Impact of BOPS and ES on Demand and Profitability: Theoretical Models and Simulation Analysis

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Abstract: With the development of information technology and mobile e-commerce, more and more retailers are beginning to provide consumers with convenient buy online and pickup in store (BOPS) shopping mode. Online channel often results in high return rates due to lack of product experience, while retailers can increase consumer perceive value by providing experience services (ES) to increase their purchases. However, the provision of BOPS and ES will incur certain operating costs. This paper establishes four profit models under different BOPS opening strategies and ES service offering strategies. Then, the study analyzes and compares the impacts of BOPS and ES on retailers' demand allocation and profitability. Finally, the simulation test is carried out by using MATLAB software. The results show that when ES is not provided before or after opening the BOPS channel, or ES is only provided after opening the BOPS channel, if the inconvenience of BOPS channel or online return rate is low, the opening of BOPS can reduce the online demand and increase the total demand and profit; when ES is provided before opening the BOPS channel and ES is not provided after opening the BOPS channel, the store demand, total demand and total profit will be reduced; when ES is not provided before opening the BOPS channel and ES is provided after opening the BOPS channel, the total demand and total profit increase more.

1 INTRODUCTION

With the rapid development of mobile Internet and O2O e-commerce, online and offline integration is increasing, and there is an emerging focus on “omnichannel retailing” that aims to provide customers with a seamless shopping experience through all available shopping channels (Bell 2014, Gallino 2014, Moreno 2014, Brynjolfsson 2013, Hu 2013, Rahman 2013, Rigby 2011). Among all omnichannel fulfillment initiatives, the BOPS mode that allows customers to buy online and pick up in store is regarded as the most important in omnichannel retailing. For example, Walmart, Best Buy, Uniqlo, and KFC have all implemented BOPS.

Under the online channel, the customer places an order online first, and the retailer delivers the goods to the consumer's home; under the offline store channel, the customer experience the product directly in the store, then places the order and picks it up to home. Different from the first two shopping modes, in the BOPS mode, consumers first place an order online and then pick up the goods at the selected physical store. Therefore, the BOPS omni-channel mode will bring new traffic and generate new orders when consumers pick up goods in offline store. Due to the lack of product experience services, the return rate of online channel is often high, which brings great losses to retailers. Especially products that need to be tried on and highly personalized products, such as fashion clothing, shoes and hats, cosmetics, etc. To this end, many retailers are starting to offer the ultimate experience service to customers in stores to improve consumers' perceived value of products and further enhance their purchase willingness and purchase conversion rates (Liu 2021, Long 2021, Hu 2021, Xu 2021). For example, Uniqlo allows users to enhance the brand’s awareness and influence while enhancing the user experience with merchandise display, personnel training, digital experience tools, and the final scan code payment. Zara stores enhance customers’ shopping experience with automated click-to-carry, self-checkout, and RFID interactive fitting mirrors. In the “Shoes HOME+” of Red Dragonfly, the intelligent retail terminal realizes three-dimensional foot measurement, big data analysis, product intelligent interaction, and product

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experience and personalized customization to enhance consumers' multilevel product experience.

However, the opening of the BOPS channel requires the cooperation and coordination of online and offline channels, including the connection of online and offline electronic systems, the increase of store service personnel and commodity inventory service capabilities, the distribution of benefits between different departments, etc. The provision of ES services also requires a certain amount of investment in people, money, equipment and facilities. Both of them will bring certain operating costs to retailers, and will inevitably have a certain impact on existing channels, demand and profits. Therefore, in this paper, we study the impact of BOPS and ES on the demand allocation and profitability of brand retailers in the following four situations: 1) ES is not provided before opening the BOPS channel; 2) ES is not provided after opening the BOPS channel; 3) ES is provided before opening the BOPS channel; 4) ES is not provided after opening the BOPS channel, and then make the best choice.

2 DECISION MODEL

2.1 Problem Description

A retailer sells products to customers with three alternative shopping channels: online channel (abbreviated as O channel), store channel (abbreviated as S channel) and BOPS channel.

We have already described similar problems in our previous paper (Liu 2021, Long 2021, Hu 2021, Xu 2021), so we won't repeat them here.

The notations used in our models and their definitions are shown in Table 1 below.

Table 1: Notations and Definitions.

Figure 1. **Notation**	Figure 2. **Definition**
p	Unit product price
c	Unit product cost
o	Consumer's shopping cost under O channel
h	Shopping inconvenient costs under S channel
l	The inconvenience of BOPS channel relative to S channel ($0 < l < 1$)
θ	Online return rate ($0 < \theta < 1$)
s	Customer perceive value of ES
w	A cross-selling net profit from each unit of store demand or BOPS demand
e	Cost factor of ES ($0 < e < 1$)
v	Product perceived value
U_i	Consumer utility under i channel ($i = O, S, and\ BOPS$)
U_{ij}	Consumer utility under i channel in case j ($i = O, S, and\ BOPS$, $j = 1, 2, 3, 4$)
Q_{ij}	The demand under i channel in case j ($i = O, S, and\ BOPS$, $j = 1, 2, 3, 4$)
Q_j	The total demand in case j ($j = 1, 2, 3, 4$)
Π_j	The total profit in case j ($j = 1, 2, 3, 4$)

According to the problem description and the notations and their definitions in Table 1, we can obtain the consumer utility functions under the three channels of O, S, and BOPS as the following (Liu 2021, Long 2021, Hu 2021, Xu 2021, Chiang 2002, Chhajed 2003, Hess 2003, Cao 2016, So 2016, Yin 2016):

$$U_O = (1-\theta)(v-p) - (1+\theta)o, \quad (1)$$

$$U_S = v - p - h + s, \quad (2)$$

$$U_{BOPS} = (1-\theta)(v-p+s) - lh. \quad (3)$$

For ease of analysis, we assume that both v and h are uniformly distributed on [0, 1].

2.2 Model Building

2.1.1 Case 1: ES Is Not Provided before Opening the BOPS Channel

In case 1, the retailer only has two channels of O and S to sell products, and he does not do any extra ES efforts in stores, i.e., $s = 0$. Thus, consumer utility functions are as following:

$$U_{O1} = U_O = (1-\theta)(v-p) - (1+\theta)o, \quad (4)$$

$$U_{S1} = v - p - h. \quad (5)$$

According to the distribution assumption of v and h, we can obtain the demand functions under the two channels of O and S as following (Liu 2021, Long 2021, Hu 2021, Xu 2021, Chiang 2002, Chhajed 2003, Hess 2003, Cao 2016, So 2016, Yin 2016):

$$Q_{O1} = (1 - p - \frac{1+\theta}{1-\theta}o)[1 - \frac{\theta}{2}(1-p) - (1-\frac{\theta}{2})\frac{1+\theta}{1-\theta}o], \quad (6)$$

$$Q_{S1}=\frac{(1+\theta)o}{2(1-\theta)}(2-2p-\frac{1+\theta}{1-\theta}o)+\frac{\theta}{2}(1-p-\frac{1+\theta}{1-\theta}o)^2 . \quad (7)$$

Then, the total demand is as follows:

$$Q_1=Q_{O1}+Q_{S1}=1-p-\frac{1+\theta}{1-\theta}o+\frac{1}{2}(\frac{1+\theta}{1-\theta}o)^2 . \quad (8)$$

In this case, because the retailer does not offer any extra ES efforts, he does not pay the ES cost. However, customers who come to the store will bring traffic and generate new orders due to cross-selling. The retailer obtains a net profit w from each unit of S demand (Gao 2017, Su 2017), thus, the total profit is obtained as follows:

$$\begin{aligned}\Pi_1&=(p-c)Q_{O1}+(p-c+w)Q_{S1}\\&=(p-c)[1-p-\frac{1+\theta}{1-\theta}o+\frac{1}{2}(\frac{1+\theta}{1-\theta}o)^2]\\&\quad+w[\frac{(1+\theta)o}{2(1-\theta)}(2-2p-\frac{1+\theta}{1-\theta}o)+\frac{\theta}{2}(1-p-\frac{1+\theta}{1-\theta}o)^2]\end{aligned} . \quad (9)$$

2.1.2 Case 2: ES Is Not Provided after Opening the BOPS Channel

In case 2, the retailer has three channels of O, S, and BOPS to sell products, but he does not offer any extra ES efforts in stores, i.e., $s=0$. Thus, consumer utility functions are obtained as following:

$$U_{O2}=U_O=(1-\theta)(v-p)-(1+\theta)o , \quad (10)$$

$$U_{S2}=v-p-h , \quad (11)$$

$$U_{BOPS2}=(1-\theta)(v-p)-lh . \quad (12)$$

Similar to Case 1, the demand functions under the three channels of O, S, and BOPS, and the total demand function can be obtained as following:

$$Q_{O2}=(1-p-\frac{1+\theta}{1-\theta}o)(1-\frac{1+\theta}{l}o)-\frac{\theta}{2}[1-p-\frac{(1-l)(1+\theta)}{\theta l}o]^2 , \quad (13)$$

$$Q_{S2}=\frac{(1+\theta)o}{2l}[2-2p-\frac{(1-l)(1+\theta)}{\theta l}o]+\frac{\theta}{2}[1-p-\frac{(1-l)(1+\theta)}{\theta l}o]^2 , \quad (14)$$

$$Q_{BOPS2}=\frac{(1+\theta)^2o^2}{2l}(\frac{1-l}{\theta l}-\frac{1}{1-\theta}) , \quad (15)$$

$$Q_2=Q_{O2}+Q_{S2}+Q_{BOPS2}=1-p-\frac{1+\theta}{1-\theta}o+\frac{(1+\theta)^2o^2}{2(1-\theta)l} . \quad (16)$$

In this case, because the retailer does not offer any extra ES, he does not pay the ES cost. However, whether customers who go to the store to try on and place an order through S channel, or customers who pick-up the goods through BOPS channel, they will bring traffic to the store and generate new orders and a net profit w. Thus, we obtain the retailer's profit function as follows:

$$\begin{aligned}\Pi_2&=(p-c)Q_{O2}+(p-c+w)Q_{S2}+(p-c+w)Q_{BOPS2}\\&=(p-c)[1-p-\frac{1+\theta}{1-\theta}o+\frac{(1+\theta)^2o^2}{2(1-\theta)l}]+w[\frac{(1+\theta)o}{2l}\cdot(2-2p-\frac{1+\theta}{1-\theta}o)+\frac{\theta}{2}(1-p-\frac{1-l}{\theta}\frac{1+\theta}{l}o)^2]\end{aligned} \quad (17)$$

2.1.3 Case 3: ES Is Provided before Opening the BOPS Channel

In case 3, the retailer only has two channels of O and S to sell products, but he does some extra ES effort in stores, i.e., $s\neq 0$. Thus, consumer utility functions are as following:

$$U_{O3}=U_O=(1-\theta)(v-p)-(1+\theta)o \quad (18)$$

$$U_{S3}=v-p-h+s . \quad (19)$$

Similar to Case 1, the demand functions under the two channels of O and S, and the total demand function can be obtained as following:

$$Q_{O3}=(1-p-\frac{1+\theta}{1-\theta}o)[1-s-\frac{\theta}{2}(1-p)-(1-\frac{\theta}{2})\frac{1+\theta}{1-\theta}o] , \quad (20)$$

$$Q_{S3}=(1-p-\frac{1+\theta}{1-\theta}o)[s+\frac{\theta}{2}(1-p)+(1-\frac{\theta}{2})\frac{1+\theta}{1-\theta}o]+\frac{1}{2}(\frac{1+\theta}{1-\theta}o+s)^2 , \quad (21)$$

$$Q_3=Q_{O3}+Q_{S3}=1-p-\frac{1+\theta}{1-\theta}o+\frac{1}{2}(\frac{1+\theta}{1-\theta}o+s)^2 , \quad (22)$$

$$\begin{aligned}\Pi_3&=(p-c)Q_{O3}+(p-c-es+w)Q_{S3}\\&=(p-c)[1-p-\frac{1+\theta}{1-\theta}o+\frac{1}{2}(\frac{1+\theta}{1-\theta}o+s)^2]+(w-es)\cdot\{(1-p-\frac{1+\theta}{1-\theta}o)[s+\frac{\theta}{2}(1-p)+(1-\frac{\theta}{2})\frac{1+\theta}{1-\theta}o]+\frac{1}{2}(\frac{1+\theta}{1-\theta}o+s)^2\}\end{aligned} \quad (23)$$

In this case, the retailer provides ES to customers of S channel, and customers who go to the store to try on and place an order through S channel will bring traffic to the store and generate new orders and a net profit w. Thus, we obtain the total profit function as Eq. (23).

2.1.4 Case 4: ES Is Provided after Opening the BOPS Channel

In case 4, the retailer sells products through three channels of O, S, and BOPS, and he does some extra ES effort in stores. Consumer utility functions are obtained as following:

$$U_{O4} = U_O = (1-\theta)(v-p) - (1+\theta)o \quad , \quad (24)$$

$$U_{S4} = v - p - h + s \quad , (25)$$

$$U_{BOPS4} = U_{BOPS} = (1-\theta)(v-p+s) - lh \quad . \quad (26)$$

Similar to Case 2 and Case 3, the demand and profit functions can be obtained as following:

$$Q_{O4} = (1-p-\frac{1+\theta}{1-\theta}o)[1-\frac{(1+\theta)o+(1-\theta)s}{l}] - \frac{1}{2}[\theta(1-p)+(1+\theta)o+s-\frac{(1+\theta)o+(1-\theta)s}{l}], \quad (27)$$
$$[1-p+s-\frac{1-l}{\theta}\frac{(1+\theta)o+(1-\theta)s}{l}]$$

$$Q_{S4} = \frac{(1+\theta)o+(1-\theta)s}{l}\{1-\frac{(1-l)[(1+\theta)o+(1-\theta)s]}{2l\theta}-p+s\} + \frac{1}{2}[\theta(1-p)+(1+\theta)o+s-\frac{(1+\theta)o+(1-\theta)s}{l}] \quad , \quad (28)$$
$$[1-p+s-\frac{1-l}{\theta}\frac{(1+\theta)o+(1-\theta)s}{l}]$$

$$Q_{BOPS4} = \frac{(1+\theta)o+(1-\theta)s}{2l} \quad , \quad (29)$$
$$\{\frac{(1-l)[(1+\theta)o+(1-\theta)s]}{\theta l} - \frac{(1+\theta)o}{1-\theta} - s\}$$

$$Q_4 = Q_{O4} + Q_{S4} + Q_{BOPS4} = 1-p-\frac{1+\theta}{1-\theta}o + \frac{(1+\theta)o+(1-\theta)s}{2l}(\frac{1+\theta}{1-\theta}o+s) \quad . \quad (30)$$

$$\Pi_4 = (p-c)Q_{O4} + (p-c-es+w)Q_{S4} + (p-c-es+w)Q_{BOPS4}$$
$$= (p-c)[1-p-\frac{1+\theta}{1-\theta}o+\frac{(1+\theta)o+(1-\theta)s}{2l}(\frac{1+\theta}{1-\theta}o+s)]$$
$$+(w-es)\{\frac{(1+\theta)o+(1-\theta)s}{2l}(2-2p+s-\frac{1+\theta}{1-\theta}o) + \frac{1}{2}[\theta(1-p)+(1+\theta)o+s-\frac{(1+\theta)o+(1-\theta)s}{l}] \quad . \quad (31)$$
$$[1-p+s-\frac{1-l}{\theta}\frac{(1+\theta)o+(1-\theta)s}{l}]\}$$

3 IMPACT OF BOPS AND ES ON DEMAND ALLOCATION AND PROFITABILITY

In this section, we analyze the impact of BOPS and ES on demand allocation and profitability in four scenarios.

3.1 No ES is Provided before and after Opening the BOPS Channel

In this scenario, by comparing the corresponding demand and profit functions (6) ~ (9) and (13) ~ (17), the following proposition 1 can be easily obtained.

Proposition 1. If ES is not provided, BOPS channel has the following effects on the retailer.

(i) The total demand increases by $\frac{o^2(1+\theta)^2(1-l-\theta)}{2l(1-\theta)^2}$, its demand from the online channel decreases by $\frac{o^2(1+\theta)^2(1-l-\theta)^2}{2l^2(1-\theta)^2\theta}$, and its demand from the store channel decreases by $\frac{o^2(1+\theta)^2(1-l-\theta)}{2l(1-\theta)\theta}$.

(ii) The total profit increases by $\frac{o^2(1+\theta)^2(1-l-\theta)[(1-l-\theta)w+(p-c+w)l\theta]}{2\theta l(1-\theta)^2}$.

Furthermore, if $w > \frac{l\theta^2(p-c)[4l-(3-\theta)(1-\theta)]}{(1-l)(1-\theta)[l(1-3\theta)-(1-\theta)^3]}$ and $l < (1-\theta)(3-\theta)/4$, the increases in total demand and total profit are negatively correlated with l and positively correlated with o. The increases in total profit and total demand are positively correlated with θ, and vice versa. These values are both independent of s.

Proposition 1(i) shows the impact of BOPS on the demand allocations when ES is not offered before and after opening the BOPS channel. Actually, some customers will switch from O channel to BOPS channel to avoid the costs of shipping and waiting time, and some customers will switch from S channel to BOPS channel to reduce the inconvenient costs of finding goods among shelves and waiting for checkout, thereby reducing the demand from both O channel and S channel. In addition, this new BOPS channel can generate new demand that was not previously available. As a result, the retailer's total

demand increases. Proposition 1(ii) shows the conditions under which the retailer benefits from opening BOPS channel due to cross-selling.

3.2 No ES is Provided before Opening the BOPS Channel and ES is Provided after Opening the BOPS Channel

In this scenario, by comparing the demand and profit functions (6) ~ (9) and (27) ~ (31), the following proposition 2 can be easily obtained.

Proposition 2. If no ES is provided before opening the BOPS channel and ES is provided after opening the BOPS channel, BOPS has the following effects on the retailer.

(i) The total demand increases by $\frac{s^2(1-\theta)^3+2os(1-\theta)^2(1+\theta)+o^2(1+\theta)^2(1-l-\theta)}{2l(1-\theta)^2}$, its demand from the online channel decreases by $\frac{(1-l-\theta)^2[o^2(1+\theta)^2+s^2(1-\theta)^2]+2s(1-\theta)^2A}{2\theta l^2(1-\theta)^2}$, and its demand from the store channel decreases by $\frac{B}{2\theta l(1-\theta)}$, when $l<\frac{o(1-\theta)[o(1+\theta)^2+2s(1-\theta^2)]+s^2(1-\theta)^3}{s(1-\theta)[2\theta(1-p)+s]+o[o(1+\theta)^2+2s(1-\theta^2)]}$. Furthermore, the increase in total demand is negatively correlated with l and positively correlated with o and s. If $l<\frac{(1-\theta)[4o^2-(1-\theta)^2(o-s)^2]}{4o^2(1+\theta)}$, the increase in total demand is negatively correlated with θ, and vice versa, where

$$A=o(1+\theta)(1-l)^2-o\theta(1+\theta)+\theta l^2(1-p),$$

$$B=o(1-l-\theta)[o(1+\theta)^2+2s(1-\theta^2)]+s(1-\theta)[s(1-\theta)^2-sl-2l(1-p)\theta].$$

(ii) The total profit increases by $\frac{C-lD+l^2E}{2\theta l^2(1-\theta)^2}$ if and only if $l<\left(D-\sqrt{D^2-4CE}\right)/(2E)$, where

$$C=(w-es)(1-\theta)^2(o+s+o\theta-s\theta)^2,$$

$$D=[(w-es)(2-\theta)-(p-c)\theta](o+s+o\theta-s\theta)^2(1-\theta)$$

$$E=s(1-\theta)^2[2ow(1+\theta)-e(o+s+\theta+o\theta-p\theta)^2+ws+2w\theta(1-p)]-o^2(1+\theta)^2[(p-c)\theta-w(1-\theta)].$$

Proposition 2(i) shows the impact of BOPS on the demand allocations when ES is not offered before opening the BOPS channel and ES is offered after opening the BOPS channel. Similar to Proposition 1, the total demand increases. Proposition 2(ii) shows the condition for the increase in total profit after opening the BOPS channel.

3.3 ES is Provided before Opening the BOPS Channel and no ES is Provided after Opening the BOPS Channel

In this scenario, by comparing the demand and profit functions (13) ~ (17) and (20) ~ (23), the following proposition 3 can be easily obtained.

Proposition 3. If ES is provided before opening the BOPS channel and no ES is provided after opening the BOPS channel, BOPS has the following effects on the retailer.

(i) If $l>\frac{o^2(1+\theta)^2(1-\theta)}{[o(1+\theta)+s(1-\theta)]^2}$, then the total demand is reduced by $\frac{ls^2(1-\theta)^2-o^2(1+\theta)^2(1-l-\theta)+2los(1-\theta^2)}{2l(1-\theta)^2}$. If $o>[\sqrt{[2s\theta l^2(1-\theta^2)]^2+8\theta sl^2(1-p)(1+\theta)^2(1-l-\theta)^2(1-\theta)^2}-2s\theta l^2(1-\theta^2)]/[2(1+\theta)^2(1-l-\theta)^2]$, the online channel demand is reduced by $\frac{o^2(1+\theta)^2(1-l-\theta)^2+2os\theta l^2(1-\theta^2)-2\theta sl^2(1-p)(1-\theta)^2}{2\theta l^2(1-\theta)^2}$, and the store channel demand is reduced by $\frac{ls\theta(2-2p+s)(1-\theta)+o^2(1+\theta)^2(1-l-\theta)}{2\theta l(1-\theta)}$. Furthermore, the reduction in total demand is positively correlated with l and s. Only when l is greater than a certain threshold, the reduction in total demand is positively correlated with o and θ.

(ii) The retailer's profit is reduced by $\frac{o^2w(1-\theta^2)\theta^2-Fl+Gl^2}{2l^2\theta(1-\theta)^2}$, if $l>\frac{F-\sqrt{F^2-4Go^2w(1-\theta^2)\theta^2}}{2G}$, where

$$F=o^2(1-\theta)(1+\theta)^2[w(2-\theta)-(p-c)\theta],$$

$$G=o^2(1+\theta)^2[(w-es\theta)(1-\theta)-(p-c)\theta]-2os\theta(1-\theta^2)[(p-c)-e(1-p)(1-\theta)]-H,$$

$$H=s\theta(1-\theta)^2[(p-c+w)s+2(1-p)(w-es)-es^2-e\theta(1-p)^2].$$

Proposition 3(i) shows that total demand is usually reduced, except for a few cases where the inconvenience of the BOPS channel is extremely low. Moreover, store channel demand is reduced, and the online channel demand is reduced under some conditions. Furthermore, the higher the l or s, the more the total demand is reduced. When l is greater than a certain threshold, the higher the o or θ, the more the total demand is reduced. Proposition 3(ii) shows that the total profit is reduced when the inconvenience of the BOPS channel exceeds a certain threshold.

3.4 ES is Provided before and after Opening the BOPS Channel

In this scenario, by comparing the demand and profit functions (27) ~ (31) and (20) ~ (23), the following proposition 4 can be easily obtained.

Proposition 4. If ES is provided before and after opening the BOPS channel, BOPS has the following effects on the retailer.

(i) The total demand increases by $\frac{(1-l-\theta)(o+s+o\theta-s\theta)^2}{2l(1-\theta)^2}$, its demand from the online channel decreases by $\frac{(o+s+o\theta-s\theta)^2(1-l-\theta)^2}{2\theta l^2(1-\theta)^2}$, and its demand from the store channel decreases by $\frac{(1-l-\theta)(o+s+o\theta-s\theta)^2}{2\theta l(1-\theta)}$. Furthermore, the increase in total demand is negatively correlated with l and positively correlated with o and s. If $l<\frac{o(3-4\theta+\theta^2)-s(1-\theta)^2}{4o}$, the increase in total demand is negatively correlated with θ, and vice versa.

(ii) If and only if $l<\frac{(w-es)(1-\theta)}{(w-es)(1-\theta)-\theta(p-c)}$, the total profit increases by $\frac{(1-l-\theta)(o+s+o\theta-s\theta)^2[(w-es)(1-l)(1-\theta)+l\theta(p-c)]}{2\theta l^2(1-\theta)^2}$, where $J=(w-es)(1-\theta)+l(1+\theta)[(p-c)\theta-(w-es)(1-\theta)]$.

Proposition 4(i) shows the impact of BOPS on the demand allocations when ES is offered before and after opening the BOPS channel. Similar to Proposition 1, the total demand increases. Proposition 4(ii) shows that the total profit increases after opening the BOPS channel when the inconvenience of the BOPS channel within a certain threshold.

Therefore, if ES is provided, the retailer's profitability under the three channels of O, S, and BOPS channel is better than that under the two channels of O and S when the BOPS channel is convenient or the online return rate is not very high.

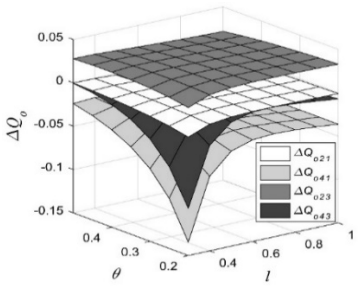
4 COMPARISON AND SIMULATION ANALYSIS

In this section, we set $p=0.6$ and $c=0.3$ with different values of l, o and θ, the value range of l is set to [0.3, 0.9], the value range of θ is set to [0.1, 05]. In addition, $o=0.04$ indicates that the shopping costs of the online channel is low, and $o=0.12$, indicates that the shopping costs of the online channel is high. The comparison and simulation analysis of the impact of opening the BOPS channel on demand and profit in the four scenarios are shown in Fig. 1 to Fig. 4 by using MATLAB software.

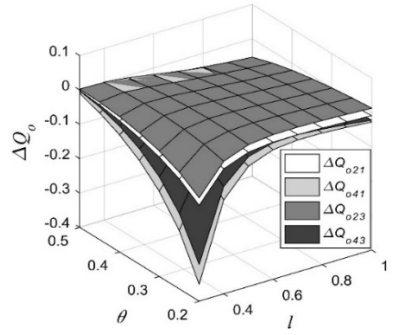
From Fig. 1, we can get the following conclusion 1.

Conclusion 1. When ES is not provided before or after opening the BOPS channel, or ES is only provided after opening the BOPS channel, the online demand will be reduced because $\Delta Q_{O21}<0$, $\Delta Q_{O41}<0$, $\Delta Q_{O43}<0$. Moreover, regardless of whether ES is provided after opening the BOPS channel, when ES is not provided before opening the BOPS channel, the online demand will be reduced more because $\Delta Q_{O41}<\Delta Q_{O43}$, $\Delta Q_{O21}<\Delta Q_{O23}$.

In addition, the opening of the BOPS channel does not necessarily reduce the online channel demand due to the lack of ES. As noted in Fig. 1 (a) and (b), the higher the shopping costs of the online channel, the more the online channel demand is reduced.



(a) $o=0.04$ (low)

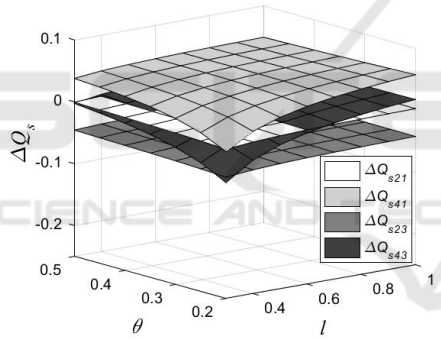


(b) $o = 0.12$ (high)

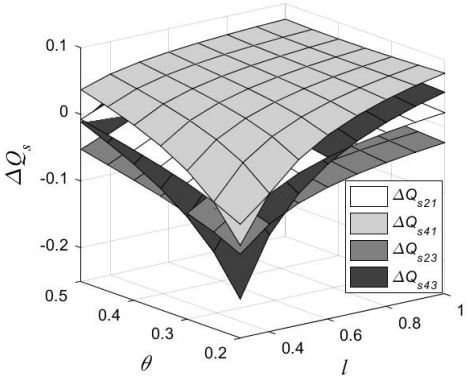
Figure 1: Ccomparison of changes in the online channel demand ΔQ_O.

From Fig. 2, the following conclusion 2 can be obtained.

Conclusion 2. The store demand is definitely reduced in the scenario where ES is provided before opening the BOPS channel and no ES is provided after opening the BOPS channel because $\Delta Q_{S23} < 0$.

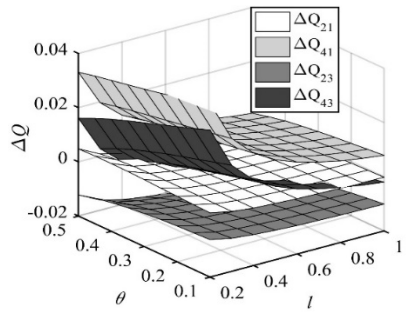


(a) $o = 0.04$ (low)

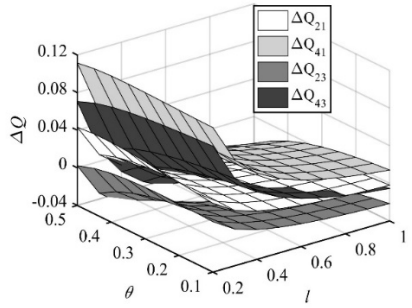


(b) $o = 0.12$ (high)

Figure 2: Comparison of changes in the store channel demand ΔQ_S.



(a) $o = 0.04$ (low)



(b) $o = 0.12$ (high)

Figure 3: Comparison of changes in the total demand ΔQ.

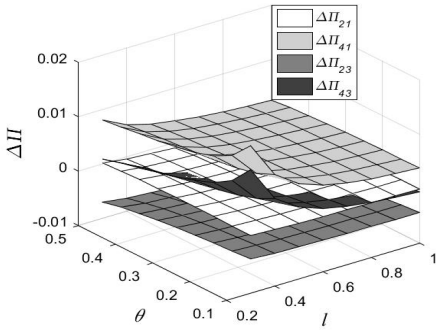
Fig. 2 demonstrates that when the inconvenience of the BOPS channel and the online return rate is not very high, if ES is provided before opening the BOPS channel, and regardless of whether ES is provided after opening the BOPS channel, the store channel demand will be reduced because $\Delta Q_{S23} < \Delta Q_{S43} < \Delta Q_{S21} < \Delta Q_{S41} < 0$. In addition, the higher the shopping costs of the online channel, the more the store channel demand is reduced.

As noted in Fig. 3 and Fig. 4, we can get the following conclusion 3.

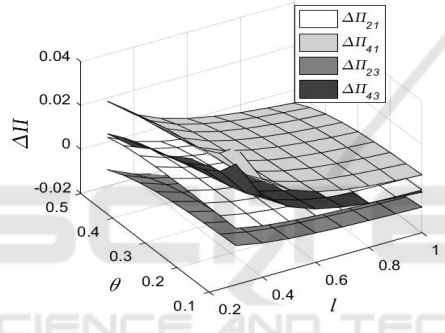
Conclusion 3. After opening the BOPS channel, when the inconvenience of the BOPS channel and the online return rate is not high, the increases in the total demand and total profit in the second scenario are the largest followed by the fourth scenario because $\Delta Q_{23} < 0 < \Delta Q_{21} < \Delta Q_{43} < \Delta Q_{41}$, $\Delta \Pi_{23} < 0 < \Delta \Pi_{21} < \Delta \Pi_{43} < \Delta \Pi_{41}$.

In addition, regardless of whether ES is provided before opening the BOPS channel, providing ES after opening the BOPS channel can increase total demand and total profit more. It reflects the significant role of ES. Furthermore, comparing (a) and (b) in Fig. 3 and Fig. 4, we observe that when the BOPS channel is more convenient and the online return rate is lower or the shopping costs of online channel is higher, the opening of the BOPS channel is more profitable.

The third scenario is the most special of the four scenarios. This scenario demonstrates that in the current new retail era, ES has become increasingly important and is an inevitable trend to provide customers with the ultimate experience service to enhance their competitive advantage.



(a) $o = 0.04$ (low)



(b) $o = 0.12$ (high)

Figure 4: Comparison of changes in the total profit $\Delta\Pi$.

5 CONCLUSIONS

In this paper, we present four models to study the impact of BOPS and ES on demand allocation and profitability. We find that whether a retailer provides ES and whether a retailer opens the BOPS channel depends on the number of stores and product characteristics of the retailer. The number of physical stores determines the convenience of the BOPS channel, the product characteristics determine the customer's demand for the experience service and the return rate. Therefore, for daily necessary products, due to the low online return rate and the high shipping cost, regardless of whether ES is provided, it is advisable to open the BOPS channel to increase store traffic and generate new demand; For fast fashion clothing, shoes and hats and consumer electronics, due to the high demand for ES, it is advisable to provide ES to increase customer purchases regardless of whether the BOPS channel is open. In the above two cases, it is more profitable to open the BOPS channel when the number of stores is large. However, if the number of stores is small (that is, the delivery is not convenient), the product lacks features or the update is slow, then the opening of the BOPS channel or providing ES will reduce the total demand and total profit.

This study offers several essential insights for retailers in omnichannel retailing and helps them develop successful omnichannel strategies. The store's ultimate experience service not only increases the purchase of the store channel and BOPS channel but also directly and indirectly reduces the total return rate. Therefore, regardless of whether BOPS is opened, we recommend retailers to provide ES in the new retail era centered on consumer experience.

BOPS is a popular fulfillment option among customers. However, not all products are suitable for store pick-up, such as large furniture, large appliances and fresh goods. Therefore, selecting an item suitable for in store and making corresponding inventory decisions may be another interesting research question in the future.

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