A Study of BOPS Cooperation Strategy of Online and Dual-Channel Retailers Considering Consumers' Heterogeneous Buying Behavior

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Abstract: For the BOPS cooperation strategies of online and dual-channel retailers, the game model is constructed under three scenarios of online retailers' online-only sales, opening offline channels, and cooperating with dual-channel retailers, and the optimal scope of BOPS cooperation among retailers is analyzed. The study shows that online and dual-channel retailers have incentives to implement BOPS cooperation when the product waiting cost is small; when the product waiting cost is large, online retailers should choose dual-channel sales online and offline.

Keywords: BOPS Cooperation; Product Waiting Costs; Pricing Strategy; Channel Selection

1. Introduction

With the development and popularization of Internet technology, e-commerce has brought convenience and choice to consumers. In order to adapt to market changes, many traditional brick-and-mortar retailers have opened online channels. This has also brought great pressure on the survival of online retailers. Facing the challenges of dual-channel retailers, online retailers urgently need to find a way out. However, if online retailers choose to open offline brick-and-mortar stores to become dual-channel retailers, when will dual-channel sales form a market equilibrium? Online retailers should consider various market factors and conditions when choosing their channel sales strategy.

The issue of retailers' sales channel selection has long been a hot topic of academic interest. Bell et al. (2013) argue that online retailers should open offline channels. Liang and Liang (2021) show that opening offline channels by online retailers will optimize profits by comparing the expected returns of online retailers opening offline channels or not. Some scholars have also analyzed channel decisions from the perspectives of product fitness (Bian, 2024), supply chain (Wallace, 2004), and operating costs (Cattani, 2006) etc. Nematollahi et al. (2024) examined the sales services of traditional and online channels.

A number of scholars have also discussed whether to adopt omni-channel or not. sun et al. (2022) argued that it is always advantageous for retailers to implement an omni-channel strategy. Lin et al. (2023) pointed out that retailers can gain a larger share of offline channels through omni-channel. the BOPS channel has also attracted a lot of attention from scholars. Gao et al. (2016) analyzed omni-channel retailing and showed that products that sell well in offline stores are not suitable for BOPS strategy. The results show that products that sell well in offline stores are not suitable for the BOPS strategy, and Cao et al. (2016) find that the benefit to retailers depends on the cost of online hassle and the unit processing cost of BOPS. A study by Kong et al. (2019) shows that products with smaller valuation differences are more suitable for BOPS strategy. Pei et al. (2024) study the impact of BOPS strategy on supply chain and conclude that BOPS cost shared between manufacturer and retailer can improve profit. Ge and Zhu (2023) consider the multiple interaction behaviors of heterogeneous consumers and show that the BOPS strategy is more applicable to the type of products with high sales return rate. Literature has also been developed from the perspectives of market competition intensity (Ge and Zhu, 2023) and third-party logistics level (Qiu et al.,2023).

Through combing, it is found that most of the existing results on channel selection focus on channel integration strategies, and less literature discusses retailers' BOPS cooperation. Based on this, this paper systematically explores the conditions of BOPS cooperation between online retailers and dual-channel retailers to provide references for retailers to rationally select sales channels.

2. Problem Description and Assumptions

Consider a product sales market consisting of a retailer with an online channel (denoted by A) and a retailer with a dual online and offline channel (denoted by C). Each of the two retailers sells a homogeneous and substitutable product to consumers and sets the price at which the product is sold based on the characteristics of their respective channels. Retailer A considers the following channel strategy.

(i) OD strategy: Retailer A sells online and the decision variable is denoted by the superscript "OD";

(ii) DD strategy: Retailer A sells through two channels and the decision variable is denoted by the superscript "DD";

(iii) BD strategy: Retailer A sells online and cooperates with Retailer C's offline channel BOPS, with the decision variable denoted by the superscript "BD".

The Hotelling model is used to portray a market where two retailers are distributed at the ends of a linear city of length 1, with retailer A located at endpoint 0 and retailer C located at endpoint 1. Retailer A and Retailer C both use the same price in their respective channels. If the two retailers do not engage in BOPS, Retailer A and Retailer C set their respective product prices based on channel demand p_A and p_C; if the two retailers engage in BOPS, Retailer A also pays Retailer C a unit compensation for each unit of BOPS order γ, which is treated as an exogenous variable in this paper.

Consumers of overall size 1 are uniformly distributed in the linear city of $[0,1]$ and value the product as v. In this paper, consumers are categorized into traditional and omni-channel consumers, where α is the proportion of traditional consumers, $1-\alpha$ is the proportion of omni-channel consumers, and $\alpha \in (0,1)$. Under the three strategies, the utility of a consumer located at x who chooses retailer C's offline brick-and-mortar store is $U_{Cs} = v - p_{Cs} - t(1-x)$, where t is the unit cost of offline shopping; the utility of choosing retailer C's online store is $U_{Co} = v - p_C - \eta$, and the utility of choosing retailer A's online store is $U_{Ao} = v - p_A - \eta$, where η is the cost of the hassle of waiting for the product to arrive. Under the DD strategy, the utility of a consumer located at x who chooses Retailer A's offline brick-and-mortar store is $U_{As}^{DD} = v - p_A^{DD} - tx$. If the consumer chooses BOPS, the expected utility is:

$$U_{Ab}^{BD} = v - p_A^{BD} - (t-m)(1-x) - \delta\eta$$

With m denoting the convenience coefficient of BOPS. And δ is the time-sensitive coefficient. This paper analyzes only the case where both retailers are in demand.

In this paper, the superscript " $-$ " represents the pricing case of $p_A^T > p_C^T$ ($T = \{DD, BD\}$). $Q_{ij}^T(\bar{Q}_{ij}^T)$ represents the j channel demand of retailer i under equilibrium strategy T, $\Pi_i^T(\bar{\Pi}_i^T)$ represents the expected revenue of retailer i under equilibrium strategy T, and $T = \{OD, DD, BD\}$.

3. Strategic Analysis

3.1 Benchmarking Model-OD Strategy

Retailer A sells through the online channel and Retailer C sells through the dual channel under the OD strategy. Since there is no demand for Retailer A's online channel at $p_A^{OD} > p_C^{OD}$ and it follows from Robert (2010) that Retailer A and Retailer C's online channels compete in Bertrand when $p_A^{OD} = p_C^{OD}$, it is assumed that $p_A^{OD} < p_C^{OD}$.

Let $U_{Cs}^{OD} = v - p_C^{OD} - t(1-x) = 0$ be $x_1^{OD} = 1 - \frac{v - p_C^{OD}}{t}$, the point of no-difference. When $p_A^{OD} < p_C^{OD}$, there is no demand for Retailer C's online channel, and omni-channel consumers will only buy products from Retailer A's online channel and Retailer C's offline channel, and according to $U_{Ao}^{OD} = U_{Cs}^{OD}$, the point of no-difference in purchasing is $x_2^{OD} = 1 - \frac{\eta - p_C^{OD} + p_C^{OD}}{t}$.

Based on the above analysis, the demand of the two retailers under the OD strategy is when $p_A^{OD} < p_C^{OD}$:

$$Q_{Ao}^{OD} = (1-\alpha)(1 - \frac{\eta - p_C^{OD} + p_A^{OD}}{t})$$

$$Q_{Cs}^{OD} = \alpha \frac{v - p_C^{OD}}{t} + (1-\alpha)\frac{\eta - p_C^{OD} + p_A^{OD}}{t}$$

$$Q_{Co}^{OD} = 0$$

The expected returns for the two retailers are:

$$\max_{p_A^{OD}} \Pi_A^{OD} = p_A^{OD} Q_{Ao}^{OD}$$

$$\max_{p_C^{OD}} \Pi_C^{OD} = p_C^{OD}(Q_{Co}^{OD} + Q_{Cs}^{OD})$$

Theorem 1 Under the OD strategy, the equilibrium pricing of the two retailers is when $\eta > \frac{(1+\alpha)t-\alpha v}{2}$:

$$p_A^{OD*} = \frac{\alpha(v-\eta)+2t-\eta}{3+\alpha}$$

$$p_C^{OD*} = \frac{(1-\alpha)(t+\eta)+2v\alpha}{3+\alpha}$$

Market demand for:

$$Q_{Ao}^{OD*} = \frac{(1-\alpha)\left[\alpha(v-\eta)+2t-\eta\right]}{(3+\alpha)t}$$

$$Q_{Cs}^{OD*} = \frac{(1-\alpha)(t+\eta)+2v\alpha}{(3+\alpha)t}$$

$$Q_{Co}^{OD*} = 0$$

Expected earnings are:

$$\Pi_A^{OD*} = \frac{(1-\alpha)\left[\alpha(v-\eta)+2t-\eta\right]^2}{(3+\alpha)^2 t}$$

$$\Pi_C^{OD*} = \frac{\left[(1-\alpha)(t+\eta)+2v\alpha\right]^2}{(3+\alpha)^2 t}$$

The situation of $\eta \le \frac{(1+\alpha)t-\alpha v}{2}$ does not exist.

Solving the partial derivatives leads to the conclusion. The following theorem is solved by the same procedure.

3.2 DD Strategy

Let the no-difference point be $x_3^{DD} = \frac{t-p_A^{DD}+p_C^{DD}}{2t}$ when $U_{As}^{DD} = U_{Cs}^{DD}$ is obtained. For an omni-channel consumer, when $p_A^{DD} < p_C^{DD}$ will only spend in Retailer A's online and offline channels and Retailer C's offline channel. Let $U_{Ao}^{DD} = U_{As}^{DD}$ be $x_4^{DD} = \frac{\eta}{t}$ and let $U_{Ao}^{DD} = U_{Cs}^{DD}$ be $x_5^{DD} = \frac{t-p_A^{DD}+p_C^{DD}-\eta}{t}$. When $p_A^{DD} > p_C^{DD}$ is used, the omnichannel consumer will only purchase the product in Retailer A's offline channel and Retailer C's online and offline channels, such that $\bar{U}_{As}^{DD} = \bar{U}_{Co}^{DD}$ yields the indifference point of $\bar{x}_6^{DD} = \frac{\eta-\bar{p}_A^{DD}+\bar{p}_C^{DD}}{t}$; and $\bar{U}_{Co}^{DD} = \bar{U}_{Cs}^{DD}$ yields the indifference point of $\bar{x}_7^{DD} = 1-\frac{\eta}{t}$.

Based on the above analysis, it can be obtained that the demand of retailer A and retailer C under DD strategy at $p_A^{DD} < p_C^{DD}$ and $p_A^{DD} > p_C^{DD}$ for online channel and offline channel respectively:

$$Q_{Ao}^{DD} = \begin{cases} (1-\alpha)\left(\frac{t-p_A^{DD}+p_C^{DD}-\eta}{t}-\frac{\eta}{t}\right) & p_A^{DD} < p_C^{DD} \\ 0 & p_A^{DD} > p_C^{DD} \end{cases}$$

$$Q_{As}^{DD} = \begin{cases} \alpha\frac{t-p_A^{DD}+p_C^{DD}}{2t}+(1-\alpha)\frac{\eta}{t} & p_A^{DD} < p_C^{DD} \\ \alpha\frac{t-\bar{p}_A^{DD}+\bar{p}_C^{DD}}{2t}+(1-\alpha)\frac{\eta-\bar{p}_A^{DD}+\bar{p}_C^{DD}}{t} & p_A^{DD} > p_C^{DD} \end{cases}$$

$$Q_{Co}^{DD} = \begin{cases} 0 & p_A^{DD} < p_C^{DD} \\ (1-\alpha)\left(1-\frac{\eta}{t}-\frac{\eta-\bar{p}_A^{DD}+\bar{p}_C^{DD}}{t}\right) & p_A^{DD} > p_C^{DD} \end{cases}$$

$$Q_{Cs}^{DD} = \begin{cases} \alpha\left(1-\frac{t-p_A^{DD}+p_C^{DD}}{2t}\right)+(1-\alpha)\left(1-\frac{t-p_A^{DD}+p_C^{DD}-\eta}{t}\right) & p_A^{DD} < p_C^{DD} \\ \alpha\left(1-\frac{t-\bar{p}_A^{DD}+\bar{p}_C^{DD}}{2t}\right)+(1-\alpha)\frac{\eta}{t} & p_A^{DD} > p_C^{DD} \end{cases}$$

The expected return function of the two retailers under the DD strategy is:

$$\max_{p_A^{DD}} \Pi_A^{DD} = p_A^{DD}(Q_{As}^{DD}+Q_{Ao}^{DD})$$

$$\max_{p_C^{DD}} \Pi_C^{DD} = p_C^{DD}(Q_{Cs}^{DD}+Q_{Co}^{DD})$$

Theorem 2 The equilibrium pricing of the two retailers is when $\eta > \frac{t}{2}$: $p_A^{DD*} = \frac{t(4-\alpha)-2\eta(1-\alpha)}{3(2-\alpha)}$, $p_C^{DD*} = \frac{2\eta(1-\alpha)+t(2+\alpha)}{3(2-\alpha)}$. Market demand for:

$$Q_{Ao}^{DD*} = \frac{(4-\alpha)(1-\alpha)(t-2\eta)}{3t(2-\alpha)}$$

$$Q_{As}^{DD*} = \frac{2\alpha(2t-7\eta)+12\eta-(t-2\eta)\alpha^2}{6t(2-\alpha)}$$

$$Q_{Co}^{DD*} = 0$$

$$Q_{Cs}^{DD*} = \frac{2\eta(1-\alpha)+t(2+\alpha)}{6t}$$

The optimal expected return is:

$$\Pi_A^{DD*} = \frac{\left[t(4-\alpha)-2\eta(1-\alpha)\right]^2}{18t(2-\alpha)}$$

$$\Pi_C^{DD*} = \frac{\left[2\eta(1-\alpha)+t(2+\alpha)\right]^2}{18t(2-\alpha)}$$

The equilibrium pricing of the two retailers is when $\eta < \frac{t}{2}$:

$$\bar{p}_A^{DD*} = \frac{2\eta(1-\alpha)+t(2+\alpha)}{3(2-\alpha)}$$

$$\bar{p}_C^{DD*} = \frac{t(4-\alpha)-2\eta(1-\alpha)}{3(2-\alpha)}$$

Market demand for:

$$\bar{Q}_{Ao}^{DD*} = 0$$

$$\bar{Q}_{As}^{DD*} = \frac{2\eta(1-\alpha)+t(2+\alpha)}{6t}$$

$$\bar{Q}_{Co}^{DD*} = \frac{(1-\alpha)(4-\alpha)(t-2\eta)}{3t(2-\alpha)}$$

$$\bar{Q}_{Cs}^{DD*} = \frac{2\alpha(2t-7\eta)+12\eta-(t-2\eta)\alpha^2}{6t(2-\alpha)}$$

The optimal expected return is:

$$\bar{\Pi}_A^{DD*} = \frac{\left[2\eta(1-\alpha)+t(2+\alpha)\right]^2}{18t(2-\alpha)}$$

$$\bar{\Pi}_C^{DD*}=\frac{\left[t(4-\alpha)-2\eta(1-\alpha)\right]^2}{18t(2-\alpha)}$$

Comparing the equilibrium results at $p_A^{DD}<p_C^{DD}$ as well as $p_A^{DD}>p_C^{DD}$ under the DD strategy yields the price and demand changes for the two retailers as shown in Corollary 1.

Corollary 1 When $\eta<\frac{t}{2}$:

(i) $p_A^{DD*}>\bar{p}_A^{DD*}$, $p_C^{DD*}<\bar{p}_C^{DD*}$;

(ii) $Q_{As}^{DD*}+Q_{Ao}^{DD*}>\bar{Q}_{As}^{DD*}+\bar{Q}_{Ao}^{DD*}$, $Q_{Co}^{DD*}+Q_{Cs}^{DD*}<\bar{Q}_{Cs}^{DD*}+\bar{Q}_{Co}^{DD*}$;

(iii) $\Pi_A^{DD*}>\bar{\Pi}_A^{DD*}$, $\Pi_C^{DD*}<\bar{\Pi}_C^{DD*}$;

When $\eta>\frac{t}{2}$

(i) $p_A^{DD*}<\bar{p}_A^{DD*}$, $p_C^{DD*}>\bar{p}_C^{DD*}$;

(ii) $Q_{As}^{DD*}+Q_{Ao}^{DD*}<\bar{Q}_{As}^{DD*}+\bar{Q}_{Ao}^{DD*}$, $Q_{Co}^{DD*}+Q_{Cs}^{DD*}>\bar{Q}_{Cs}^{DD*}+\bar{Q}_{Co}^{DD*}$;

(iii) $\Pi_A^{DD*}<\bar{\Pi}_A^{DD*}$, $\Pi_C^{DD*}>\bar{\Pi}_C^{DD*}$;

Corollary 1 shows that retailer A will have higher returns when the product waiting cost is lower than retailer C when the price is lower, and retailer A will have higher expected returns when the price is higher than retailer C when the product waiting cost is higher. This indicates that product waiting cost is an important factor influencing the pricing decisions of dual-channel retailers.

3.3 BD Strategy

As with the OD strategy, the traditional consumer can only consume at Retailer C's offline store with no point of difference at $x_8^{BD}=1-\frac{v-p_C^{BD}}{t}$. When $p_A^{BD}<p_C^{BD}$ is used, the omni-channel consumer only purchases in Retailer A's online channel, BOPS channel, and Retailer C's offline channel. From $U_{Ao}^{BD}=U_{Ab}^{BD}$, the no-difference point is $x_9^{BD}=1-\frac{(1-\delta)\eta}{t-m}$; and by making $U_{Ab}^{BD}=U_{Cs}^{BD}$, the no-difference point is $x_{10}^{BD}=1-\frac{\delta\eta-p_C^{BD}+p_A^{BD}}{m}$. When $p_A^{BD}>p_C^{BD}$ is used, the omnichannel consumer buys only from Retailer A's BOPS channel and Retailer C's online and offline channels. Omni-channel consumers closer to Retailer C are more motivated to choose BOPS to purchase the product, so that $\bar{U}_{Ab}^{BD}=\bar{U}_{Cs}^{BD}$ yields the no-difference point of $\bar{x}_{11}^{BD}=1-\frac{(1-\delta)\eta-\bar{p}_A^{BD}+\bar{p}_C^{BD}}{t-m}$; and $\bar{U}_{Ab}^{BD}=\bar{U}_{Cs}^{BD}$ yields the no-difference point of $\bar{x}_{12}^{BD}=1-\frac{\delta\eta+\bar{p}_A^{BD}-\bar{p}_C^{BD}}{m}$.

Based on the above analysis, the demand of retailer A and retailer C under BD strategy can be obtained as:

$$Q_{Ao}^{BD}=\begin{cases}(1-\alpha)(1-\frac{(1-\delta)\eta}{t-m}) & p_A^{BD}<p_C^{BD}\\ 0 & p_A^{BD}>p_C^{BD}\end{cases}$$

$$Q_{Ab}^{BD}=\begin{cases}(1-\alpha)(\frac{(1-\delta)\eta}{t-m}-\frac{\delta\eta+p_A^{BD}-p_C^{BD}}{m}) & p_A^{BD}<p_C^{BD}\\ (1-\alpha)(\frac{(1-\delta)\eta-\bar{p}_A^{BD}+\bar{p}_C^{BD}}{t-m}-\frac{\delta\eta+\bar{p}_A^{BD}-\bar{p}_C^{BD}}{m}) & p_A^{BD}>p_C^{BD}\end{cases}$$

$$Q_{Cs}^{BD}=\begin{cases}\alpha\frac{v-p_C^{BD}}{t}+(1-\alpha)\frac{\delta\eta+p_A^{BD}-p_C^{BD}}{m} & p_A^{BD}<p_C^{BD}\\ \alpha\frac{v-\bar{p}_C^{BD}}{t}+(1-\alpha)\frac{\delta\eta+\bar{p}_A^{BD}-\bar{p}_C^{BD}}{m} & p_A^{BD}>p_C^{BD}\end{cases}$$

$$Q_{Co}^{BD}=\begin{cases}0 & p_A^{BD}<p_C^{BD}\\ (1-\alpha)(1-\frac{(1-\delta)\eta+\bar{p}_C^{BD}-\bar{p}_A^{BD}}{t-m}) & p_A^{BD}>p_C^{BD}\end{cases}$$

The expected returns of the two retailers under the BD strategy are:

$$\max_{p_A^{BD}}\Pi_A^{BD}=p_A^{BD}Q_{Ao}^{BD}+(p_A^{BD}-\gamma)Q_{Ab}^{BD}$$

$$\max_{p_C^{BD}}\Pi_C^{BD}=p_C^{BD}(Q_{Cs}^{BD}+Q_{Co}^{BD})+\gamma Q_{Cb}^{BD}$$

Theorem 3 Under the BD strategy, if $p_A^{BD}<p_C^{BD}$, the equilibrium of the two retailers are respectively: p_A^{BD*}, p_B^{BD*}; Q_{Ao}^{BD*}, Q_{Ab}^{BD*}, Q_{Co}^{BD*}, Q_{Cs}^{BD*}; Π_A^{BD*}, Π_C^{BD*} .If $p_A^{BD}>p_C^{BD}$, the equilibrium pricing of the two retailers are respectively: $\bar{p}_A^{BD*}$, $\bar{p}_C^{BD*}$; $\bar{Q}_{Ab}^{BD*}$, $\bar{Q}_{Ao}^{BD*}$; $\bar{Q}_{Co}^{BD*}$, $\bar{Q}_{Cs}^{BD*}$; $\bar{\Pi}_A^{BD*}$, $\bar{\Pi}_C^{BD*}$ .The expressions are too long to go into detail here.

Since the equilibrium results of the two retailers at $p_A^{BD}<p_C^{BD}$ and $p_A^{BD}>p_C^{BD}$ under the BD strategy are more complicated, the following paper uses numerical simulation to analyze the impact of η on retailer A. The results are shown in the following table. Assume $v=1$, $\alpha=0.3$, $\eta=0.3$, $t=0.6$, and to fulfill the condition of $0<m<t$, assume $m=0.2$, $\delta=0.6$. The comparison chart of retailer A's pricing, demand and revenue is not detailed here, and the results are directly given as follows.

Retailer A's product price and aggregate demand are higher at $p_A^{BD}<p_C^{BD}$ than at $p_A^{BD}>p_C^{BD}$ when the product waiting cost is small, retailer A's product price is lower at $p_A^{BD}<p_C^{BD}$ than at $p_A^{BD}>p_C^{BD}$ when the product waiting cost is large, and retailer A's aggregate demand is lower at $p_A^{BD}<p_C^{BD}$ than at $p_A^{BD}>p_C^{BD}$ when the product waiting cost is large enough. Retailer A's expected revenue is higher at $p_A^{BD}<p_C^{BD}$ than at $p_A^{BD}>p_C^{BD}$ under the BD strategy.

4. Optimal Channel Opening Strategy for Retailers

In this section, Maple software is used to analyze the retailer's optimal channel opening strategy.

4.1 Optimal Strategy Analysis for Online Retailers

Suppose $v=1$, $\alpha=0.3$, $\gamma=0.3$, $t=0.6$, $m=0.2$, $\delta=0.6$. By Theorem 1, it can be shown that under the OD strategy, when $\eta>0.24$, retailer A chooses $p_A^{DD}<p_C^{DD}$. By Theorem 2, it can be seen that under DD strategy, when $\eta<0.3$, retailer A chooses $p_A^{DD}<p_C^{DD}$ and when $\eta>0.3$, retailer A chooses $p_A^{DD}>p_C^{DD}$. Under BD strategy, retailer A will only choose $p_A^{DD}<p_C^{DD}$. Therefore, at $0<\eta<0.24$, we compare the relationship between the size of the expected returns Π_A^{DD*} and Π_A^{BD*}; at $0.24<\eta<0.3$, we compare the size of the expected returns Π_A^{OD*}, Π_A^{DD*}, and Π_A^{BD*}; at $0.3<\eta<1$, we compare the size of the expected returns Π_A^{OD*}, $\bar{\Pi}_A^{DD*}$, and Π_A^{BD*} .The result graphs are not detailed here, and the result is given directly.

For Retailer A, facing competition from Retailer C, the optimal decision is to open an offline channel and adopt dual-channel sales both online and offline (η when larger), or to proactively seek cooperation with Retailer C's BOPS (η when smaller).

Numerical simulations continue to be used to compare prices and demand for three channel selection strategies for different product waiting cost ranges ($0<\eta<0.24$, $0.24<\eta<0.3$, $0.3<\eta<1$). Due to space constraints, the resulting graph will not be described here.

When the product waiting cost (η) is small ($0<\eta<0.24$ and $0.24<\eta<0.3$), as η increases, retailer A's price and demand decrease under all three strategies, and the price is the highest and the demand is the lowest under the BD strategy. Retailer A's choice of BOPS with retailer C is the optimal strategy choice when the product waiting cost is small.

4.2 Optimal Strategy Analysis for Dual-Channel Retailers

Based on the above analysis, it can be obtained that the optimal strategy of retailer A is the BOPS model that adopts online sales and cooperates with retailer C when the product waiting cost is small, and the optimal strategy of retailer A is dual-channel sales when the product waiting cost is large. This subsection will analyze the optimal strategy of the dual-channel retailer. The comparison results are not detailed here.

Retailer C's expected returns under the BD strategy are higher than the other strategies, regardless of the product waiting cost. Combined with the findings in the previous subsection, this indicates that the two retailers are able to reach BOPS cooperation at $0<\eta<0.51$. When the product waiting cost is large ($0.51<\eta<1$), retailer A chooses the DD strategy and adopts the dual-channel strategy to compete with retailer C. The retailer A chooses the DD strategy when the product waiting cost is large. This suggests that Retailer A's DD strategy severely harms Retailer C's returns when product waiting costs are large.

5. Conclusion

This paper investigates the BOPS cooperation problem between online retailers and dual-channel retailers, establishes three channel models for online retailers' online-only channel sales, dual-channel sales, and BOPS cooperation with dual-channel retailers, and investigates the optimal scope of BOPS cooperation between online and dual-channel retailers. The study shows that: when the product waiting cost is small, both online retailers and dual-channel retailers have incentives to engage in BOPS cooperation, and the optimal decision of online retailers is dual-channel sales when the product waiting cost is large; when the product waiting cost is small, BOPS cooperation can increase the expected revenues of online retailers and dual-channel retailers. When product waiting costs are large, the online retailer's change to dual-channel selling harms the dual-channel retailer's returns.

References

[1] Bell D R, Gallino S, Moreno A. Inventory showrooms and customer migration in omni-channel retail: the effect of product information [J]. SSRN Electronic Journal, 2013, 2370535.

[2] Liang Xi, Liang Lunhai. Dual-channel supply chain pricing strategy and channel selection considering channel cost

differences[J]. Industrial Engineering, 2021, 24(02): 1-9.

[3] Bian Y W, Cheng W C. Research on offline channel strategy and operation mode selection of platform supply chain[J/OL]. China Management Science: 1-26 [2024-01-17].

[4] Wallace D W, Giese J L, Johnson J L. Customer retailer loyalty in the context of multiple channel strategies[J]. Journal of Retailing, 2004, 80(4): 249-263.

[5] Cattani K, Gilland W, Heese H S, et al. Boiling frogs: piecing strategies for a manufacturer adding a direct channel that competes with the traditional channel[J]. Production and Operations Management, 2006, 15(1): 40-56.

[6] Nematollahi M, Hosseini-Motlagh S M, Pazari P. Analytical insights into coordination and competition in dual-channel supply chains: a multi-factor dependent demand perspective[J]. Journal of Retailing and Consumer Services, 2024, 78: 103706.

[7] Sun C S, Adamopoulos P, Ghose A, et al. Predicting Stages in Omnichannel Path to Purchase: a Deep Learning Model[J]. Information Systems Research, 2022, 33(02): 399-764.

[8] Lin H, Kumar S. Benefit of consumer showrooming for a physical retailer: a distribution channel perspective[J]. Management Science, 2023, 9-28.

[9] Gao F, Su X M. Omnichannel retail operations with buy-online-and-pick-up-in-store[J]. Management Science, 2016, 63(8): 2478-2492.

[10] Cao J, So K C, Yin S. Impact of an "online-to-store" channel on demand allocation, pricing and profitability[J]. European Journal of Operational Research, 2016, 248(1): 234-245.

[11] Kong R X, Guan Z Z, Luo L. Research on omni-channel supply chain structure based on BOPS[J]. Journal of Management, 2019, 16(07):1072-1080.

[12] Pei Z, Ghose S, Yan R L, et al. The strategic value of buy online and pick up from store service to the dual channel coordination[J]. Journal of Retailing and Consumer Services, 2024, 77: 103648.

[13] Ge C C, Zhu J J. Research on omni-channel competitive strategy considering heterogeneous customers' multiple interaction behaviors[J]. Systems Engineering Theory and Practice, 2023, 43(05): 1395-1413.

[14] Ge C C, Zhu J J. Effects of BOPS implementation under market competition and decision timing in omnichannel retailing[J]. Computer & Industrial Engineering, 2023, 179: 109227.

[15] Qiu J, Zhao J, Fang X Y, Li T X. Research on retailers' BOPS strategy based on third-party logistics service pricing[J]. Journal of Management Engineering, 2023, 37(03):169-177.

[16] Robert R R. Bertrand competition with cost uncertainty[J]. Economic Letters, 2010, 107(3): 356-359.