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Research on Multi-Channel Pre-Sale Strategies for New Retail Enterprises in the Context of Big Data

Xuerui Qin^{a,1} and Hao Chen^a

School of Economics and Business Administration, Yibin University, Yibin City, Sichuan 644000, China ORCiD ID: Xuerui Qin https://orcid.org/0009-0005-5677-5299 Hao Chen https://orcid.org/0000-0003-0877-8979

Abstract. High-tech industries such as information technology, big data and artificial intelligence have developed rapidly. New retail has gradually developed from the dual channel mode of mutual independence and competition between online and offline to the multi-channel mode of mutual resource sharing, coordination and cooperation and mutual drainage. And this model has become the current trend of China's business model development. When online and offline pre-sale strategies are jointly adopted, this paper aims at maximizing the profits of enterprises, introduces consumer functions, solves multi-channel pre-sale strategies, obtains profit maximizing pre-sale discounts and sales prices. Through examples, it is proved that in the stage of production and pre-sale, the profit of new retail enterprises in controlling discounts, pricing and inventory through pre-sale discount strategies.

Keywords. New retail, Multi-channel, Pre-sale

1. Introduction

In recent years, big data technology has been widely used in the fields of national defense, production and manufacturing, retail, marketing, scientific research, medical treatment and logistics. Sales enterprises can use big data to achieve precision marketing, predict sales trends and accurately grasp consumer demand, consumption habits and other information. Consumers can also obtain information such as commodity price changes and customer evaluations at any time through mobile phones and other mobile terminals. Through the analysis and application of big data, the information of the buyer and the seller is gradually transparent, and the elimination of the information for the seller becomes more intense[1].

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Multi-channel supply chain refers to the dual channel model in which enterprises, both online and offline, are independent and compete with each other. By adjusting cooperation, two or more marketing channels are jointly provided to customers with information, goods, services, etc. In the modeling process of this paper, multi-channel is classified into network channels and physical channels, namely online and offline multi-channel.

Pre-sale refers to the act of the seller allowing the buyer to purchase a product in advance before it is actually obtained. Research shows that pre-sale benefits both sellers and consumers. On the one hand, pre-sale can enable consumers to obtain direct price concessions. On the other hand, pre-sale can enable the seller to obtain demand information in advance, help the seller plan in advance and reduce demand changes, so as to benefit consumers by reducing breach of contract and lowering payment prices. The pre-sale strategy belongs to the field of operation management and revenue management, and has also aroused widespread concern in the academic circles of management and economics in recent years. Therefore, it is necessary to summarize and sort out the research on pre-sale strategies based on consumer behavior in order to promote theoretical construction and practical application.

2. Literature Review

2.1. Research on multi-channel supply chain

The multi-channel supply chain is an important research direction in the field of supply chain management at present. The early multi-channel supply chain only includes two channels of manufacturers and retailers, but now it refers to multi-channel sales methods such as online and offline, and such research has been widely concerned by scholars.

Zhang R studied the Stackelberg game and Nash equilibrium under the leadership of manufacturers and retailers respectively under the condition that products are fungible, and analyzed the impact of the equilibrium on the whole supply chain^[2]. Dan Bin studied the optimal price under centralized and decentralized decision-making in a dual channel supply chain, and proposed a coordinated compensation strategy for dual channels[3]. Junhai Ma studied the dynamic game problem between a two-channel supply chain composed of manufacturers and retailers, in which manufacturers can also sell goods to consumers and retailers become competitors according to changes in market demand[4]. Liu Tingting uses principal-agent theory to analyze the impact of asymmetric production costs on the effectiveness of supply chains, and coordinates supply chains through optimal contracts. However, the supply chain studied in the above literature is not a dual channel supply chain [5]. Zhang Linlin explored the dual channel price consistency strategy by building a game model of different power structures[6]. Yi Shiming studied the impact of customer value in a dual channel supply chain, constructed separate unified pricing models for direct channels and online retail platform distribution channels, and discussed pricing models under decentralized and centralized decision-making respectively[7].

2.2. Research Status of Pre-sale Strategy

The pre-sale discount strategy is an effective measure to attract and lock customers and reduce the uncertainty of market demand. This kind of research started relatively late, basically relying on the development of e-commerce, and the existing research basically focuses on the determination of pre-sale prices and returns.

Prasad proposes that advance booking puts consumers at risk, but providing appropriate discounts can make up for such risks, and adopts the newsboy model to give the optimal pricing and inventory strategies under the pre-sale mode respectively^[8]. Mr Mu Yinping studied option purchase and pre-sale under random demand, and the study shows that pre-sale can lock up part of the demand, and when the demand is normal distribution, there is a unique pre-sale discount[9]. Mao Zhaofang studied the optimal pre-sale price and order quantity based on the behavior characteristics of strategic consumers[10]. Zhai Shuo et al. studied the optimal pricing strategy under uncertain market demand, and found that the supply during the pre-sale period depends on the purchase cost of the product, and when the risk coefficient of consumers is high, the pre-sale price and profit are low[11]. Li Xuemei studied the pre-sale strategies of two sellers with different credit levels under the effect of publicity diffusion through prepayment, vouchers and gifts[12]. Wei Ming cheng has studied a pre-sale strategy to deal with consumers' strategic consumption, and the use of price guarantee contracts or output restraint strategies can significantly improve retailers' profits[13]. Sun Hongyan et al. put forward that in a competitive market, the discount pre-sale strategy of merchants can prevent competitors from entering the market by enhancing consumer comments[14].

Based on the above literature, it can be found that most scholars consider the behavior of strategic consumers between price discounts and no discounts in pricing strategies, but few scholars consider the impact of discounts on other multi-channel supply chains due to online or offline channels. Therefore, this paper considers the optimal pricing strategy and order quantity for a company with both online and offline multi-channel supply chains, under both discounted and non-discounted conditions, when consumers have multiple channel options.

3. Research on the multi-channel pre-sale strategy of new retail enterprises under the background of big data

3.1. Problem Description

The multi-channel pre-sale assumes that the new retail enterprise has its own factory, the brand dealer of the new retail has two retail channels: online network and offline entity, and the consumers of the two channels are homogeneous and independent from each other. When adopting the pre-sale strategy, the retailer will summarize the pre-sale volume and the forecast commodity demand and submit them to the factory. At the same time, retailers need to maximize the profits of the supply chain, determine the pre-sale discount and the order quantity in the normal sales period[15].



Figure 1. Short caption.

3.2. Model assumptions and parameter descriptions

Consider that the same brand has two sales channels, online and offline, that are completely independent between the two sales channels, that the consumers of the two channels are homogeneous and independent from each other, and that all consumer needs are random. Suppose that the demand of the two channels follows the normal distribution (μ_e, σ_e) and (μ_r, σ_r) respectively, and the dispersion coefficient of the demand of the two channels is the same, that is, $\theta = \mu_e / \sigma_e = \mu_r / \sigma_r$, and there is $\mu_e + \mu_r = \mu$; Assume that $s < C_i < \varphi_i \cdot P_i$, that is, the residual value of the goods sold through online or offline channels is less than the cost, and the cost is less than the final selling price of the goods. The parameters used in this paper are shown in Table 1.

Parameter	Description	Parameter	Description
θ	Discretization coefficient of demand	x	Commodity discount
i, j	$i, j = \{e, r\}$, where e refers to online network channels; R refers to offline physical channels.	D_i^y	Demand at pre-sale of channel i
S	Product residual value	D_i^z	Channel i normal sales demand
C_{i}	Cost of goods	D_{i}	Demand for online or offline channel commodities
$arphi_i$	Discount factor	$\pi_i(arphi_i)$	Profits at discount for online or offline channels
P_i	Sales price	TC_i	Shortage cost of online or offline channels
r _{ie} ∖ r _{ir}	Proportion of consumers in channel i choosing online or offline channels	Q_i	Order quantity of commodities in online or offline channels
a, b	Channel selection parameters caused by such factors as consumer loyalty and price sensitivity		

 Table 1 Parameter Description

In the environment of multi-channel sales by new retail enterprises, if one of the channels adopts a pre-sale strategy, it will attract some consumers who are sensitive to product prices from other channels, but at the same time, taking into account consumer loyalty and price sensitivity, this paper quotes the consumer response function proposed by Bellantuono[16].

The proportion of consumers in channel i who choose to pre-sell from online channels is:

$$r_{ie} = 1 - ax^f \tag{1}$$

The proportion of consumers in channel i who choose to pre-sell from offline channels is:

$$r_{ir} = 1 - bx^g \tag{2}$$

Considering that consumers are sensitive to the loyalty and price of different sales channels, this paper assumes that a < b; For the convenience of subsequent solution, suppose f = g = 1.

The demand D_i^y at the time of pre-sale of channel i is composed of the pre-sale volume and the commodity demand in the official sales season, so there are:

$$D_i^{y} = R_{ie} \cdot D_e + R_{ir} \cdot D_r \tag{3}$$

$$D_{i}^{z} = (1 - R_{ie} + R_{ir})D_{i}$$
(4)

3.3. Model solution

When new retail enterprises adopt pre-sale strategies in both online and offline channels, each channel will not only stimulate loyal consumers in its own channels to participate in pre-sale. At the same time, because when the discounts of the two channels are different, they will also attract consumers from the other channel. At this time, the commodity demand during the online and offline pre-sale periods and the normal sales season is as follows:

$$D_r^{\gamma} = R_{rr} \cdot D_r + R_{ee} \cdot D_e \tag{5}$$

$$D_r^z = (1 - R_{rr} - R_{re}) \cdot D_r \tag{6}$$

$$D_e^{\nu} = R_{er} \cdot D_e + R_{re} \cdot D_r \tag{7}$$

$$D_e^z = \left(1 - R_{er} - R_{ee}\right) \cdot D_e \tag{8}$$

At this time, the profits obtained by online and offline channels are:

$$\pi_r(\varphi_r) = (\varphi_r P_r - C_r) \cdot (D_r^y + D_e^y) + P_r \cdot \min(Q_r, D_r^z) + s(Q_r - D_r^z)^+ - TC_r(D_r^z - Q_r)^+ - C_r Q_r$$
(9)

$$\pi_{e}(\varphi_{e}) = (\varphi_{e}P_{e} - C_{e}) \cdot (D_{r}^{y} + D_{e}^{y}) + P_{e} \cdot \min(Q_{e}, D_{e}^{z}) + s(Q_{e} - D_{e}^{z})^{+} - TC_{e}(D_{e}^{z} - Q_{e})^{+} - C_{e}Q_{e}$$
(10)

Wherein, ()⁺ refers to the positive part of the content of the part. In order to solve the discount coefficients φ_r and φ_e at the time of maximum profit, the partial derivative of the discount coefficients in formulas (9) and (10) is equal to 0.

$$\varphi_e = \frac{P_e + \lambda b C_e (1 + k_r \theta) + a(1 - \lambda) T_e}{2 P_e \left\lceil a(1 - \lambda) + b\lambda \right\rceil}$$
(11)

$$\varphi_r = \frac{P_r + C_r \left[\lambda a + b(1-\lambda)\right] + a\lambda T_r}{2P_r \left[a\lambda + b(1-\lambda)\right]}$$
(12)

The optimal online and offline order quantities for normal sales quarters are:

$$Q_e = \mu_e + k_e \sigma_e = (1 + k_e \cdot \theta)(1 - \lambda)\mu(a\varphi_e + b\varphi_r)$$
⁽¹³⁾

$$Q_r = \mu_r + k_r \sigma_r = (1 + k_r \cdot \theta) \lambda \cdot \mu (a\varphi_e + b\varphi_r)$$
(14)

Where :

$$k_{e} = \phi^{-1} \left(\frac{P_{r} + TC_{r} - C_{r}}{P_{r} + TC_{r} - s} \right); \quad k_{r} = \phi^{-1} \left(\frac{P_{e} + TC_{e} - C_{e}}{P_{e} + TC_{e} - s} \right)$$
(15)

$$T_e = (P_e - C_e + TC_e) - \theta (P_e + TC_e - s)\phi(k_e)$$
(16)

$$T_r = (P_r - C_r + TC_r) - \theta (P_r + TC_r - s)\phi(k_r)$$

$$\tag{17}$$

The expected profits π_e^{Ex} and π_r^{Ex} online and offline are:

$$\pi_e^{E_x} = \lambda \mu T_e = \left(\varphi_e P_e - C_e\right) \mu \left\{1 - \left\lceil \lambda b + (1 - \lambda) \right\rceil a \varphi_r\right\} + (1 - \lambda) (1 + a \varphi_r) T_e$$
(18)

$$\pi_r^{E_x} = (1-\lambda)\mu T_r = (\varphi_r P_r - C_r)\mu \left[\lambda(1-a\varphi_r) + (1-\lambda)(1-b\varphi_e)\right] + \lambda\mu a\varphi_r T_r$$
(19)

It can be seen that when both channels adopt a pre-sale strategy, $r_{er} \cdot D_e$ (number of consumers) will move from online to offline channels during pre-sale. At the same time, during online pre-sales, $r_{er} \cdot D_e$ will shift from offline to online consumption. Thus, it can be concluded that new retail enterprises, both online and offline, adopt a discounted pre-sale strategy, and their profits are higher than when the original channel does not have pre-sales. As for a single channel, adopting a pre-sale strategy results in higher profits compared to not adopting or partially adopting a pre-sale strategy

4. Case Analysis

This paper selects a sports shoe from the ANTA brand as an example for analysis. According to the actual production and sales data of the product, the demand of the online and offline sales channels of the product is designed to obey the normal distribution, and the basic date is: $P_e = 299$, $C_e = 200$, s = 100, $P_r = 349$, $C_r = 200$, $\lambda = 0.5$, $\mu = 100$, a = 0.85, b = 0.9, $\theta = 0.3$.

By substituting these basic data into the previous formula, the optimal price discount for profit maximizing is $\varphi_e = 0.96$ and $\varphi_r = 0.93$, and the maximum profits obtained online and offline are $\pi_e = 4604.4$ and $\pi_r = 7413.7$ respectively. On this basis, the profits of online and offline sales channels when there is no discount or only partial discount are compared, as shown in Table 2.

	φ_{e}	$arphi_r$	π_{e}	π_r	Total profit
No discount	-	-	3744.7	6125.1	9869.8
Only online discount	0.96	-	3370.2	7413.7	10783.9
Only offline discount	-	0.93	4604.4	5206.3	9810.7
Online and offline discounts	0.96	0.93	4604.4	7413.7	12078.1

Table 2 Profit comparison of different discount forms

As can be seen, the profit is higher when discount pre-sale is adopted online and offline. The profit gap when only online pre-sale at a discount or only offline is not large. This is because some price sensitive consumers are attracted by pre-sale discounts to switch channels to purchase goods. When the online and offline channels adopt pre-sale strategies at the same time, they obviously obtain more profits than other sales methods.

According to the discount coefficient and pre-sale strategy in the example, the relationship chart between the inventory level and market share of online and offline channels with or without pre-sale strategy is drawn.



without pre-sale It can be seen in Figure 2, the inventory level of online and offline channels increases with the increase of the market share of the channel, regardless of whether there is a pre-sale strategy. Moreover, for the online and offline channels, the inventory with pre-sale is higher than that without pre-sale, which also explains that pre-sale will

stimulate some price sensitive consumers to purchase goods. Similarly, the relationship between the inventory level and the dispersion coefficient can be analyzed when there is no pre-sale online or offline, as shown in Figure 3. It can be seen that when there is no pre-sale online or offline, the inventory level increases with the increase of the dispersion coefficient, and new retail enterprises will increase the inventory level to deal with the uncertainty of the market. From this analysis, the trend of dispersion coefficient and inventory level at the time of pre-sale cannot be determined, and only all discount coefficients can be determined, and the inventory level of the same channel with pre-sale will be higher than that without presale.

5 Conclusion

This paper studies the multi-channel pre-sale problem of new retail enterprises, and conducts comparative analysis and quantitative modeling according to whether online and offline pre-sale strategies are adopted. When a channel adopts a pre-sale discount strategy, consumers can book products in advance before the normal sales season at a certain discount price. By establishing profit maximizing models for online and offline channels respectively, the optimal order quantity, optimal price discount and maximum expected profit under the condition of profit maximizing are obtained. As a result, greater profits can be made by adopting the pre-sale strategy. In the multi-channel supply chain of new retail enterprises, in the face of competition between online and offline channels, supply chain members will maximize their own interests in various ways. The pre-sale strategy is to attract price sensitive consumers through the pre-sale discount strategy before formal sale, and lock some consumers in advance. The pre-sale discount strategy can not only stimulate potential consumers and reduce the cash flow pressure of enterprises, but also reduce the uncertainty of market demand and reduce the inventory pressure of enterprises by locking some consumers. Finally, in the production and pre-sale stages, the pre-sale discount strategy is used to assist the new

retail enterprises in inventory control and maximize the multi-channel profits of the new retail enterprises.

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