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International Manufacturer’s Online Marketplace Choice Considering Behavior-Based Pricing
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Abstract: Considering the fact that the phenomenon of consumer behavior-based pricing (BBP) is becoming more prominent in global online sales, an international online channel decision-making model composed of an e-commerce firm and a manufacturer is established. The e-commerce firm is the leader, while the manufacturer is the follower. This study analyzes the decision-making problems in two cases. The first case happens when an international manufacturer establishes its own online-selling website. The second case uses the e-commerce firm’s online-selling platform. We make a horizontal and vertical comparison of equilibrium decision-making for these two participants, respectively. We examine how the manufacturer makes choices and how the e-commerce firm makes decisions about the referral fee rate and franchise fee under the BBP in the international environment. Whether the two players make different decisions between new customers and regular customers is verified. By constructing mathematical models under different channel structures and solving them, and finally, by comparing the equilibrium decisions under different structures and numerical analysis with the help of mathematical software, we have obtained some interesting conclusions. It is found that if the manufacturer establishes its own online-selling website, the e-commerce firm will provide new customers with lower prices than the price for regular customers. At this point, as direct competition forms between the e-commerce platform and the manufacturer, this allows the platform to offer lower prices to new customers in order to attract more new customers to shop on the platform. The manufacturer would differentiate new customers and regular customers according to the unit selling cost of its own website and consumers’ shopping costs. If the manufacturer uses the online-selling platform of the e-commerce firm, the manufacturer will provide a lower price to new customers; however, the e-commerce firm’s attitude to new and regular customers is affected by the referral fee rate. In addition, when the referral fee rate is reduced and the franchise fee is moderated, or the referral fee rate is moderate, and the franchise fee is reduced, the e-commerce firm will decide to attract manufacturers to sell products on its online platform. The manufacturer will give up establishing its own online-selling website and prefer to sell on the e-commerce firm’s online platform.

Keywords: behavior-based pricing; E-business; online marketplaces; game theory

1. Introduction

Information technology, for example, member management system, online-selling website, and customer login system, has provided more possibilities for enterprises to trace the purchase history information of consumers. Enterprises can distinguish customers that are regular consumers or new consumers through this information [1,2]. In the sales process, enterprises treat new customers and regular customers differently by providing different prices or services and even giving purchase priority to regular customers or restricting the purchase of new customers [3–5]. This behavior-based pricing (BBP) is common in online sales and O2O (Online to Offline refers to the offline operation or offline consumption driven by online marketing or online purchase) [6]; for example, merchants on TMALL and JD offer coupons for first-time customers and DiDi provides a discount for the first-time customers.
customers. However, there are also many enterprises that focus on their regular customers and offer some scales of incentives for repeat purchasers [7]; for example, some styles of Nike shoes are only available to members.

Current studies on behavior-based targeting mainly focus on the pricing decisions of enterprises, especially about enterprises how to make different prices for regular customers and new customers [8–11], and these researches show that enterprises will pay more attention to new consumers and provide them a lower price. Here we study the implication of BBP in an online marketplace setting. In this setting, we investigate the impact of BBP on the profits of channel members, consumer surplus, and social welfare. The main contribution of this paper is showing how BBP influences the manufacturer’s online channel construction strategy and showing how some basic results of existing literature will change. For example, we found that when the referral fee rate is low and the franchise fee is moderate, or the referral fee rate is moderate and the franchise fee is low, it can be achieved that the e-commerce platform attracts manufacturers to the platform while the manufacturer is willing to choose to be in the e-commerce platform. This result is quite different from the results of a similar study in a single-stage setting [12].

We were inspired by the operation mode of Amazon and established a two-period game-theoretic model in which a manufacturer competes with an e-commerce firm by selling substitute products. The manufacturer has two options to compete with Amazon [12,13], establishing its own online-selling website and selling on the e-commerce firm’s online-selling platform. As these two members master the purchasing history information about consumers, they will differentiate the regular customers and new customers using that information [1,14]. In an online marketplace, there will be different decisions between using own online-selling website and the e-commerce firm’s website for manufacturers [15,16]. For this reason, we consider two cases. In the first case, the manufacturer establishes its own online-selling website to sell its products. In the second case, the manufacturer will use the e-commerce firm’s online-selling platform to sell its products. The implication of the manufacturer’s option is analyzed, such as the price decisions, profits, consumer surplus, and social welfare of these two members. Furthermore, we extend this model to investigate two situations in which there is a selling cost using the e-commerce firm’s platform and there is a difference in the products sold in the two periods.

We make some key assumptions in our model. The first is that given the huge platform effect of the e-commerce firm’s online-selling platform, we assume that the e-commerce firm is dominant in the market and the manufacturer is the follower. This assumption is consistent with the research of Bakos [17] and Bhargava and Choudhary [18]. The second is that consumers have complete information about two-period pricing, i.e., they have clear information about the two-stage pricing of two members. Some studies on two-period pricing make the same assumption, i.e., Shin and Sudhir [19] and Li [20]. The third is that members sell the same product in the first and second periods; that is, there is no difference in the products sold in different periods (see [21,22]). The last one is that the unit selling cost of products sold on the e-commerce firm’s platform is lower than the unit selling cost of the manufacturer’s own online-selling website. This assumption has been studied by many researchers [18,23]. Without losing generality, we set the unit selling cost of products sold on the e-commerce form’s platform to zero. Note that the results of these studies have proven the validity of this assumption because e-commerce platforms are able to gain more benefits than other firms in their daily operations. These benefits include reduced transaction costs and inventory costs, as well as improved supply chain management [12].

2. Literature Review and Contribution
2.1. Literature Review

Our research is closely related to both BBP and channel construction. Many scholars pay attention to how enterprises differentiate between regular customers and new consumers in pricing. Some of them believe that there are many different factors will affect the rewards of firms to new customers, transfer compensation for first-time purchasing [24,25],
the scale of discount for first-time purchasing [22,26], customers’ switching cost [27], heterogeneity and preference of customers [19], or the customers’ perceptions of unfairness [28]. However, some of the existing research holds that enterprises will reward their regular customers, and this behavior will be affected by some factors, such as whether consumers are high-value or low-value [29] and the cost difference between these two enterprises [30].

Existing research has analyzed how BBP affects firms’ profits and affects the competition in the market under different circumstances. Zhang [31] believes that the use of consumers’ purchases history information to distinguish consumers will harm consumer differences, and the different prices set for regular and new consumers based on the above information make the market competition more intense and she (he) found that forward-thinking companies will consciously hide information about consumers’ purchase histories to mitigate competitive conflicts. In the study of Pazgal and Soberman [21], using BBP will reduce the profits of the two competing enterprises at the same time and will intensify the competition in the first period. However, if a firm can reward more benefits than the other to regular consumers, it will achieve an increasing profit in the second period. In a Stackelberg game setting, Gehrig et al. [32] argue that in the case of horizontal enterprise differentiation, unless the dominant firm was protected by much higher switching costs than its competitor, BBP would not promote that firm’s dominant position but would intensify the competition in the market. In addition, prohibiting price discrimination based on purchasing history usually benefits regular consumers and hurts new customers. Moreover, consumer surplus and firms’ profits using BBP are higher than using a uniform pricing strategy. Shin and Sudhir [19] constructed a two-period monopoly model based on segmenting consumers into high-cost customer groups and low-cost customer groups to examine how a pricing strategy based on customer purchase history information can lead to more demand and revenues. They find that while information based on consumer purchases can help firms increase profits in the second period, it may also reduce firms’ profits over two periods because strategic consumers may delay purchases to avoid higher prices in the future.

Lastly, our research related to the literature on online marketplace choice, which refers to how manufacturers or retailers choose to establish their own online-selling website or use an e-commerce firm’s online-selling platform. Grieger [33] and Wang et al. [34] reviewed the literature on electronic marketplaces. With the continuous development of e-commerce, the research on channel selection has been richer. Bernstein et al. [35] considered a model of how a physical retailer makes a choice between establishing selling-website and aligning with a pure e-retailer. Ru and Wang [36], inspired by the operation mode of Amazon, considered a model in a retailer sales product through Amazon and shares revenue with Amazon. Ryan et al. [12] consider a single retailer that currently sells its product only through its own website but who may choose to contract with Amazon to sell its product through the marketplace system. Karray and Sigue [37] think that in the face of the pressure of the online market, many retailers will also try to build online channels, so they launched relevant discussions. The results show that when the online market is large, retailers should open online channels and set different sales prices for online and offline channels. Chen et al. [38] studied the impact of retailers’ offline discount stores on manufacturers’ direct online channels. The results show that manufacturers should integrate the cost and the threat of retailers’ discount stores to decide whether to open online channels. In the environment of trade-old-for-new, Cao et al. [39] compare the choice of the best channel mode of the retailer under three modes of only online channel mode, only online channel mode, and dual channel mode. The results show that the transportation cost of products and renewal directly affects the choice of channel mode. The online marketplace that we study in this paper is also inspired by the operation mode of Amazon [40], and we construct a two-stage game model between a manufacturer and an e-commerce firm.

In general, existing literature on BBP and online marketplace has achieved fruitful results. However, it is unclear whether the attitude of enterprises towards new and old customers will change or not in the online marketplace situation. In addition, it is also unclear how enterprises change their online marketplace choice under a BBP situation.
2.2. Contribution and Novelty

Although the research on the selection of online channel construction strategy is relatively rich, there is a lack of research on the selection of online channels under the two-stage pricing environment, especially the construction of online channels with BBP. Different from the existing research, this paper makes innovative attempts from the following two aspects: (1) learn from the operation mode of the existing famous e-commerce platforms, introduce the reality that e-commerce platforms provide an online sales platform for franchisees (manufacturers) while selling competitive products into the model, so as to build a competition and cooperation decision-making model between e-commerce platform and the manufacturer; (2) considering the multi-stage characteristics of consumer purchase and the reality that online sales participants distinguish between new and regular customers, this paper discusses how manufacturers choose between establishing online direct channel and entering e-commerce platforms under BBP situation. We have reason to believe that this study will provide some reference for channel construction and will also enrich the research on two-stage pricing and BBP.

The remainder of the paper is organized as follows. In Section 3, we provide a model description and formal problem statement. In Section 4, we provide the research methodology. In Section 5, we provide the empirical results with the comparison between two different online channel structures. In Section 6, we analyze the main results and explain the intuitions. We conclude, in Section 7, with directions for future work.

3. Problem Description

3.1. Basic Setup

We consider the following problem setting. A manufacturer sells goods through its own website (referred to as channel B) and has an option of selling its goods through an online platform (referred to as channel A). Although there are many possible channel structures, in reality, we only consider the case of the manufacturer selling products with the e-commerce platform in the channel A case. In the channel structure B scenario, since the e-commerce platforms considered in this paper are drawn from Amazon, such e-commerce platforms will sell their own products to consumers. These products form a direct competition with the products on the manufacturer’s own website. Therefore, when the manufacturer sells its products to consumers through its own website, the e-commerce platform will sell competing products to consumers on its platform. The e-commerce firm which possesses the online platform will also provide substituting goods for consumers. Consumers are strategic, i.e., they will make the optimal purchase decision according to utility maximization. Assuming that consumers have a heterogeneous valuation of goods, \( v \) and \( \bar{v} \) are uniformly distributed in the interval \([0, 1]\). Consumers are uniformly distributed on a Hotelling line that ranges from 0 to 1, where the e-commerce firm locates at 0, and the manufacturer locates at 1. The location of a consumer on the line represents the consumer’s choice of a certain product. There is a shopping cost \( tx \) if a consumer is located at \( x \) and purchases the e-commerce firm’s products and a shopping cost \( t(1 - x) \) if the consumer purchases the manufacturer’s product, where \( t \) represents the unit shopping cost to the consumer. Denoting \( p_E \) and \( p_M \) as the price for the e-commerce firm’s and the manufacturer’s product, respectively. Thus, consumers will obtain utility \( U_E = v - tx - p_E \) from purchasing the e-commerce firm’s product and obtain utility \( U_M = v - t(1 - x) - p_M \) from purchasing the manufacturer’s product.

We normalize the unit selling cost for the e-commerce firm selling products through its own online platform and for the manufacturer selling products through channel A. However, assuming that there will incur a unit selling cost \( c \) if the manufacturer is selling products through channel B, and the selling cost \( c \) is constant and related to the product amount. This is because of the scale effect, which reduces the unit cost for the e-commerce firm and will lower this cost for the manufacturer. However, a certain portion, \( \alpha \), of the manufacturer’s selling revenue should be paid as a referral fee, and a franchise fee \( F \) in a fixed period should be provided to the e-commerce firm if the manufacturer will provide
the sales product through channel A. Figure 1 depicts the channel structures when the manufacturer sales its products through channel B and channel A respectively.

![Figure 1](image.png)

**Figure 1.** Channel structures under different online marketplace systems.

Given the setting, Figure 1 shows that there are two channel structures that should be considered. We use B to indicate the channel structure in which the manufacturer builds its own e-commerce website selling products and competing with the e-commerce firm’s products, and we use A to indicate the channel structure in which the manufacturer abandons building its own website and sales product through the e-commerce firm’s online platform, and competes with the e-commerce firm.

### 3.2. Sequence of Events and Decisions

Next, we give the timing of the game and the decisions in our model. In the first period, there are three stages. In the first stage, as the dominant player, the e-commerce firm will set its first-period price, which is denoted by \( p_E \). In the second stage, as the follower in the market, the manufacturer will set its first-period price denoted by \( p_M \) according to the decision of the e-commerce firm. Thus, in the third stage, consumers will make their purchase decisions according to the prices decisions which are decided by these two participants in the first and second stages. In the same way, there are three stages in the second period. In the first stage, the e-commerce firm will set its second-period prices for regular customers and new customers, respectively, which are denoted by \( p'_E \) and \( p''_E \). In the second stage, the manufacturer will set its second-period prices for regular customers and new customers, respectively, which are denoted by \( p'_M \) and \( p''_M \). In the third stage, consumers will decide whether to move and purchase another participant’s products or buy the original participant’s products based on the prices for regular customers and new customers from the e-commerce firm and the manufacturer in the first two stages. In our model, we assume that the e-commerce firm is the dominant player. This is a realistic assumption because the e-commerce firm has set its price and sold its products before the manufacturer decides to use channel A. Thus, it is perfectly in line with our decision sequence in different stages.

### 4. Research Methodology

Manufacturer has two choices to sell their products, using channel A and channel B. We first analyze the choice that manufacturer uses channel B with BBP. The biggest difference between the two choices is whether manufacturer has to pay fees to e-commerce firm.

#### 4.1. Manufacturer Uses the Channel B

Considering the previous description about manufacturer selling products through channel B, which manufacturer will build its own online selling website to compete with the e-commerce firm’s online platform. It is a two-period game between manufacturer and the e-commerce firm; we use backward to solve this game problem.

#### 4.1.1. The Second Period

In the second period, consumers will decide whether to still buy the e-commerce firm’s products or move to buy the manufacturer’s products. She will decide to still buy the e-commerce firm’s product if \( v - tx_E - p'_E > v - t(1 - x_E) - p'_M \) and moves to buy the manufacturer’s product if \( v - tx_E - p'_M < v - t(1 - x_E) - p'_E \).
Thus, we can figure out the location of the marginal consumer who is indifferent but still buys the e-commerce firm’s product and moves to buying the manufacturer’s product, using $x_{E}$ to indicate this location. Then we have $v - tx_{E} - p_{E}^{*} = v - t(1-x_{E}) - p_{M}^{n}$. The left-hand side of this equation is the utility of still buying the e-commerce firm’s product at the repeat-customer price $p_{E}^{*}$. The right-hand side is the utility of switching to the manufacturer’s product at the new-customer price $p_{M}^{n}$.

Similarly, the marginal consumer locates at $x_{M}$ is indifferent between still buying the manufacturer’s product and switching to buying the e-commerce firm’s product. We therefore write $v - tx_{M} - p_{E}^{*} = v - t(1-x_{M}) - p_{M}^{n}$. In the second period, these two participants’ profit functions are given by $\Pi_{E2}$ and $\Pi_{M2}$.

Where $x$ indicates that consumers located in $[0, x)$ will purchase the e-commerce firm’s product, and consumers located in $(x, 1]$ will purchase the manufacturer’s product in the first period. Using first-order conditions, we obtain the second prices for regular customers and new customers; second-order conditions are also satisfied. Prices are given by $p_{E}^{n}(x)$, $p_{M}^{n}(x)$.

4.1.2. The First Period

The marginal consumer at $x$ will make a trade-off between purchasing the e-commerce firm’s product and the manufacturer’s product in the first period, and the trade-off is made according to maximizing total utilities over two periods. Thus, there are two choices for a consumer switching her purchase decision: (1) purchasing the e-commerce firm’s product in the first period at price $p_{E}$ and switching to buying the manufacturer’s product at the new-customer price $p_{M}^{n}$ in the second period; (2) purchasing the manufacturer’s product at price $p_{M}$ in the first period and switching to buy the e-commerce firm’s product at the new-customer price $p_{E}^{n}$ in the second period. We can write that

$$v - tx - p_{E} + [v - t(1-x) - p_{M}^{n}] = v - t(1-x) - p_{M} + (v - tx - p_{E}^{*})$$

(1)

Consistent with the BBP literature [19,20,25], we can use $p_{E}^{n}(x)$ and $p_{M}^{n}(x)$ as consumer’s rational expectations in the second period. Thus, substituting $p_{E}^{n}(x)$ and $p_{M}^{n}(x)$ for $p_{E}^{*}$ and $p_{M}^{*}$ in Equation (1). We have $x = \frac{1}{2} - \frac{t}{c_{E}(p_{E}-p_{M})}$. The manufacturer and e-commerce firm will make an optimal price in the first period to maximize its over two periods. The profit functions of these two participants are given by $\Pi_{E}^{n}$ and $\Pi_{M}^{n}$.

Lemma 1 summarizes the Stackelberg game equilibrium outcomes (for detailed proof, see the Appendix A.1).

**Lemma 1.** If the manufacturer uses channel B to compete with the e-commerce firm under BBP, there exists a unique equilibrium for this case. (Please refer to the Appendix A.1 for details).

4.2. Manufacturer Uses the Channel A

We next consider the setting in which the manufacturer decides to sell at the e-commerce firm’s online platform but does not build its own online selling website. We want to know how would the equilibrium outcomes of the participants change compared to Section 4.1 if they also used BBP. Similarly, the analysis will be shown in two periods, respectively.

4.2.1. The Second Period

We use the same notation to indicate the marginal consumer’s locations in Section 4.1. Obviously, the specific expression of $x_{E}$ and $x_{M}$ are same as the second-period expressions in Section 4.1. Thus, the profit functions of the manufacturer and the e-commerce firm will change to $\Pi_{E}^{n}$ and $\Pi_{M}^{n}$. Similarly, using first-order conditions, we obtain the second prices for regular customers and new customers; second-order conditions are also satisfied (detailed proof can be found in Appendix A.1). Prices are given by $p_{E}^{n}(x)$, $p_{M}^{n}(x)$.
4.2.2. The First Period

Using the logic which is same as in Section 4.1, we can figure out the location of the marginal consumers in the first period, \( x \). Substituting \( p^{An}_{E}(x) \) and \( p^{An}_{M}(x) \) for \( p^{n}_{E} \) and \( p^{n}_{M} \) in e-commerce platform’s profit functions Equation in channel B, we can write
\[
x = \frac{1}{2} + \frac{\alpha t - (2-\alpha)(p_{E} - p_{M})}{\eta t}.
\]
Similarly, when manufacturer uses channel A to sell its product, two participants’ profit functions over two periods are given by \( \Pi^{A}_{E} \) and \( \Pi^{A}_{M} \). Lemma 2 summarizes the equilibrium outcomes (for detailed proof, see the Appendix A.2).

**Lemma 2.** If the manufacturer uses channel A to compete with the e-commerce firm under BBP, there exists a unique equilibrium for this case. The equilibrium prices are as follows (superscript A refers to the manufacturer’s use of channel A, and superscript r and n refer to the regular consumer and new customer in the second period, respectively):

5. Empirical Results

There are some results will be obtained by comparing the equilibrium outcomes in Sections 4.1 and 4.2

**Proposition 1.** The e-commerce firm will provide a lower price to new-customer than the price to regular-customer if the manufacturer uses channel B. However, the manufacturer will provide a lower price to new-customer than the price to regular-customer if it uses channel A.

The BBP literature shows that retailer will rewards new customers by providing a lower price than the price that regular customers should pay in a typical BBP setting [19,27,30]. Proposition 1 provides a different insight about BBP in the online marketplace; the e-commerce firm and the manufacturer will reward the new customers by offering a lower price in different online marketplace systems. It is possible that they will simultaneously reward the new customers in a certain online channel structure, but it will be subject to some factors. For example, it will be subject to the consumer’s shopping cost if the manufacturer uses channel B and be subjected to the referral fee if the manufacturer uses channel A. When the manufacturer uses channel B, it will reward new customers by offering a lower price if consumers’ shopping costs and the manufacturer’s selling costs in channel B are small simultaneously. In this case, the competition between the e-commerce firm and the manufacturer is more equal, and it is difficult for the e-commerce firm to affect the manufacturer’s price decision by the referral fee rate, and a small shopping cost for the consumer means a lower switch cost. Thus, it is more likely to change the demand by rewarding new consumers. However, when the manufacturer uses channel A, the e-commerce firm will reward new customers at a lower price if the referral fee rate is large. It is because when the manufacturer adopts channel A, its price will be affected by the referral fee rate, and the price for regular customers with increase with the referral fee rate (\( \partial p^{n}_{M}/\partial \alpha > 0 \)); the e-commerce firm can then offer lower prices to attract more new customers to shift their demand.

The previous analysis demonstrates that BBP has a different influence on the online marketplace and the traditional channel. This result is the opposite of the finding in the BBP literature that retailers or manufacturers will reward new customers by offering a lower price [5]. Next, we investigate the difference between the first period and the second period.

**Proposition 2.** When the manufacturer uses channel A, the prices of the manufacturer and the e-commerce firm in the second period will be simultaneously lower than those in the first period.

Proposition 1 shows the difference between the price for a regular customer and a new customer in the second period and indicates that participants will reward new customers according to the channel structure. Proposition 2 shows the difference between the price in the first period and the price in the second period and indicates that the manufacturer and the e-commerce firm will reward consumers by offering lower prices in the second period.
if the manufacturer uses channel A. Thus, it is clear that not only will the participants’ attitudes to the regular customers and new customers be affected by the channel structure, but the prices in different periods will also be affected. It is interesting that although the two participants set a lower price in the second period than in the first period, the resulting demands have different changes. The e-commerce firm will obtain an increasing demand in the second period due to decreasing its second prices for regular customers and new customers. However, the manufacturer’s demand will reduce in the second period if it provides lower prices for regular customers and new customers. It is because the e-commerce firm will provide a higher price than the manufacturer in the first period, but the demand change caused by the e-commerce firm’s price decisions will exceed the demand change caused by the manufacturer’s price decision in the second period.

In contrast, the price changes in the two periods of the manufacturer using channel B are more complex. Only when the consumer’s shopping cost is small \((0 < t < 37/139)\), and the unit sales cost under the situation that the manufacturer uses its own online-selling website is small \((0 < c < 139t/37)\) at the same time, or the consumer’s shopping cost is high \((37/139 < t < 1)\), the two participants will reduce its prices for regular customers and new customers in the second period. Thus, we can know that if participants simultaneously establish their own online-selling websites, they should try their best to collect information on consumers’ shopping costs to provide a reference for the price decision in the second period. In addition, they can even adjust the price decision by changing the shopping cost of consumers, such as providing convenient transportation conditions for consumers.

Proposition 2 shows the price difference of each participant between two periods in different online marketplace systems. To a great extent, these price decisions will decide the profits difference, which is shown in Proposition 3.

**Proposition 3.** BBP can only increase the second-period profits of two participants if consumers’ shopping cost is sufficiently small and the cost of the manufacturer’s unit selling cost using its own online-selling website is sufficiently high when the manufacturer uses channel B; However, BBP will decrease the second-period profits when the manufacturer uses the channel A.

The literature does not discuss the impact of BBP on the profits in different periods; they only analyzed the influence of using BBP on firms’ whole profits in two periods. This result provides new insights from two aspects. First, it shows that firms should pay attention to different factors to discriminate between regular customers and new customers in certain online marketplace systems. Firms should realize that BBP does not certainly improve the profits in the second period. When the manufacturer uses channel B, the e-commerce firm will obtain more profit in the second period than that in the first period if and only if the parameters satisfy \(0 < t < 7/15\) and \(15t/7 < c < 1\), the manufacturer will obtain more profit in the second period than that in the first period if and only if the parameters satisfy \(0 < t < (40\sqrt{3014} - 693)/6589\) and \((693 + 40\sqrt{3014})t/659 < c < 1\). Obviously, firms in online marketplace prefer a relatively small consumer’s shopping cost and a relatively large unit selling cost for manufacturer sales products on its own website. For this reason, firms have incentives to reward customers in the second period by offering discounts, and the manufacturer has a lower pressure to cut its unit selling costs for its own website. If the condition is to require a relatively small cost for the manufacturer, it should try its best to reduce cost when using BBP in the second period. Otherwise, it is better to carry out the competition in the first period.

Secondly, firms should not compete on channel A under the situation of BBP. Many firms use BBP to improve their profit or attract customers from competitors, but the fierce competition in the second period makes the above goals not certainly achieved. In our model, two competitors’ profits will reduce in the second period simultaneously, and only the e-commerce firm can increase demand in the second period. Therefore, BBP is not a good choice for the participants in terms of the profit of the second period if they simultaneously compete with each other on the e-commerce firm’s online-selling platform.
Those analyses are based on the comparison in a certain online marketplace system for a participant. We respectively compare the equilibriums with different online marketplace systems to obtain the optimal choices for two participants; the results are shown with Proposition 4–6.

**Proposition 4.** The e-commerce firm will prefer the manufacturer to choose channel $A$ if and only if the parameters satisfy the following sets of conditions:

1. If $0 < c < \hat{c}_1$;
2. If $0 < \alpha < \hat{\alpha}_1$ and $\hat{F}_1 < F < 1$, or $\hat{\alpha}_1 < \alpha < 1$, and:
   a. If $0 < t < \hat{t}_1$ and $\hat{c}_1 < c < \hat{c}_1$,  
   b. If $\hat{t}_1 \leq t < 1$ and $\hat{c}_1 < c < 1$,
3. If $\hat{F}_1 < F < 1$ and $0 < t < \hat{t}_1$ and $\hat{c}_2 < c < 1$.

These conditions are derived from the e-commerce firm’s profit comparison between the manufacturer’s use of channel $B$ and channel $A$. The e-commerce firm’s online marketplace system preference depends on the interaction between the problem parameters, $c$, $t$, $\alpha$, and $F$. Significantly, for a sufficiently small value of the manufacturer’s selling cost, $c$, any range of the other three parameters is possible for the e-commerce firm to lure the manufacturer into using channel $A$. This is because when the cost is low, the manufacturer is more likely to establish its own online-selling website. At this time, the e-commerce firm should attract the manufacturer to use channel $A$ as much as possible. As would be expected, the e-commerce firm will provide three different using fee groups based on the different parameters and conditions to the manufacturer: charging a lower referral fee rate and a larger franchise fee, only charging a larger referral fee rate, or only charging a larger franchise fee. The e-commerce firm will provide a sufficiently small referral fee rate and a sufficiently large franchise fee to the manufacturer if the consumer’s shopping cost is sufficiently small and the unit cost of the manufacturer selling on its own website is moderate, or the consumer’s shopping cost is sufficiently high, and the unit cost of manufacturer selling on its own website is sufficiently large. However, the e-commerce firm will only charge a sufficiently large referral fee rate for the manufacturer if the consumer’s shopping cost is sufficiently small and the unit cost of the manufacturer selling on its own website is moderate or consumer’s shopping cost and the unit cost of manufacturer selling on its own website is sufficiently large. Finally, the e-commerce firm will only charge a sufficiently large franchise fee for the manufacturer if and only if the consumer’s shopping cost is sufficiently small and the net cost of the manufacturer selling on its own website is sufficiently large. It is interesting that a sufficiently small consumer’s shopping cost and a moderate unit cost of the manufacturer selling on its own website have the same influence on the e-commerce firm’s charge for the manufacturer with a sufficiently large consumer’s shopping cost and unit cost of manufacturer selling on its own website. Significantly, the case that the e-commerce firm charges a sufficiently small referral fee rate and charges a sufficiently large franchise fee has the same feasible region as the case that the e-commerce firm charges a sufficiently large referral fee rate.

The above analysis considers the e-commerce firm’s decision based on the assumption that the manufacturer accepts the charge of the e-commerce firm and sells products through the e-commerce firm’s online-selling platform. Next, in Proposition 5, we consider the question of what conditions are satisfied will make the manufacturer choose to sell products through channel $A$. 
Proposition 5. The manufacturer will choose to use channel A if and only if the parameters satisfy the following sets of conditions:

1. If $0 < \alpha < \tilde{\alpha}_2$ and $0 < F < \tilde{F}_1$, and:
   a. If $0 < t < \tilde{t}_2$ and $0 < c \leq \tilde{c}_1$,
   b. If $\tilde{t}_2 \leq t < 1$.

2. If $\tilde{\alpha}_1 < \alpha < \tilde{\alpha}_2$ and $0 < F < \tilde{F}_1$, and:
   a. If $0 < t \leq \tilde{t}_1$ and $\tilde{c}_1 < c < \tilde{c}_2$,
   b. If $\tilde{t}_1 < t < \tilde{t}_2$ and $\tilde{c}_1 < c < 1$.

These results are derived from the manufacturer’s profits comparison between it uses channel B and channel A. One interesting observation from this Proposition is that there are two possibilities for the manufacturer to sell products through channel A; one is the e-commerce firm charges a sufficiently small referral fee rate and franchise fee; the other is to charge a moderate referral fee rate and a sufficiently small franchise fee. It is clear that no matter how other conditions change, if the e-commerce firm wants the manufacturer to sell products through channel A, it must guarantee a sufficiently small franchise fee. This finding is consistent with reality. It is because the manufacturer needs to pay a fixed franchise fee regardless of its sales revenue on the e-commerce firm’s online-selling platform. At this time, the franchise fee is equivalent to the sunk cost of the manufacturer. If the franchise fee is too high, the manufacturer will give up selling products on the platform for fear of too much investment in the previous period.

Comparing the range of referral fee rates under the two possibilities, it can be seen that although these two possibilities have the same maximum value of the referral fee rate, under certain conditions, the e-commerce firm can appropriately increase the minimum value of the referral fee rate, which will not affect the manufacturer’s decision of using the channel A, and, in the situation of the e-commerce firm increasing the minimum value of referral fee rate, a sufficiently small consumer’s shopping cost and a moderate manufacturer’s selling cost using its own online-selling website has the same role as that of a moderate consumer’s shopping cost and a sufficiently large manufacturer’s selling cost using its own website.

Proposition 6. The e-commerce firm will prefer the manufacturer to choose channel A, and the manufacturer will choose to use channel A if and only if the parameters satisfy the following sets of conditions:

1. If $0 < \alpha < \tilde{\alpha}_2$ and $0 < F < \tilde{F}_2$ and $0 < c \leq \tilde{c}_1$.

2. If $0 < \alpha < \tilde{\alpha}_2$ and $\tilde{F}_1 < F < \tilde{F}_2$, and:
   a. If $0 < t < \tilde{t}_2$ and $\tilde{c}_1 < c \leq \tilde{c}_2$,
   b. If $\tilde{t}_2 \leq t < 1$ and $\tilde{c}_1 < c < 1$.

3. If $\tilde{\alpha}_1 < \alpha < \tilde{\alpha}_2$ and $\tilde{F}_1 < F < \tilde{F}_2$, and:
   a. If $0 < t < \tilde{t}_1$ and $\tilde{c}_2 < c < \tilde{c}_3$,
   b. If $\tilde{t}_1 < t < \tilde{t}_2$ and $\tilde{c}_2 < c \leq 1$.

4. If $\tilde{\alpha}_2 < \alpha < \tilde{\alpha}_3$ and $0 < F < \tilde{F}_2$, and:
   a. If $0 < t < \tilde{t}_1$ and $\tilde{c}_1 < c < \tilde{c}_3$,
   b. If $\tilde{t}_1 < t < 1$ and $\tilde{c}_1 < c < 1$. 
Deriving these results should compare these two participants’ profits in different cases, ensuring that the profits of the two participants in the case the manufacturer uses channel A are at least equal to the profits in the case of the manufacturer using channel B. Obviously, there are four charge possibilities that make the e-commerce firm attracts the manufacturer to sell products through channel A, and the manufacturer chooses to use channel A simultaneously. Firstly, it requires a relatively small referral fee rate and a relatively small franchise fee if the unit selling cost of the manufacturer’s own onlineselling website. This result is different from the decision space of the e-commerce firm in Proposition 4 because the e-commerce firm needs to ensure that the fees charged for the manufacturer are relatively small to attract it to use channel A. Secondly, a relatively small referral fee rate and a moderate franchise fee are required. This possibility has the same franchise fee space as the third possibility, which requires a relatively moderate referral fee rate and a moderate franchise fee. The difference in the referral fee rate space is due to the different range of other parameters in their respective conditions. For example, if the minimum value of the referral fee rate is changed, the consumer’s shopping cost and the unit selling cost of the manufacturer’s online-selling website need to be changed simultaneously to attract two participants. Finally, the last possibility has the same franchise fee space as the first one, but it simultaneously requires a moderate referral fee rate.

According to the results of Proposition 4–6, it should be pointed out that whether the manufacturer decides to use channel A or the e-commerce firm decides to attract the manufacturer to sell products through channel A, the pros and cons of the decision should be measured under the existing market conditions. These market conditions include the consumer’s shopping costs and the unit selling cost of the manufacturer’s own online-selling website. Moreover, in some cases, participants can change the relevant market conditions to achieve their own decisions.

The previous analysis shows that there is no dominant online marketplace system for the whole channel system for the manufacturer and the e-commerce firm if these two online systems adopt BBP. Then, we respectively compare the consumer surplus, producer surplus, and social welfare. Using $\Delta CS = \sum_{i=M, E} CS_i^A - \sum_{i=M, E} CS_i^B$ denote the consumer surplus difference between the manufacturer uses channel A and uses channel B, and the implication is provided in Figure 2a. Using $\Delta \Pi = \sum_{i=M, E} \Pi_i^A - \sum_{i=M, E} \Pi_i^B$ denote the producer surplus difference between the manufacturer uses channel A and uses channel B, and the implication is provided in Figure 2b. In order to make our study more realistic, we use realistic data in the subsequent numerical analysis part to validate the results or develop the analysis as much as possible. For example, based on the information of the referral fee rate $\alpha$ charged to companies that have moved in published on the official website of Amazon, we set the range of the referral fee rate $\alpha$ at [2–15%].

![Figure 2](image.png)

Figure 2. The consumer surplus difference (a) and producer surplus difference (b) of two online marketplace systems.
Figure 2a indicates that there is a higher consumer surplus for the manufacturer using channel B than using channel A. It is because the price competition in the case of the manufacturer using channel B is more intense than it is using channel A. It is interesting that the consumer surplus difference between these two online marketplace systems will increase with the cost of the consumer’s shopping, but it will not significantly change with the referral fee rate. This is because the change in the consumer’s shopping cost will affect the prices of two participants to a great extent, while the influence of the referral fee rate on the prices is not significant compared with the consumer’s shopping cost. According to Figure 2a, it can be seen that the variation of the difference in consumer surplus under different channel structures ranges from $-0.95$ to $-0.07$. The above difference is minimized when the consumer’s shopping cost $t$ is sufficiently small. Figure 2b shows that, for the whole online marketplace, although the manufacturer using channel B will produce a higher consumer surplus, it will produce a lower producer surplus than using channel A. In addition, with the increase in the consumer’s shopping cost and referral fee rate, the difference in producer surplus between manufacturers using channel A and using channel B will gradually increase. Therefore, from the perspective of the whole online system, the manufacturer using channel A is better than using channel B. However, it is different from the change of consumer surplus; although producer surplus difference will increase with consumer’s shopping cost, the change in the referral fee rate will be affected by the cost of consumer’s shopping. Specifically, with the gradual increase in the consumer’s shopping cost, the impact of the referral fee rate on the difference in producer surplus is also increasing. In contrast, the variation of the producer surplus difference under different channel structures ranges from 0.1 to 1.1. Moreover, the difference is minimized only when the consumer shopping cost $t$ is sufficiently small and maximized only when the consumer shopping cost $t$ is sufficiently large, and the referral fee rate $\alpha$ of the e-commerce platform is sufficiently small.

Using $\Delta SW = \sum SW^A - \sum SW^B$ denotes the social welfare difference between the manufacturer using channel A and using channel B, and the implication is provided in Figure 3a, b shows the different changes from the viewpoint of the referral fee rate.

![Figure 3. Comparison of social welfare in high fee rate (a) and low fee rate (b).](image)

Figure 3 indicates that the social welfare of manufacturer uses channel A is not necessarily better than that of manufacturer uses channel B. Only when consumer’s shopping cost is relative large and the referral fee rate is relative large, the social welfare of manufacturer using channel A is higher than that of uses channel B (Figure 3a). It is noteworthy that the manufacturer uses channel A will produces higher social welfare if referral fee rate is high (i.e., $\alpha > 8\%$) and uses channel B will derives higher social welfare if referral fee rate is low (i.e., $\alpha < 8\%$) (Figure 3b). In addition, the impact of the referral fee rate on the social welfare difference between the two online marketplace systems becomes profounder.
with the increase of the consumer’s shopping cost. This is similar to the change of producer surplus difference between these two online marketplace systems.

6. Discussion of the Main Results

The main findings of this study have well solved the key problems we mentioned at the beginning, thus providing relevant management enlightenment:

Will the strategy of the manufacturer and e-commerce platform to treat new and regular customers change due to the change in online channel structure? The study found that the manufacturer and the e-commerce platform will change their attitudes towards new and regular customers due to different online channel modes. For example, when the manufacturer builds its own online direct channel, the e-commerce platform will provide a more favorable price for new customers. At this time, the manufacturer treats new and regular customers depends on the specific situation; when the manufacturer enters the e-commerce platform, the manufacturer will provide more favorable prices for new customers, and the e-commerce platform will decide how to treat new and old customers differently according to the referral rate. It can be seen that how competitors treat new and regular customers differently in the online sales environment needs not only to be determined according to costs and other factors but also to consider the competitive structure of the entire online market, especially the structural mode of the online channel. The e-commerce platform can affect the manufacturer’s online channel mode choice by treating new and regular customers differently, and affect the manufacturer’s channel mode choice by adjusting the referral rate, thus affecting the manufacturer’s attitude towards new and regular customers. What manufacturers need to do is understand how to make decisions based on the e-commerce platform.

Which online channel mode will manufacturers choose? How should e-commerce platforms formulate introduction rates and franchise fees to attract manufacturers to join? Our analysis suggests that the e-commerce platform will comprehensively change the referral rate and franchise fee to attract manufacturers, such as a higher referral rate and lower franchise fee or lower referral rate and higher franchise fee, while the manufacturers will enter the e-commerce platform due to lower franchise fee and lower referral rate. However, there is a certain choice scope for the e-commerce platform to attract the manufacturer to enter at the same time, such as a moderate referral rate and small franchise fee or small referral rate and moderate franchise fee. It can be seen that under the two-stage pricing decision, the cost selection of the e-commerce platform directly determines the entry of the manufacturer. The e-commerce platform can adjust the relevant fees to achieve the purpose of letting manufacturers enter or not. For the manufacturer, although it can only make its own decisions based on the e-commerce platform, it can affect the cost choice of the e-commerce platform by improving its own operating efficiency. When the manufacturer’s cost is low enough, the e-commerce platform will be motivated to attract them.

7. Conclusions and Future Work

The development of information technology has made it easier for enterprises to gather consumers’ purchase history information, thus making another advantage of online-selling has gradually emerged. Enterprises will decide how to treat new and regular customers differently according to their own conditions and external competitive environment. Considering the fact that enterprises pay more and more attention to distinguishing new and regular customers in the online-selling environment, this paper studies the manufacturer’s online channel construction strategy based on BBP and focuses on how manufacturers choose between establishing their own online-selling website and using the online-selling platform of the e-commerce firm.

There are many limitations in this study. For example, e-commerce platforms have a higher market position relative to many manufacturers or are the dominant players in the market relative to manufacturers. This paper does not consider the existence of this possibility. Furthermore, in reality, not all firms distinguish between new and existing
customers, which in turn can have a direct impact on competition. This paper considers the existence of only some of these cases. Thus, we point out several directions for future research. First, consider a situation with different power structures of the participants. Not all manufacturers are dominated by e-commerce firms, and the presence of powerful manufacturers cannot be ignored. Thus, the situation where the manufacturer is the leader and the two players have power parity can be analyzed to study the impact of players’ power structures on manufacturers’ online channel choice strategy. Second, consider a situation where a player does not distinguish between new and regular customers. Not all firms treat new and regular customers differently, so it is possible to analyze separately whether the manufacturer or e-commerce firm uses BBP or not and examine how whether participants distinguish between new and regular customers will influence the manufacturer’s online channel choice strategy. Finally, we believe that it is interesting to model the asymmetric information sharing of the two parties.

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Appendix A
Appendix A.1 Proof of Lemma 1

Since the participants use BBP, we solve the two periods backwards.

Firstly, we solve the second period. Since the manufacturer is the follower in the game, we derive the second-order Hessian matrix about the price $p^r_M$ and $p^n_M$ for the manufacturer’s profit function in equation $\prod_{M2} = (p^r_M - c)(1 - x_M) + (p^n_M - c)(x - x_E)$. Thus, we can write

$$H(p^r_M, p^n_M) = \begin{bmatrix} -1/t & 0 \\ 0 & -1/t \end{bmatrix}$$

Obviously, the profit function in equation $\prod_{M2} = (p^r_M - c)(1 - x_M) + (p^n_M - c)(x - x_E)$ is a joint concave function of the two prices, $p^r_M$ and $p^n_M$. It means that there is a unique equilibrium solution to make the profit function optimal. Next, we respectively derive the manufacturer’s profit function with respect to $p^r_M$ and $p^n_M$, and simultaneously set them equal to zero. Solving the equations set about two prices, \( \frac{\partial \prod_{M2}}{\partial p^r_M} = 0, \quad \frac{\partial \prod_{M2}}{\partial p^n_M} = 0 \), we can obtain the reaction function of the manufacturer. It is given by

$$p^r_M = \frac{t + c + p^n_E}{2}, \quad p^n_M = \frac{c + 2tx - t + p^n_E}{2}$$

Substituting manufacturer’s reaction function into the profit function of the e-commerce firm in equation $\prod_{E2} = x_E p^n_E + (x_M - x) p^r_E$ and derive the second-order Hessian matrix about $p^n_E$ and $p^r_E$. It is given by

$$H(p^n_E, p^r_E) = \begin{bmatrix} -1/2t & 0 \\ 0 & -1/2t \end{bmatrix}$$
Similarly, we can respectively derive the e-commerce firm’s profit function with respect to $p_E^1$ and $p_E^n$, and set them equal to zero. Solving the equations set about two prices, \( \frac{\partial \Pi_{M2}}{\partial p_M} = 0, \quad \frac{\partial \Pi_{E}}{\partial p_E} = 0 \), we can write the optimal price decision of the e-commerce firm in the second period. Thus, we have

\[
p_{E}^{Br}(x) = \frac{c + t + 2tx}{2}, \quad p_{E}^{Bn}(x) = \frac{c + 3t - 4tx}{2}.
\]

It is the price decision of the e-commerce firm in the second period. Substituting this decision into the reaction function of the manufacturer, we can write the price decision of the manufacturer in the second period. It is given by

\[
p_{M}^{Br}(x) = \frac{3c + 5t - 4tx}{4}, \quad p_{M}^{Bn}(x) = \frac{3c + 6tx - t}{4}.
\]

Next, we solve the first period. Substituting $p_{E}^{Br}(x)$, $p_{E}^{Bn}(x)$, $p_{M}^{Br}(x)$, $p_{M}^{Bn}(x)$ into the manufacturer’s profit function over two periods in equation $\Pi_{M}^{1} = (p_{M} - c)(1 - x) + \Pi_{M2}^{2}(x)$, and derive its second-order derivative with respect to the price in the first period $p_{M}$. The result show that the second-order derivative is less than zero, $\frac{\partial^2 \Pi_{M}^{1}}{\partial p_{M}^2} = - \frac{16}{45} < 0$. Thus, we know that there is a unique solution making the manufacturer’s over two periods profit optimal in the first period. We derive the first order derivative with respect to the price $p_{M}$ and let it equal to zero. Resolving the equation, $\frac{\partial \Pi_{M}^{1}}{\partial p_{M}} = 0$, we can obtain the manufacturer’s reactions function in the first period, it is given by

\[
p_{M}^{B}(p_{E}) = \frac{25c + 49t + 2p_{E}}{30}.
\]

Substituting this reaction function into the e-commerce firm’s over two periods profit function in equation $\Pi_{E}^{1} = xp_{E} + \Pi_{E2}^{2}(x)$, then deriving the second order derivative with respect to the first period price $p_{E}$. The result show that the second-order derivative is less than zero, $\frac{\partial^2 \Pi_{E}^{1}}{\partial p_{E}^2} = - \frac{16}{45} < 0$. Therefore, there is a unique solution making the e-commerce firm’s over two periods profit optimal in the first period. Deriving the profit function’s first order derivative with respect to $p_{E}$ and letting the derivative equal to zero, $\frac{\partial \Pi_{E}^{1}}{\partial p_{E}} = 0$. The e-commerce firm’s equilibrium price in the first period is given by $p_{E}^{B} = \frac{16c + 59t}{25}$. Substituting $p_{E}^{B}$ into the manufacturer’s reaction function, we obtain the manufacturer’s optimal price decision in the first period, $p_{M}^{B} = \frac{15c + 28t}{15}$. Lastly, substituting $p_{E}^{B}$ and $p_{M}^{B}$ into the prices decisions in the second period, $p_{E}^{Bn}(x)$, $p_{M}^{Br}(x)$, $p_{E}^{Br}(x)$, $p_{M}^{Bn}(x)$, we can obtain the specific expression of these two participants in the second periods,

\[
p_{M}^{Br}(x) = \frac{27c + 34t}{40}, \quad p_{M}^{Bn}(x) = \frac{69c + 37t}{80}, \quad p_{E}^{Br}(x) = \frac{23c + 39t}{40}, \quad p_{E}^{Bn}(x) = \frac{7c + 11t}{20}.
\]

**Appendix A.2 Proof of Lemma 2**

The method of proof for Lemma 2 is similar to that of Lemma 1. Thus, we will not go into detail here.

The profit functions of the manufacturer and the e-commerce firm will change to

\[
\Pi_{M2}^{1} = (1 - \alpha)(p_{M}^{'}(1 - x_{M}) + p_{M}^{n}(x - x_{E})) - F
\]

\[
\Pi_{E2}^{1} = x_{E}p_{E}^{n} + p_{E}^{n}(x - x_{E}) + \alpha[p_{M}^{'}(1 - x_{M}) + p_{M}^{n}(x - x_{E})] + F
\]

Thus, using the same method in proof of Lemma 1, in the second stage, we have

\[
p_{E}^{Ar}(x) = \frac{(1 + \alpha) + 2tx(1 + \alpha)}{2 - \alpha}, \quad p_{E}^{Bn}(x) = \frac{(3 + 4x - 4\alpha)}{2 - \alpha}, \quad p_{E}^{Br}(x) = \frac{8 - 4x}{4 - 2\alpha}, \quad p_{M}^{An}(x) = \frac{62 - 4x}{4 - 2\alpha}.
\]

Similarly, when manufacturer use channel A selling its product, two participants’ profit functions over two periods are given by
\[ p^A_E = \frac{t(21 + a(9 - 2a))}{2(2 - a)} \quad \text{and} \quad p^A_M = \frac{t(35 - 2a)}{4(2 - a)^2}. \]

Thus, in the first stage, we have
\[ p^{Ar}_E = \frac{t(49 - a(47 + 12a))}{14(2 - a)^3}, \quad p^{Ar}_M = \frac{t(35 - 64a)}{28(2 - a)^2}. \]

**Appendix A.3 Proof of Proposition 1**

Firstly, we respectively compare the equilibrium price for the regular customer and the new customers in the second period for each participant when the manufacturer uses channel B. Thus, according to the equilibrium price, we have
\[ p^B_E - p^E_E = \frac{9c + 17t}{40} > 0, \quad p^B_M - p^E_M = \frac{5l - 3c}{16}. \]

It means that the e-commerce firm will reward a lower price for the new customer. However, the manufacturer’s attitude to the new customers is affected by consumer’s shopping cost and the manufacturer’s unit selling cost through its own online-selling website.

Then, we make a same comparison in the case of the manufacturer uses the channel A. We can write
\[ p^{Ar}_E - p^{An}_E = \frac{(7 + a(2a - 85))t}{14(2 - a)^3}, \quad p^{Ar}_M - p^{An}_M = \frac{(63 + 46a)t}{28(2 - a)^2} > 0. \]

Obviously, the manufacturer will retain the new customer with a lower price than the price to the regular customer. The e-commerce firm will decide to differentiate these two different types consumer according to consumer’s shopping cost and the referral fee rate.

**Appendix A.4 Proof of Proposition 2**

Similarly, we compare the price decision of two participants in two periods. When the manufacturer uses channel B, we have
\[ p^B_E - p^B_E = \frac{139t - 30c}{100}, \quad p^B_M - p^B_M = \frac{207t - c}{100}. \]

Thus, we know that the price in the first period will not certainly larger than the prices to the regular customer and new customer in the second period.

When the manufacturer uses channel A, we have
\[ p^A_E - p^A_E = \frac{(49 + (55 - 5a))t}{7(2 - a)^3} > 0, \quad p^A_E - p^A_M = \frac{5(21 + 5a)t}{14(2 - a)^3} > 0. \]

Thus, the prices in the first period will larger than that in the second period if the manufacturer uses channel A.

**Appendix A.5 Proof of Proposition 3**

Firstly, we compare the whole market profit between two periods in case that the manufacturer uses channel B. We have
\[
\left(\prod_{M2}^B + \prod_{E2}^B\right) - \left(\prod_{M1}^B + \prod_{E1}^B\right) = \frac{13789l^2 + 426ct - 1779c^2}{12800t} \quad \text{(A1)}
\]

Set the Equation (A1) greater than zero, we can figure out the condition which is given by
Then, making a same comparison in the case of the manufacturer uses channel $A$, we have
\[
\left( \frac{\prod_{M_1} A}{\prod_{E_1}} \right) - \left( \frac{\prod_{M_2} A}{\prod_{E_2}} \right) = \frac{t[39837 - 4a(7728 + a(3509 - 24a(120 - a)))]}{1568(2 - a)^2} > 0
\]

\[
0 < t < \frac{1280\sqrt{15} - 213}{13789} \text{ and } \frac{71t}{593} + \frac{1280\sqrt{3}t}{593\sqrt{3}} < c < 1
\]

Appendix A.6 Proof of Proposition 4–6

Due to the complexity of participants’ income expression in different online marketplace systems, it is more complex to compare them. Therefore, we analyze the comparison work with the help of Wolfram Mathematica 12 and Matlab 2016, and obtain the corresponding parameter conditions in Proposition 4–6. If necessary, we can provide the calculation process of mathematical software.

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