBP in marketing channels. We examine a channel structure with two competing manufacturers that sell to consumers through exclusive retailers. We investigate how the adoption of BBP by channel members affects their profits, as well as consumer surplus, social welfare, and manufacturers' optimal wholesale price contracts. We summarize the main findings and implications as follows.

How does BBP affect profits of channel members? Our analysis shows that the impact of BBP on channel members' profits depends on which channel members adopt BBP. In particular, when only retailers use behavior-based retail prices, channel members' profits are lower than those without BBP. By contrast, when manufacturers also use behavior-based wholesale prices, channel members' profits exceed profits without BBP. Therefore, by contrast to findings of the BBP literature in non-channel settings, we show that BBP is a profitable business practice in channels when manufacturers and retailers use BBP. This finding suggests that retailers and manufacturers can benefit from sharing customers' purchase history data for BBP.

How does BBP affect consumer surplus and social welfare? The impact of BBP on consumer surplus also depends on which channel members adopt BBP. When only retailers use BBP, consumer surplus is higher than that without BBP. When manufacturers also use BBP, consumer surplus is lower. Therefore, when public policy makers design regulations to protect consumers, they need to treat different channel members' use of consumers' data differently. Furthermore, BBP induces consumers to switch to less ideal retailers and reduces social welfare. Social welfare is even lower when manufacturers and retailers use BBP than when only retailers use BBP.

Should manufacturers offer long-term wholesale price contracts to retailers? The optimal choice of wholesale price contracts depends on whether manufacturers can access customers' purchase history data to use BBP. Short-term contracts lead to higher profits for manufacturers if they can use BBP. If manufacturers cannot use BBP, however, they can reap higher profits by offering fixed wholesale prices using long-term contracts. Therefore, manufacturers need to take the feasibility of BBP into account when they design optimal wholesale price contracts.

This research points to several directions for future research. First, our model is built on a traditional channel structure in which competing manufacturers sell to consumers through exclusive retailers. It would be worthwhile to examine how channel members' adoption of BBP affects channel profits in alternative channel structures (Lee et al. 2013). Second, we focus on the case with symmetric firms. In reality, firms differ in size, production costs, brand equity, retailer loyalty, and so on. Future research could examine the impact of firm characteristics on the decision to adopt BBP, equilibrium pricing, and channel profits. Third, we used a two-period model to examine the impact of BBP in a channel setting. Future research could use a model with overlapping generations of consumers to further examine BBP's dynamic implications. Last, we focus on the competition between horizontally differentiated firms when channel members can use BBP. It would be interesting to extend this study by examining the competition between vertically differentiated firms in marketing channels.

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Appendix

Second-Period Equilibrium Prices in Case 2

In the second period, the equilibrium prices depend on the location of the first-period marginal consumer denoted by x_1. Figure A.1 depicts the three consumption patterns in the second period when x_1 falls into three different regions. We solve all three cases and summarize the second-period equilibria in Lemma 3.

Lemma 3. *When only retailers use BBP, the second-period equilibrium prices are*:

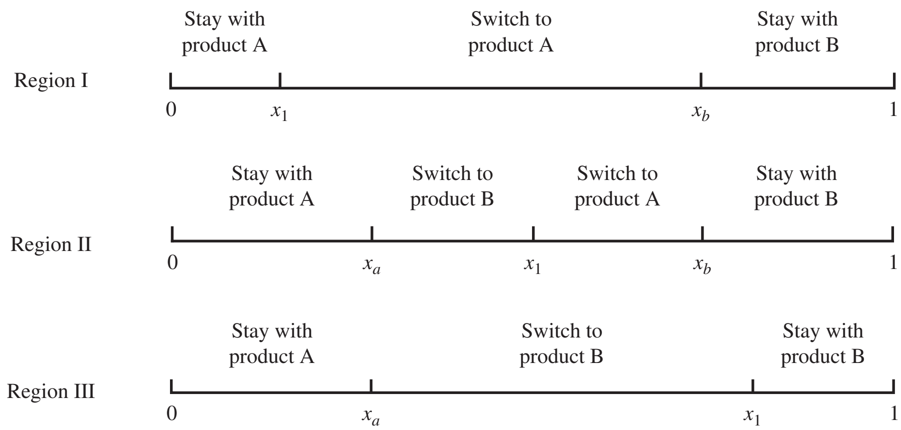
(a) Region I: *If* $x_1 \in [0, \frac{1}{5}]$: $w^*_{a2}(x_1) = ((9+2x_1)/3)t$, $w^*_{b2}(x_1) = ((9-2x_1)/3)t$, $a^*_o(x_1) = (4(3-2x_1)/3)t$, $a^*_n(x_1) = (2(18-5x_1)/9)t$, $b^*_o(x_1) = (4(9-2x_1)/9)t$, *and* $b^*_n(x_1) = ((9-2x_1)/3)t$. *Only retailer A poaches retailer B's customers.*

(b) Region II: *If* $x_1 \in (\frac{1}{5}, \frac{4}{5})$: $w^*_{a2}(x_1) = ((5-x_1)/3)t$, $w^*_{b2}(x_1) = ((4+x_1)/3)t$, $a^*_o(x_1) = ((5x_1+17)/9)t$, $a^*_n(x_1) = ((23-13x_1)/9)t$, $b^*_o(x_1) = ((22-5x_1)/9)t$, *and* $b^*_n(x_1) = ((10+13x_1)/9)t$. *Both retailers poach each other's customers.*

(c) Region III: *If* $x_1 \in [\frac{4}{5}, 1]$: $w^*_{a2}(x_1) = ((7+2x_1)/3)t$, $w^*_{b2}(x_1) = ((11-2x_1)/3)t$, $a^*_o(x_1) = (4(2x_1+7)/9)t$, $a^*_n(x_1) = ((7+2x_1)/3)t$, $b^*_o(x_1) = (4(2x_1+1)/3)t$, *and* $b^*_n(x_1) = (2(13+5x_1)/9)t$. *Only retailer B poaches retailer A's customers.*

Proof. Region II. Suppose that $x_1 \in (\frac{1}{5}, \frac{4}{5})$. Retailers set second-period BBP prices to maximize second-period profits. If $x_a < x_1 < x_b$, first-order condition gives that $a^*_o(x_1) = (2x_1+1)t/3 + (2w_{a2}+w_{b2})/3$, $b^*_n(x_1) = (4x_1-1)t/3 + (w_{a2}+2w_{b2})/3$, $a^*_n(x_1) = (3-4x_1)t/3 + (2w_{a2}+w_{b2})/3$, and $b^*_o(x_1) = (3-2x_1)t/3 + (w_{a2}+2w_{b2})/3$. The second-order condition holds. Manufacturers set their uniform second-period wholesale prices to

Figure A.1. Regions of x_1 and Second-Period Consumption Patterns



maximize second-period profits. The first-order condition gives that $w^*_{a2}(x_1) = ((5 - x_1)/3)t$ and $w^*_{b2}(x_1) = ((4 + x_1)/3)t$. The second-order condition holds. The marginal consumers are at $x^*_a(x_1) = (1 + 4x_1)/9$ and $x^*_b(x_1) = (4 + 4x_1)/9$. It is satisfied that $x^*_a(x_1) < x_1 < x^*_b(x_1)$ for $x_1 \in (\frac{1}{5}, \frac{4}{5})$. Plugging the equilibrium values of wholesale prices into the representations of retail prices, we have $a^*_o(x_1) = ((5x_1 + 17)/9)t$, $b^*_o(x_1) = ((22 - 5x_1)/9)t$, $a^*_n(x_1) = ((23 - 13x_1)/9)t$, and $b^*_n(x_1) = ((10 + 13x_1)/9)t$. Lemma 1 shows that the pure-strategy equilibrium exists in Region II. Therefore, we report the second-period equilibrium prices in Region II in the paper.

Region I. Suppose instead that $x_1 \in [0, \frac{1}{5})$. Then, $b^*_n(x_1) < w^*_{b2}(x_1)$, i.e., retailer B's poaching price in Region II is lower than the second-period wholesale price, which is a dominated strategy. Thus, retailer B sets $b^*_n(x_1) = w_{b2}(x_1)$ and retailer A sets $a^*_o(x_1) = w_{b2}(x_1) + t(1 - 2x_1)$ such that the consumer at x_1 is indifferent between staying with retailer A and switching to retailer B, i.e., $x_1 = x^*_a(x_1)$. The first-order condition gives the second-period retail prices in B's turf: $a^*_n(x_1) = ((3 - 4x_1)/3)t + (2w_{a2} + w_{b2})/3$ and $b^*_o(x_1) = ((3 - 2x_1)/3)t + (w_{a2} + 2w_{b2})/3$. Applying first-order conditions on manufacturers' second-period wholesale prices, we obtain $w^*_{a2}(x_1) = ((9 + 2x_1)/3)t$ and $w^*_{b2}(x_1) = ((9 - 2x_1)/3)t$. Plugging the equilibrium values of wholesale prices into the representations of retail prices, we have $a^*_o(x_1) = (4(3 - 2x_1)/3)t$, $a^*_n(x_1) = (2(18 - 5x_1)/9)t$, $b^*_o(x_1) = (4(9 - 2x_1)/9)t$, and $b^*_n(x_1) = ((9 - 2x_1)/3)t$. Region I. Suppose instead that $x_1 \in [0, \frac{1}{5})$. Then, $b^*_n(x_1) < w^*_{b2}(x_1)$, i.e., retailer B's poaching price in Region II is lower than the second-period wholesale price, which is a dominated strategy. Thus, retailer B sets $b^*_n(x_1) = w_{b2}(x_1)$ and retailer A sets $a^*_o(x_1) = w_{b2}(x_1) + t(1 - 2x_1)$ such that the consumer at x_1 is indifferent between staying with retailer A and switching to retailer B, i.e., $x_1 = x^*_a(x_1)$. The first-order condition gives the second-period retail prices in B's turf: $a^*_n(x_1) = ((3 - 4x_1)/3)t + (2w_{a2} + w_{b2})/3$ and $b^*_o(x_1) = ((3 - 2x_1)/3)t + (w_{a2} + 2w_{b2})/3$. Applying first-order conditions on manufacturers' second-period wholesale prices, we obtain $w^*_{a2}(x_1) = ((9 + 2x_1)/3)t$ and $w^*_{b2}(x_1) = ((9 - 2x_1)/3)t$. Plugging the equilibrium values of wholesale prices into the representations of retail prices, we have $a^*_o(x_1) = (4(3 - 2x_1)/3)t$, $a^*_n(x_1) = (2(18 - 5x_1)/9)t$, $b^*_o(x_1) = (4(9 - 2x_1)/9)t$, and $b^*_n(x_1) = ((9 - 2x_1)/3)t$.

Region III. By the same logic, suppose that $x_1 \in (\frac{4}{5}, 1]$, then $a^*_n(x_1) < w^*_{a2}(x_1)$, i.e., retailer A's poaching price in Region II is lower than the second-period wholesale price, which is a dominated strategy. Thus, retailer A sets $a^*_n(x_1) = w_{a2}(x_1)$ and retailer B sets $b^*_o(x_1) = w_{a2}(x_1) + t(2x_1 - 1)$ such that the consumer at x_1 is indifferent between staying with B and switching to A, i.e., $x_1 = x^*_b(x_1)$. The first-order condition gives the second-period retail prices in A's turf: $a^*_o(x_1) = (2x_1 + 1) \cdot t/3 + (2w_{a2} + w_{b2})/3$, $b^*_n(x_1) = (4x_1 - 1)t/3 + (w_{a2} + 2w_{b2})/3$. Applying first-order conditions on manufacturers' second-period wholesale prices, we obtain $w^*_{a2}(x_1) = ((2x_1 + 7)/3)t$ and $w^*_{b2}(x_1) = ((11 - 2x_1)/3)t$. Plugging the equilibrium values of wholesale prices into the representations of retail prices, we have $a^*_o(x_1) = (4(2x_1 + 7)/9)t$, $a^*_n(x_1) = ((2x_1 + 7)/3)t$, $b^*_o(x_1) = (4(2x_1 + 1)/3)t$, and $b^*_n(x_1) = (2(13 + 5x_1)/9)t$. □

Proof of Lemma 1. We prove this lemma using two claims.

Claim 1. *When only retailers use BBP, a pure-strategy equilibrium exists in Region* II.

Suppose that $x_1 \in (\frac{1}{5}, \frac{4}{5})$; then, the second-period equilibrium in Region II applies. The first-period marginal consumer is at $x_1 = \frac{1}{2} + 9(b_1 - a_1)/(26t) \in (\frac{1}{5}, \frac{4}{5})$, which holds as long as $b_1 - a_1 \in (-13t/15, 13t/15)$. Retailers set first-period retail prices to maximize total profits over two periods. The first-order condition gives that $a^*_1(w_1) = 11t/9 + (35w_{b1} + 152w_{a1})/187$ and $b^*_1(w_1) = 11t/9 + (152w_{b1} + 35w_{a1})/187$, where $w_1 \equiv \{w_{a1}, w_{b1}\}$. The second-order condition is satisfied. We have $b^*_1(w_1) - a^*_1(w_1) = 117(w_{b1} - w_{a1})/187$. For prices to fall into Region II, the condition $b^*_1(w_1) - a^*_1(w_1) \in (-13t/15, 13t/15)$ requires that $w_{b1} - w_{a1} \in (-187t/135, 187t/135)$. In this price region, manufacturers set first-period wholesale prices to maximize profits over two periods. Using first-order conditions, we obtain that $w^*_{a1} = w^*_{b1} = 214t/81$. The second-order condition is satisfied. As a result, the second-period wholesale prices are $w^*_{a2} = w^*_{b2} = 3t/2$, the first-period retail prices are $a^*_1 = b^*_1 = 313t/81$, past-customer retail prices are $a^*_o = b^*_o = 13t/6$, and new-customer retail prices are $a^*_n = b^*_n = 11t/6$. Manufacturers' total profits are $\Pi^*_{wat} = \Pi^*_{wbt} = 671t/324$, retailers' total profits are $\Pi^*_{rat} = \Pi^*_{rbt} = 8t/9$, and channel members' total profits are $\Pi^*_{at} = \Pi^*_{bt} = 959t/324$. The marginal consumers are at $x^*_a = \frac{1}{3}$, $x^*_1 = \frac{1}{2}$, and $x^*_b = \frac{2}{3}$.

We check that neither manufacturers nor retailers have incentives to deviate off-the-equilibrium path, that is, to set prices that result in profit specifications of Regions I and III.

Given that two channels are symmetric, we check manufacturer A's and retailer A's incentives to deviate. Manufacturer B's and retailer B's incentives to deviate are the mirror image of A's. Suppose that retailer A deviates to the price range of Region I, i.e., $x_1 \in [0, \frac{1}{5}]$, which occurs if $b_1 - a_1 \in [-13t/9, -13t/15]$. As $b_1^* = 313t/81$ and $w_{a1}^* = w_{b1}^* = 214t/81$, it requires that $a_1 \in [1{,}916t/405, 430t/81]$. We have $\partial\Pi_{rat}^{\mathrm{I}}/\partial a_1 < 0$ over this region, which implies that retailer A deviates to $\hat{a}_1^{\mathrm{I}} = 1{,}916t/405$ to maximize profit in this region. Retailer A's profit after deviation is $\Pi_{rat}^{\mathrm{I}}(\hat{a}_1^{\mathrm{I}}, b_1^*) = 331t/450 < \Pi_{rat}^{\mathrm{II}}(a_1^*, b_1^*) = 8t/9$. Therefore, retailer A does not have incentives to deviate to Region I. Now, suppose that retailer A deviates to the price range of Region III, i.e., $x_1 \in [\frac{4}{5}, 1]$. It occurs when $b_1 - a_1 \in [13t/15, 13t/9]$, which requires that $a_1 \in [196t/81, 1{,}214t/405]$. Then, $\partial\Pi_{rat}^{\mathrm{III}}/\partial a_1 = 0$ gives that $\hat{a}_1^{\mathrm{III}} = 232t/81$. Retailer A's profit after deviation is $\Pi_{rat}^{\mathrm{III}}(\hat{a}_1^{\mathrm{III}}, b_1^*) = 13t/18 < \Pi_{rat}^{\mathrm{II}}(a_1^*, b_1^*) = 8t/9$. Therefore, retailer A does not have incentives to deviate to Region III.

Suppose that manufacturer A deviates to the price range of Region I, i.e., $w_{b1} - w_{a1} = [-187t/81, -187t/135]$ so that $x_1^*(w_{a1}, w_{b1}) \in [0, 1/5]$. As $w_{b1}^* = 214t/81$, the price range for the deviation to Region I is $w_{a1} \in [1{,}631t/405, 401t/81]$. We have $\partial\Pi_{wat}^{\mathrm{I}}/\partial w_{a1} < 0$ over this region, which implies that manufacturer A deviates to $\hat{w}_{a1}^{\mathrm{I}} = 1{,}631t/405$ to maximize profit in this region. Manufacturer A's total profit after deviation is $\Pi_{wat}^{\mathrm{I}}(\hat{w}_{a1}^{\mathrm{I}}, w_{b1}^*) = 29{,}521{,}223t/50{,}808{,}600 < \Pi_{wat}^{\mathrm{II}}(w_{a1}^*, w_{b1}^*) = 671t/324$. Therefore, manufacturer A has no incentive to deviate to Region I. Now, suppose that manufacturer A deviates to the price range of Region III, i.e., $w_{b1} - w_{a1} \in [187t/135, 187t/81]$ such that $x_1^*(w_{a1}, w_{b1}) \in [\frac{4}{5}, 1]$. As $w_{b1}^* = 214t/81$, the price range for the deviation to Region III is $w_{a1} \in [509t/405, t/3]$. For any deviation price $\hat{w}_{a1}^{\mathrm{III}}$ in this region, $x_1^{\mathrm{III}}(\hat{w}_{a1}^{\mathrm{III}}, w_{b1}^*) > 1$. Therefore, manufacturer A cannot deviate to Region III. Thus, neither channel members have incentives to deviate from the equilibrium in Region II, and the equilibrium in Region II exists. ◻

Claim 2. *When only retailers use BBP, a pure-strategy equilibrium does not exist in Region* I *or Region* III.

Given that two channels are symmetric, Regions I and III are a mirror image of each other. We only need to prove that a pure-strategy equilibrium does not exist in Region I. Suppose that $x_1 \in [0, \frac{1}{5}]$. The second-period equilibrium in Region I applies. The first-order condition gives the first-period equilibrium retail prices $a_1^* = 111t/97 + (17w_{a1} + 80w_{b1})/97$ and $b_1^* = 18t/97 + (8w_{a1} + 89w_{b1})/97$. The second-order condition is satisfied. Then, we solve for manufacturers' first-period equilibrium prices using first-order conditions and obtain that $w_{a1}^* = 24{,}466t/23{,}085$ and $w_{b1}^* = 55{,}334t/23{,}085$. This equilibrium does not exist as retailers have incentives to deviate off-the-equilibrium to prices in Region II. To see this, suppose that retailer A deviates to Region II so that $x_1 \in [1/5, 4/5]$, which arises when $b_1 - a_1 \in [-13t/15, 13t/15]$. Given that $w_{a1}^* = 24{,}466t/23{,}085$, $w_{b1}^* = 55{,}334t/23{,}085$, and $b_1^* = 18t/97 + (8w_{a1} + 89w_{b1})/97 = 19{,}024t/7{,}695$, the price range for retailer A to deviate into is $a_1 \in [2{,}471t/1{,}539, 25{,}693t/7{,}695]$. Then, $\partial\Pi_{rat}^{\mathrm{II}}/\partial a_1 = 0$ gives that retailer A's best-response price in this region is $\hat{a}_1^{\mathrm{II}} = 2{,}720{,}399t/1{,}169{,}640$. Retailer A's profit after deviation is $\Pi_{rat}^{\mathrm{II}}(\hat{a}_1^{\mathrm{II}}, b_1^*) = 3{,}955{,}422{,}721t/4{,}000{,}168{,}800 > \Pi_{rat}^{\mathrm{I}}(a_1^*, b_1^*) = 10{,}579{,}241t/13{,}158{,}450$. Therefore, retailer A has incentives to deviate to Region II and the equilibrium in Region I does not exist. ◻

Second-Period Equilibrium Prices in Case 3

Lemma 4. *When both manufacturers and retailers use BBP, the second-period equilibrium prices are*:

(a) Region I: If $x_1 \in [0, 1/10]$: $w_{ao}^*(x_1) = (1 - 4x_1)t$, $w_{an}^*(x_1) = (9 - 10x_1)t/3$, $w_{bo}^*(x_1) = (9 - 8x_1)t/3$, and $w_{bn}^*(x_1) = 0$. $a_o^*(x_1) = (1 - 2x_1)t$, $a_n^*(x_1) = (4t(9 - 10x_1))/9$, $b_o^*(x_1) = (4t(9 - 8x_1))/9$, and $b_n^*(x_1) = 0$. Only retailer A poaches retailer B's customers.

(b) Region II: If $x_1 \in (1/10, 9/10)$: $w_{ao}^*(x_1) = (8x_1 + 1)t/3$, $w_{an}^*(x_1) = (9 - 10x_1)t/3$, $w_{bo}^*(x_1) = (9 - 8x_1)t/3$, and $w_{bn}^*(x_1) = (10x_1 - 1)t/3$. $a_o^*(x_1) = (4t(8x_1 + 1))/9$, $a_n^*(x_1) = (4t(9 - 10x_1))/9$, $b_o^*(x_1) = (4t(9 - 8x_1))/9$, and $b_n^*(x_1) = (4t(10x_1 - 1))/9$. Both retailers poach each other's customers.

(c) Region III: If $x_1 \in [9/10, 1]$: $w_{ao}^*(x_1) = (8x_1 + 1)t/3$, $w_{an}^*(x_1) = 0$, $w_{bo}^*(x_1) = (4x_1 - 3)t$, and $w_{bn}^*(x_1) = (10x_1 - 1)t/3$. $a_o^*(x_1) = (4t(8x_1 + 1))/9$, $a_n^*(x_1) = 0$, $b_o^*(x_1) = (2x_1 - 1)t$, and $b_n^*(x_1) = (4t(10x_1 - 1))/9$. Only retailer B poaches retailer A's customers.

Proof. Region II. Suppose that $x_1 \in (1/10, 9/10)$. Retailers set second-period behavior-based retail prices to maximize second-period profits. If $x_a < x_1 < x_b$, the first-order condition gives that $a_o^*(x_1, w_2') = (2x_1t + t + 2w_{ao} + w_{bn})/3$, $a_n^*(x_1, w_2') = (3t - 4x_1t + 2w_{an} + w_{bo})/3$, $b_o^*(x_1, w_2') = (3t - 2x_1t + w_{an} + 2w_{bo})/3$, and $b_n^*(x_1, w_2') = (4x_1t - t + w_{ao} + 2w_{bn})/3$, where $w_2' \equiv (w_{ao}, w_{an}, w_{bo}, w_{bn})$. The second-order condition holds. Manufacturers set their behavior-based wholesale prices to maximize second-period profits. The first-order condition gives that $w_{ao}^*(x_1) = (8x_1 + 1)t/3$, $w_{an}^*(x_1) = (9 - 10x_1)t/3$, $w_{bo}^*(x_1) = (9 - 8x_1)t/3$, and $w_{bn}^*(x_1) = (10x_1 - 1)t/3$. The second-order condition holds. The marginal consumers are at $x_a^*(x_1) = (1 + 8x_1)/18$ and $x_b^*(x_1) = (9 + 8x_1)/18$. For $x_1 \in (1/10, 9/10)$, it is satisfied that $x_a^*(x_1) < x_1 < x_b^*(x_1)$. Plugging the equilibrium values of wholesale prices into the representations of retail prices, we have $a_o^*(x_1) = (4t(8x_1 + 1))/9$, $a_n^*(x_1) = (4t(9 - 10x_1))/9$, $b_o^*(x_1) = (4t(9 - 8x_1))/9$, and $b_n^*(x_1) = (4t(10x_1 - 1))/9$. Lemma 2 shows that the pure-strategy equilibrium exists in Region II. Therefore, we report the second-period equilibrium prices in Region II in the paper.

Region I. Suppose instead that $x_1 \in [0, 1/10)$. Then, $w_{bn}^*(x_1) < 0$, i.e., manufacturer B's poaching wholesale price in Region II is lower than 0, which is a dominated strategy. Manufacturer B sets $w_{bn}^*(x_1) = 0$ and manufacturer A sets $w_{ao}^*(x_1) = (1 - 4x_1)t$ such that the consumer at x_1 is indifferent between staying with A and switching to B, i.e., $x_1 = x_a^*(x_1)$. The first-order condition gives the second-period wholesale prices in B's turf: $w_{an}^*(x_1) = (9 - 10x_1)t/3$, $w_{bo}^*(x_1) = (9 - 8x_1)t/3$. Plugging the equilibrium values of wholesale prices into the representations of retail prices, we have $a_o^*(x_1) = (1 - 2x_1)t$, $a_n^*(x_1) = (4t(9 - 10x_1))/9$, $b_o^*(x_1) = (4t(9 - 8x_1))/9$, and $b_n^*(x_1) = 0$.

Region III. By the same logic, suppose that $x_1 \in (9/10, 1]$. Then, $w_{an}^*(x_1) < 0$, i.e., manufacturer A's poaching wholesale price in Region II is lower than 0, which is a dominated strategy. Manufacturer A sets $w_{an}^*(x_1) = 0$ and manufacturer B sets $w_{bo}^*(x_1) = (4x_1 - 3)t$ such that the consumer at x_1 is indifferent between staying with B and switching to A, i.e., $x_1 = x_b^*(x_1)$. The first-order conditions give manufacturers' second-period wholesale prices in A's turf. We obtain $w_{ao}^*(x_1) = (8x_1 + 1)t/3$ and $w_{bn}^*(x_1) = (10x_1 - 1)t/3$. Plugging the equilibrium values of wholesale prices into the representations of retail prices, we have $a_o^*(x_1) = (4t(8x_1 + 1))/9$, $a_n^*(x_1) = 0$, $b_o^*(x_1) = (2x_1 - 1)t$, and $b_n^*(x_1) = (4t(10x_1 - 1))/9$. ◻

Proof of Lemma 2. We prove this lemma using two claims.

Claim 3. *When manufacturers and retailers use BBP, a pure-strategy equilibrium exists in Region* II.

Suppose that $x_1 \in (1/10, 9/10)$; then, the second-period equilibrium in Region II applies. The first-period marginal consumer is at $x_1 = \frac{1}{2} + 9(b_1 - a_1)/80 \in (1/10, 9/10)$, which holds as long as $b_1 - a_1 \in (-32t/9, 32t/9)$. Retailers set first-period retail prices to maximize total profits over two periods. The first-order condition gives that $a_o^*(x_1, w_2') = (2x_1 t + t + 2w_{ao} + w_{bn})/3$, $a_n^*(x_1, w_2') = (3t - 4x_1 t + 2w_{an} + w_{bo})/3$, $b_o^*(x_1, w_2') = (3t - 2x_1 t + w_{an} + 2w_{bo})/3$, and $b_n^*(x_1, w_2') = (4x_1 t - t + w_{ao} + 2w_{bn})/3$, where $w_2' \equiv (w_{ao}, w_{an}, w_{bo}, w_{bn})$. The second-order condition is satisfied. $b_1^*(w_1) - a_1^*(w_1) = 90(w_{b1} - w_{a1})/229$. For prices to fall into Region II, the condition $b_1(w_1) - a_1(w_1) \in (-32t/9, 32t/9)$ requires that $w_{b1} - w_{a1} \in (-3{,}664t/405, 3{,}664t/405)$.

Manufacturers set first-period wholesale prices to maximize profits over two periods. Using first-order conditions, we obtain that $w_{a1}^* = w_{b1}^* = 916t/81$. As a result, the second-period wholesale prices are $w_{ao}^* = w_{bo}^* = 5t/3$ and $w_{an}^* = w_{bn}^* = 4t/3$. The first-period retail prices are $a_1^* = b_1^* = 1{,}276t/81$, past-customer retail prices are $a_o^* = b_o^* = 20t/9$, and new-customer retail prices are $a_n^* = b_n^* = 16t/9$. Manufacturers' total profits are $\Pi_{wat}^* = \Pi_{wbt}^* = 1{,}039t/162$, retailers' total profits are $\Pi_{rat}^* = \Pi_{rbt}^* = 401t/162$, and channel members total profits are $\Pi_{at}^* = \Pi_{bt}^* = 80t/9$. The marginal consumers are at $x_a^* = 5/18$, $x_1^* = 1/2$, and $x_b^* = 13/18$.

We check that neither manufacturers or retailers have incentives to deviate off-the-equilibrium path, that is, to set prices that result in profit specifications of Regions I and III. Given that two channels are symmetric, we check manufacturer A's and retailer A's incentives to deviate. Manufacturer B's and retailer B's incentives to deviate are the mirror image of A's. Suppose that retailer A deviates to the price range of Region I, i.e., $x_1 \in [0, 1/10]$, which occurs if $b_1 - a_1 \in [-40t/9, -32t/9]$. As $b_1^* = 1{,}276t/81$, it requires that $a_1 \in [1{,}564t/81, 1{,}636t/81]$. $\partial \Pi_{rat}^{\mathrm{I}}/\partial a_1 < 0$ over this region, which implies that retailer A deviates to $\hat{a}_1^{\mathrm{I}} = 1{,}564t/81$ to maximize profit in this region. Retailer A's profit after deviation is $\Pi_{rat}^{\mathrm{I}}(\hat{a}_1^{\mathrm{I}}, b_1^*) = 4{,}921t/4{,}050 < \Pi_{rat}^{\mathrm{II}}(a_1^*, b_1^*) = 401t/162$. Therefore, retailer A does not have incentives to deviate to Region I. Now, suppose that retailer A deviates to the price range of Region III, i.e., $x_1 \in [9/10, 1]$. It occurs when $b_1 - a_1 \in [32t/9, 40t/9]$, which requires that $a_1 \in [916t/81, 988t/81]$. We have $\partial \Pi_{rat}^{\mathrm{III}}/\partial a_1 > 0$ over this region. Therefore, retailer deviates to $\hat{a}_1^{\mathrm{III}} = 988t/81$ to maximize profit in this region. Retailer A's profit after deviation is $\Pi_{rat}^{\mathrm{III}}(\hat{a}_1^{\mathrm{III}}, b_1^*) = 4{,}921t/4{,}050 < \Pi_{rat}^{\mathrm{II}}(a_1^*, b_1^*) = 401t/162$. Therefore, retailer A does not have incentives to deviate to Region III.

Suppose that manufacturer A deviates to the price range of Region I, i.e., $w_{b1} - w_{a1} = [-3{,}664t/405, -916t/81]$ such that $x_1^*(w_{a1}, w_{b1}) \in [0, 1/10]$. As $w_{b1}^* = 916t/81$, the price range for the deviation to Region I is $w_{a1} \in [1{,}832t/81, 916t/45]$. However, $x_1^{\mathrm{I}}(\hat{w}_{a1}^{\mathrm{I}}, w_{b1}^*) < 0$ for prices in this region. Therefore, manufacturer A cannot deviate to Region I. Now, suppose that manufacturer A deviates to the price range of Region III, i.e., $w_{b1} - w_{a1} \in [3{,}664t/405, 916t/81]$ such that $x_1^*(w_{a1}, w_{b1}) \in [9/10, 1]$. As $w_{b1}^* = 916t/81$, the price range for the deviation to Region III is $w_{a1} \in [0, 916t/405]$. For any wholesale prices $\hat{w}_{a1}^{\mathrm{III}}$ that manufacturer A deviates to in this region, $x_1^{\mathrm{III}}(\hat{w}_{a1}^{\mathrm{III}}, w_{b1}^*) > 1$. Therefore, manufacturer A cannot deviate to this region. Thus, neither channel members have incentives to deviate from the equilibrium in Region II, and the equilibrium in Region II exists. □

Claim 4. *When manufacturers and retailers use BBP, a pure-strategy equilibrium does not exist in Region* I *or Region* III.

Given that two channels are symmetric, Region I and Region III are a mirror image of each other. We only need to prove that a pure-strategy equilibrium does not exist in Region I. Suppose that $x_1 \in [0, 1/10]$. The second-period equilibrium in Region I applies. The first-order condition gives the first-period equilibrium retail prices $a_1^* = 96{,}676t/13{,}041$ and $b_1^* = 65{,}782t/13{,}041$. The second-order condition is satisfied. Then, we solve for manufacturers' first-period equilibrium prices using first-order conditions and obtain that $w_{a1}^* = 257{,}902t/39{,}123$ and $w_{b1}^* = 110{,}708t/39{,}123$. This equilibrium does not exist as manufacturers and retailer B have incentives to deviate off-the-equilibrium to prices in Region II. We only need to show that one channel member has incentives to deviate. Suppose that retailer B deviates to Region II so that $x_1 \in (1/10, 9/10)$, which arises when $b_1 - a_1 \in (-32t/9, 32t/9)$. Given that $w_{a1}^* = 257{,}902t/39{,}123$, $w_{b1}^* = 110{,}708t/39{,}123$, and $a_1^* = 96{,}676t/13{,}041$, the price range for retailer B to deviate into is $b_1 \in (50{,}308t/13{,}041, 143{,}044t/13{,}041)$. Then, $\partial \Pi_{rbt}^{\mathrm{II}}/\partial b_1 = 0$ gives that retailer B's best-response price in Region II is $\hat{b}_1^{\mathrm{II}} = 30{,}513{,}244t/4{,}160{,}079$. Retailer B's profit after deviation is $\Pi_{rbt}^{\mathrm{II}}(\hat{b}_1^{\mathrm{II}}, a_1^*) = 30{,}687{,}672{,}871t/12{,}055{,}908{,}942 > \Pi_{rbt}^{\mathrm{I}}(b_1^*, a_1^*) = 30{,}779{,}089t/18{,}896{,}409$. Therefore, retailer B has incentives to deviate to Region II and the equilibrium in Region I does not exist. □

Endnotes

[1] We envision the non-channel setting as a channel with vertically centralized manufacturers and retailers. In this sense, we consider decentralized channels in this paper.

[2] Though the replacement cycle for cars could be long, the prevalence of switching discounts that car makers and dealers advertise makes it easier for consumers to recognize that future prices depend on their current purchase decisions. As manufacturers in more industries with shorter replacement cycles adopt BBP, there is a wider range of situations in which the rational-expectation assumption applies.

[3] As the motivating examples illustrate, manufacturers use BBP when the competitor faces difficulties (e.g., scandal, bankruptcy). Indeed, we find that it is more profitable for manufacturers to use BBP when their competitor faces a major difficulty. Thus, it is feasible for manufacturers to use BBP in a channel's setting. Our main model assumes symmetric firms to show that BBP is generally profitable even without asymmetric manufacturers as long as manufacturers and retailers use BBP (for the detailed analysis, see Section A-1.2 in the online appendix).

[4] Alternatively, we could use $\delta_c \in [0, 1]$ to denote the degree to which consumers consider or discount future prices and utilities. If $\delta_c = 1$, consumers are strategic, forward looking, and weigh the second-period prices and utilities as much as they weigh first-period prices and utilities. If $\delta_c = 0$, consumers are myopic and do not know or care about future prices (Villas-Boas 1999, Chen and Zhang 2009). As δ_c increases (i.e., consumers become more strategic), they are less sensitive to first-period prices. As a result, first-period prices and channel members' profits increase. Our main result that channel members' profits are higher with wholesale and retail BBP holds as long as $\delta_c \geq 0.34$ (i.e., consumers are not too short-sighted).

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