**BOPS in Omnichannel Retailing with Return and Cross-selling**

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Abstract—Many retailers have started to integrate online and store channels (such as BOPS) in order to enhance the consumer experience. This paper studies a decision problem of when it is preferable for a dual-channel retailer to introduce BOPS strategy. Based on the utility functions, we develop a model to investigate the interplay between the monopolist retailer and consumers. Our results show that the introduction of BOPS has two aspects of influence: intensifying channel competition and eliminating the effects of cross-selling. Besides, we find that BOPS is not always beneficial to the retailer. Especially for the store, when the impact of cross-selling is too large or too small, introducing BOPS actually damages the store's profit.

Keywords—omnichannel retailing; BOPS; channel competition; cross-selling; return

I. INTRODUCTION

In recent years, the rapid development of e-commerce and IT intelligent devices has motivated more and more consumers to choose online shopping. Therefore, to facilitate consumers, many retailers have added online channels while owning brick-and-mortar stores. In 2011, Darrel Rigby proposed the concept of “omnichannel retailing” [1]. As the name suggests, it refers to retailers interacting with consumers through every possible channel. A 2014 survey reported by Forrester Research shows that Buy-Online-and-Pick-up-in Store (BOPS) is one of the most advantageous modes of omnichannel retailing. BOPS provides consumers with a better shopping experience. Consumers can purchase products online and pick them up in the nearest physical store. They purchase with BOPS will confirm the value of the product before picking it up, and there will be no return later. They don’t like, they can refuse to pick it up without any cost.

Many large retailers have launched BOPS, such as the Japanese casual wear retailer Uniqlo, sporting goods retailers Decathlon, health and beauty retailer Watsons, etc. BOPS has also been concerned by many scholars. Liu and Fan [2] optimize the profits through inventory decision and study the impact of BOPS introduction on retailer demand and profits. Cao et al. [3] study the impact of an “online-to-store” channel on the demand allocations and profitability of a retailer. Yan et al. [4] examine whether retailers should implement a BOPS channel and develop theoretical models to derive the optimal pricing strategy and sales efforts. Shi et al. [5] divide the purchase into two periods, the informed consumers may make pre-orders with unknown valuations in the first period and pick up the pre-orders in store with realized valuations in the second period. Ming et al. [6] develop a theoretical model and derive the optimal BOPS decisions on pricing and recommended radius of the service area. In addition, this similar strategy may have other names. Peng et al. [7] study the “preorder-online, pickup-in-store” (POPU) strategy for dual-channel retailer.

The return problem of online shopping is widespread due to the uncertain value of products. Lei et al. [8] consider supply chain coordination with the returns policy. Chen and Bell [9] examine how a firm that faces customer returns can enhance profit by using different customer returns policies. In addition, according to a UPS study, 45% of consumers who choose BOPS make other purchases when they pick up the products in a physical store. This phenomenon called “cross-selling” generates a lot of profits for physical stores. Armony and Gurvich [10] exam how to make use of the cross-selling opportunities. Instead of studying the design of a cross-selling strategy, Gao and Su [11] focus on the impact of cross-selling benefits on implementation of BOPS.

In this paper, we have some innovations: (1) Based on the Hotelling model [12], we introduce the BOPS channel; (2) In light of the actual situation, we consider the impact of return on omnichannel retailing. (3) Meanwhile, we also consider another key feature that consumers make addition purchases once they enter the store called “cross-selling”. In the end, we get the optimal pricing strategy, analyze the impact of BOPS on consumers and retailers, and clarify when retailers should adopt the BOPS strategy.

II. MODEL AND ANALYSIS

Our study considers a retailer who sells an identical product through store and online channels, with the price $p_s$ and $p_o$ respectively. These two channels are operated by two teams of the same company. We assume that the online and offline shops are located at each end of the Hotelling line of length 1, and the consumers are uniformly spread on the horizontal line between 0 and 1. The channel preference of every consumer is completely characterized by his location $x$ on the line, which influences the consumer's utility when he purchases a product.
A consumer at \( x \) incurs a hassle cost \( tx \) (e.g., traveling to the store) when buying a product in the store and a hassle cost \( t(1-x) \) (e.g., browsing websites, click and pay online) when buying a product online, where \( t \) is the unit hassle cost parameter. Here, the hassle cost of store and online is actually a relative concept, which can also be understood as the relative channel aversion of consumers.

We suppose the consumer’s valuation \( v \) is big enough to ensure that each consumer chooses one of these two channels. Only when the consumer touches the product can he be sure whether he likes it or not. The probability that the consumers like the product is \( \alpha \), while the probability that they dislike is \( 1 - \alpha \). There is a key difference between store and online: Consumers touch the product before purchasing in store, while the consumers online examine the product only after receiving the product and online purchase may be returned. Each returned unit generates an additional hassle cost \( r > 0 \) to the consumers.

### A. Basic Model Without BOPS

Firstly, we consider the scenario before BOPS is introduced. The consumers’ utility function from going to the store can be given by

\[
U_s = \alpha (v - p_s) - tx
\]

\[
U_o = \alpha (v - p_o) - t(1-x) - (1-\alpha)r\tag{2}
\]

We illustrate the consumer utilities at online and offline channels with the change of \( x \) in Fig. 1. And we can get a point \( x_o \) that the utility of online is equal to offline. Thus consumers with a high value of index \( x \) will choose the online channel and the others will choose to visit store. It is clear that the demand functions of the store and online channels are

\[
D_s = \frac{\alpha [t^T + (1-\alpha)r - 2h]}{1 \alpha r} \quad \text{and} \quad D_o = \frac{\alpha [t^T + (1-\alpha)r - 2h]}{1 \alpha r}.
\]

In the store channel, there is an additional profit \( h \) from every consumer coming to the store because consumers tend to make additional purchase. But in the online channel, consumers find products through direct search, so consumers are less likely to pay attention to the additional products. Accordingly, the channel functions can be written as

\[
\pi_s = \alpha p_s D_s + hD_s
\]

\[
\pi_o = \alpha p_o D_o
\]

There is an optimal strategy without BOPS that

\[
p^*_s = \frac{t^T + (1-\alpha)r - 2h}{1 \alpha r} \quad \text{and} \quad p^*_o = \frac{t^T + (1-\alpha)r - 2h}{1 \alpha r}.
\]

The retailers make profits \( \pi^*_s = \frac{\alpha [t^T + (1-\alpha)r - 2h]^2}{1 \alpha r} \) and \( \pi^*_o = \frac{\alpha [t^T + (1-\alpha)r - 2h]^2}{1 \alpha r} \). And the total profit is \( \pi^*_s = \frac{\alpha [t^T + (1-\alpha)r - 2h]^2}{1 \alpha r} \).

**Proposition 1** Cross-selling not only affects store channel but also online channel:

(i) (Price) With the increase of \( h \), both the store and online prices will decrease, but \( p^*_s \) will decrease more than \( p^*_o \);

(ii) (Profit) While cross-selling increases store profit, it hurts online profit, but the total profit in the supply chain still increases.

Cross-selling phenomenon will bring additional sales to the store. Therefore, the store will appropriately lower the price to attract more consumers and thus increase profits through cross-selling. The online shop is indirectly affected by cross-selling. If the online price does not change, some consumers who originally choose online purchase will go to the store because of the decrease of store prices. It will lead to a reduction in online demand and thus a reduction in online profits. Therefore, in order to compete with the store channel, online prices have to be reduced. But this can only reduce the loss of online channel, while the existence of cross-selling will still damage online profit. The total profits in the supply chain will still increase because the profits increased by cross-selling is greater than the profits reduced by the price cut.

### B. Extended Model with BOPS

Now we turn to the scenario where the retailer implements BOPS. The consumers’ utility of BOPS is

\[
U_b = \alpha (v - p_o) - t \tag{5}
\]

As shown in Fig. 2, we can get three points \( x_{ob}, x_{bo}, x_{sb} \). Thus consumers with a high value of \( x \) will choose the online channel, with a low value of \( x \) will choose to go to the store and the others will choose BOPS. Therefore, the demand functions of these three channels are

\[
D^b_s = \frac{\alpha [p_o - p_s] + (1-\alpha)r - t}{\alpha} \quad D^b_o = \frac{1 - (1-\alpha)r}{\alpha} \quad \text{and} \quad D^b_o = \frac{\alpha [p_o - p_s] + (1-\alpha)r - t}{\alpha}.
\]

Fig. 1. Consumer utilities at online and store channels.

Fig. 2. Consumer utilities at online, store and bops channels.
We classify order revenue of BOPS into the online retailer, and the cross-selling revenue of BOPS is attributed to the store retailer. So the channel profit functions can be written as

\[ \pi^p = \alpha p^p D^p + h(D^p + D^o) \]  
\[ \pi^o = \alpha p^o (D^o + D^s) \]

With BOPS, the optimal prices of store and online channels are \( p^s = \frac{2t}{\alpha + h} \) and \( p^o = \frac{1 - (1 - a)r}{t} \). At the same time, the demands of these three channels are \( D^s = \frac{2}{\alpha + h} \), \( D^o = 1 - \frac{1 - (1 - a)r}{t} \) and \( D^s = \frac{1 - a + r}{(1 - a)r} \). The retailers make profits \( \pi^p = \frac{4t}{\alpha + h} \) and \( \pi^o = \frac{\alpha}{\alpha + h} \). And the total profit is \( \pi^p = \frac{4t}{\alpha + h} \) and \( \pi^o = \frac{\alpha}{\alpha + h} \).

**Proposition 2** When BOPS is introduced, the optimal profits of store and online exactly satisfy \( p^p = 2p^o \) and the store demand is exactly a fixed value \( \frac{4t}{\alpha + h} \).

In this case, the consumer who chooses online or BOPS rather than store must be the one sensitive to price. So the factors that affect online profits are \( p^o \) and \( D^o + D^s \) which is related to \( p^s \) and \( p^o \). If \( p^o \geq p^o \), BOPS and online channel will have no advantage and be replaced by store channel completely. To ensure that online profits are not zero, \( p^o \) must be lower than \( p^o \). The lower the \( p^o \), the more consumers choose to order online (including buying online and using BOPS). But when \( p^o \) is zero, no profit can be generated from online channel. Therefore, in the quadratic function, the pricing decision \( p^o = \frac{2t}{\alpha + h} \) can make the largest online profits. In addition, \( D^o + D^s \) is positively correlated with \( p^o \), so \( D^o = 1 - \frac{1 - (1 - a)r}{t} \) is negatively correlated with \( p^o \) and \( p^o \).

Here, in the case of maximizing profits, \( p^s = \frac{2t}{\alpha + h} \) and \( p^o = \frac{1 - (1 - a)r}{t} \). The optimal prices are positively correlated with \( \frac{1}{\alpha + h} \), while the store demand \( 1 - \frac{1 - (1 - a)r}{t} \) is negatively correlated with \( \frac{1}{\alpha + h} \), hence \( \frac{1}{\alpha + h} \) is canceled. Therefore, the store demand is a constant that will not be affected by any parameter.

**Proposition 3** When BOPS is a viable option, cross-selling does not impact on the price and demand in any channel. More importantly, online profits are not affected by cross-selling any more.

Here, we find that consumers who choose to purchase online are primarily concerned with returning and visiting costs rather than prices. Therefore, the online demand is a price-independent constant. When the market size is \( 1, D^o + D^s \) which affect the cross-selling profit of the store, is also a constant independent of price. Therefore, the profit of cross-selling has been fixed and does not change with \( p^o \) or \( p^s \). Conversely, cross-selling does not impact on the price and demand in any channel. Because cross-selling only occurs in store, it does not affect online profits.

## III. Comparison and Analysis

We compare the situations with and without BOPS and analyze the impact of BOPS on retailers and consumers. Recall that in the market without BOPS, to ensure that the market exists online and store channels at the same time, \( 0 < h < \min \left\{ 3t - (1 - a)r, \frac{2t + (1 - a)r}{2} \right\} \) needs to be satisfied. When we introduce BOPS to the market, the demands of store, online and BOPS are positive if \( 0 < h < \frac{2t + (1 - a)r}{2} \) and \( t > \frac{1}{1 - a}r \). Comparing the values \( 3t - (1 - a)r \) and \( \frac{2t + (1 - a)r}{2} \), we have \( \frac{2t + (1 - a)r}{2} < 3t - (1 - a)r \) when \( t > \frac{1}{1 - a}r \). Therefore, to focus on the comparison of with and without BOPS, and exclude the trivial cases, we assume \( 0 < h < \frac{2t + (1 - a)r}{2} \) in the rest of our study.

**Proposition 4** Compared to the model without BOPS, there exists \( h^p_1 = \frac{2t + (1 - a)r}{2} \) and \( h^p_2 = 2t - (1 - a)r \).

(i) If \( h < h^p_1 \), both \( p^o \) and \( p^o \) will decrease because of BOPS;

(ii) If \( h^p_1 < h < h^p_2 \), \( p^o \) will increase while \( p^o \) will decrease;

(iii) If \( h > h^p_2 \), both \( p^o \) and \( p^o \) will increase because of BOPS.

When BOPS is introduced, market competition becomes fiercer because consumers have more choices. So retailers from different channels reduce prices in order to retain consumers. As we know from Proposition 1, cross-selling will affect the prices of store and online in the basic model. With the increase of \( h \), both the store and online prices will decrease, but \( p^o \) will decrease more than \( p^o \). However, the impact of cross-selling is eliminated when we introduce BOPS. As a result, BOPS has two effects on prices: (1) Intensifying competition in the channels and thus lowering prices; (2) Eliminating the effects of cross-selling and increasing prices. Therefore, the prices increase or decrease after the introduction of BOPS depends on which one of the two effects is more significant.

**Proposition 5** Compared to the model without BOPS, there exists \( h_1 = \frac{2t + (1 - a)r}{2} \) and \( h_2 = 5(1 - a)r - 3t \).\( h_2 < h < h_2 \).

(i) If \( h < h_1 \), some consumers who opted to purchase online before will visit store or choose BOPS;

(ii) If \( h > h_2 \), some consumers who went to store before will choose to online shopping or BOPS;

(iii) If \( h_1 < h < h_2 \), some consumers who purchased in store or online before will switch to use BOPS.

![Fig. 3. Comparison of consumer behavior with and without bops.](image-url)
There are three cases discussed in Proposition 4. First, if \( h \) is small, the price reduction caused by channel competition reduces the gap between store price and online price. Therefore, consumers who care about prices now pay more attention to returns. So in Fig. 3, some consumers who choose online channel will turn to store or BOPS. If \( h \) is large, the price increase caused by eliminating cross-selling increases the gap between store price and online price while the price reduction due to channel competition is relatively small. So prices become the most important factor affecting consumer behavior. Therefore, some consumers who originally bought in the store may choose BOPS or online. Then, if \( h \) is moderate, both cross-selling and channel competition have moderate impact on prices. As shown in Fig. 3, some online and store consumers choose BOPS to avoid return and for discounted price respectively.

**Proposition 6** Compared to the model without BOPS,

(i) When \( (1 - \alpha) \tau < t < \frac{27 + 6\varepsilon}{38} (1 - \alpha) \tau \), BOPS increases store profit if \( 8(1 - \alpha) \tau - 3t - A < h < \frac{2\varepsilon + (1 - \alpha) \tau}{3} \).

(ii) When \( \frac{27 + 6\varepsilon}{38} (1 - \alpha) \tau < t < (1 - \alpha) \tau \), BOPS increases store profit if \( 8(1 - \alpha) \tau - 3t - A < h < \frac{2\varepsilon + (1 - \alpha) \tau}{3} \) but reduces store profit if \( h \in (0, 8(1 - \alpha) \tau - 3t - A) \cup \left(8(1 - \alpha) \tau - 3t + A, \frac{2\varepsilon + (1 - \alpha) \tau}{3}\right) \), where \( A = \sqrt{4t^2 - 21(1 - \alpha) \tau t^2} - 3(1 - \alpha) \tau . \)

According to Proposition 6, when \( t \) is small, \( h \) is the main reason that affect retailer's profits in store. If \( h \) is small, profits of cross-selling are not sufficient to compensate for the loss caused by the price reduction, despite the increase in store demand; otherwise, if \( h \) is large, profit of cross-selling is large enough, so the store profit increases despite the decrease in store demand. In addition, when \( t \) is large, consumers consider about the hassle cost when they choose channels, and in these three channels, BOPS has the highest hassle cost, so fewer consumers choose BOPS. From Proposition 5, when \( h \) is too large, the store demand will decrease as well. Therefore, the reduction of store traffic reduces the total profits of the store and cross-selling. And when \( h \) is too small, profits of cross-selling are not large enough to make up for the loss caused by the price reduction. So, only if \( h \) is moderate, BOPS can increase store profit here.

**Proposition 7** Compared to the model without BOPS,

(i) If \( (3 - \sqrt{2}) t - (1 - \alpha) \tau < h < \frac{2\varepsilon + (1 - \alpha) \tau}{3} \), then adding a BOPS option increases online profit (i.e., \( \pi^e \) > \( \pi^o \)); if \( 0 < h < (3 - \sqrt{2}) t - (1 - \alpha) \tau \), BOPS reduces online profit (i.e., \( \pi^e < \pi^o \));

(ii) If \( \frac{27 + 6\varepsilon}{38} (1 - \alpha) \tau < h < \frac{2\varepsilon + (1 - \alpha) \tau}{3} \), BOPS increases total profit (i.e., \( \pi^E > \pi^O \)); if \( 0 < h < \frac{7(1 - \alpha) \tau - 2}{2} \), BOPS reduces total profit (i.e., \( \pi^E < \pi^O \)), where \( B = \sqrt{45(1 - \alpha)^2 \tau^2 - 16t^2} \).

According to Proposition 5 and 6, if \( h \) is small, BOPS decreases the online price and demand. Obviously, the online profit decreases because of BOPS. Similarly, if \( h \) is large, BOPS increases online price and demand, thereby increasing online profits. As for total profit, it depends on store profit and online profit. When \( h \) is small, both store profit and online profit decrease, and total profit inevitably decreases. When \( h \) is large, almost all store profit and online profit increase, and total profit also increases. In the case of Proposition 7 (ii), it has made the increase in online profit far greater than the reduction in store profit. So there is such a threshold, when \( h \) exceeds the threshold, the total profit increases.

**IV. CONCLUSION**

In this paper, we study a specific omnichannel strategy called BOPS. We build consumer utility models and compare the operational decisions, profits with and without BOPS. It is worth noting that we consider the conditions for mutual restriction between each channel, and no channel in our model is absolutely dominant. And we get some interesting findings.

Our first finding is that adding BOPS has the following two aspects of influence: (1) Eliminating the effect of cross-selling. If the store increases the extra purchases per unit customer by adjusting the product placement, etc., they will not cause losses to online channel. (2) Intensifying competition among channels. The combination of these two effects is a key factor influencing the retailer's price decisions. If the price gap is smaller, consumers will be more concerned about the return so as not to choose online channel; if the price gap is larger, consumers will be attracted by low price and thus not select the store channel; if the price gap is moderate, more consumers will turn to BOPS.

Then, we find it is wrong that store with higher cross-selling is more suitable for introducing BOPS. The benefit of introducing BOPS to the store is to increase customer traffic, thereby increasing the profit of cross-selling. Therefore, BOPS is a good strategy when the hassle cost is low. However, when the hassle cost is high, consumers will give priority to other convenient channels because the BOPS process is too cumbersome. In this case, BOPS will reduce the store traffic and damage store profit. Therefore, stores with high cross-selling effect are more suitable for BOPS, but should also pay attention to their location and traffic conditions.

In the future, we hope to study whether BOPS can reduce the return rate of online channels. In addition, we can transfer research objects from existing customers to the entire market, and study whether introducing BOPS can expand the market scale and attract more consumers.

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