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Research on the Selection of Sales Channels and Pricing for Perishable Products Based on the Pre-sale Strategy

Xiaozhuo Wu*, Sicheng He

College of Management, Shanghai University, Shanghai 200444, China

**Corresponding author e-mail: wuxiaozhuo@shu.edu.cn*

ABSTRACT. *In order to solve the problems of overproduction and demand uncertainty of perishable products. Retailers often adopt the pre-sale strategy to understand the needs of consumers, and then take more reasonable pricing decisions and sales decisions. Based on the perspective of retailers, this paper studies how to determine the optimal selection of sales channels and pricing strategy in the advance selling when retailers are faced with different market environments.*

KEYWORDS: *pre-sale strategy, perishable products, selection of sales channels, pricing strategy*

1. Introduction

The development of Internet and information technology makes the application of pre-sale more extensive. Pre-sale strategy is often applied to perishable products, such as moon cakes and fresh market. Retailers reduce inventory risk by pre-selling, making orders in line with the actual market demand. In addition, some electronic products, books, clothing and other new products have also adopted the online pre-sale strategy, providing some preferential policies to encourage consumers to pre-order before the official release.

Scholars have studied the pre-sale strategy from different perspectives. Some scholars believe that consumers have great uncertainty in the valuation of products. Xie Jinhong et al. studied the service market and found that when consumers were uncertain about the value of products, sellers could increase market demand and increase profits by implementing pre-sale strategies [1]. According to Robert S, during the period of spot sales, consumers will not buy products if the valuation is lower than the selling price. However, these consumers may choose to buy products

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when the pre-sale valuation is uncertain online [2]. Some scholars also consider the effects of capacity constraints and market size uncertainty on pre-sale strategy. Wang and Zeng studied the pre-sale strategy in the model of capacity constraint and demand uncertainty, and the results showed that the optimal advance selling strategy depends on the seller's capacity and the number of informed buyers [3]. Chao and Tang studied three strategies of suppliers who produce and sell seasonal products to retailers when the market size is uncertain. The study showed that the dynamic sales strategy combining pre-sale and spot sales is favorable for manufacturers and unfavorable for retailers [4].

There are two kinds of pricing strategies in the pre-sale environment. One is the dynamic pricing strategy, which means that retailers announce the pre-sale price in the pre-sale period and the spot price in the spot period. The other is a price commitment strategy, in which the retailer announces two prices at the same time during the pre-sale period, and the price will not be changed once it is announced. This paper also introduces the reference price effect. Kahneman et al. proposed the concept of reference price for the first time, laying the theoretical foundation for the concept of reference price [5]. Winer first proposed the consumer selection model based on reference price, and took reference price and actual price as variables influencing consumers' purchasing decisions [6]. Rajendran et al. believed that the reference price is the arithmetic mean of the lowest price, the highest price and the mean price [7]. Chandrashekaran et al. made a weighted average between the advertising price and the internal memory price in the market to obtain the reference price [8].

As for the research on the selection of sales channels, the traditional retail industry mainly adopts the form of offline stores. Consumers purchase products through offline channels and have an intuitive perception of product quality, price and service level of stores. With the development of e-commerce and the change of consumer behavior pattern, the form of retail sales has become diversified. Subsequently, the concept of "new retail" came into being. The core of new retail is the integration of online and offline channels. According to Bin Dan and Guangye Xu, manufacturers are more and more inclined to choose the dual channel operation strategy combining online and offline, and adopt a centralized price decisions and service decision [9].

2. Model

Parameters:

q: The quality of the product

t: The travel cost of offline consumers in the spot period

c_1: The cost of a retailer selling per unit product online

c_2: The cost of a retailer selling per unit product offline

p_1: The unit price in the pre-sale period

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p_2 : The unit price in the spot period

δ : The quality discount coefficient for consumers during the pre-sale period, subjects to uniform distribution $\delta \sim U[0,1]$

α : The coefficient of the reference price effect, subjects to uniform distribution $\alpha \sim U[0,1]$

This paper considers a monopolistic retailer selling products in two stages. The first stage is the pre-sale period, where consumers can order online at pre-sale prices, but can only obtain the product until the second stage. The second stage is the spot period. At this stage, consumers can purchase products directly at spot prices through offline channels, and cannot make transactions through online channels. In this study, the retailer adopts the price commitment strategy. At the beginning of the pre-sale period, the retailer will announce the price of the two-stage at the same time. Once the price is announced, no modification is allowed. In addition, in order to encourage consumers to order in the pre-sale period, so as to obtain more demand information, this paper assumes that retailer takes discount pre-sale, that is, the pre-sale price is lower than the spot price.

(1) The consumers' utility in the pre-sale period is affected by the quality of the product and the pre-sale price. Since pre-orders are made online, consumers' estimates of product quality are uncertain. This paper assumes that consumers who purchase products in the pre-sale period will discount their valuation of product quality. This quality discount has a direct effect on the consumers' utility. The consumers' utility is: $u_1 = \delta q - p_1$

(2) The utility of consumers in the spot period is related to the quality of products, the spot price, the reference price and the travel cost of offline consumers. In this paper, the reference price effect is taken into account. Since consumers in the spot period complete the transaction offline, the online reference price effect will bring psychological loss to consumers. Consumers in the spot period have a preference for the price difference between the two periods. The consumers' utility is: $u_2 = q - p_2 - \alpha(p_2 - p_1) - t$

(3) The retailer's total profit is the sum of pre-sale profit and spot profit. The profit at each period is the demand multiplied by the unit product profit. To simplify the calculation, unit product profit is the unit product price minus the cost of selling unit product. Therefore, the retailer's profit can be expressed as:

$$\pi = d_{pre-sale} * (p_1 - c_1) + d_{spot} * (p_2 - c_2)$$

By comparing the consumers' utility of two periods, analyze under what conditions consumers will buy in the pre-sale period? Under what conditions consumers will buy in the spot period? What is the market share of the pre-sale period and the spot period? For retailer, this paper analyzes the optimal price decision and optimal profit in difference market environment. In addition, the sensitivity of the optimal decision model is tested by numerical analysis.

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3. Results

Market 1:

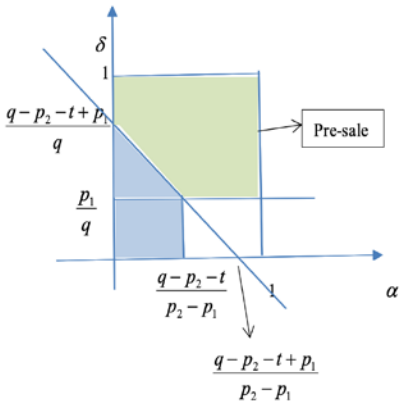

Figure. 1

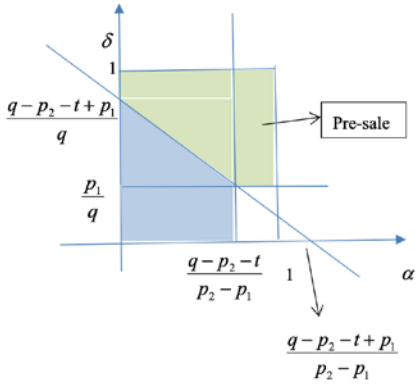

Figure. 2

When parameters satisfy the conditions: $p_1 < p_2 < q-t$, $2p_2 - p_1 > q-t$ (figure 1) or $p_1 < p_2 < q-t$, $2p_2 - p_1 > q-t$, $p_2 - p_1 < \frac{q-t}{2}$ (figure 2), The pre-sale and spot market shares are shown in the figure. After two periods of sales, the retailer did not occupy the whole market share. There are a small percentage of consumers who choose not to buy the product. The retailer's profit is:

$$\pi_1 = [(1-\frac{q-p_2-t+p_1}{q}) + \frac{(2-\frac{q-p_2-t}{p_2-p_1})(\frac{q-p_2-t}{q})}{2}](p_1-c_1)$$

$$+[\frac{(\frac{p_1}{q}+\frac{q-p_2-t+p_1}{q})(\frac{q-p_2-t}{p_2-p_1})}{2}](p_2-c_2)$$

$$= \frac{2p_1^2 - p_2^2 - 2p_1p_2 + p_2(4q-2t) - 2qp_1 - (t-q)^2}{2q(p_2-p_1)}(p_1-c_1)$$

$$+\frac{p_2^2 - 2p_1p_2 - 2p_2(q-t) + 2p_1(q-t) + (q-t)^2}{2q(p_2-p_1)}$$

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Market 2:

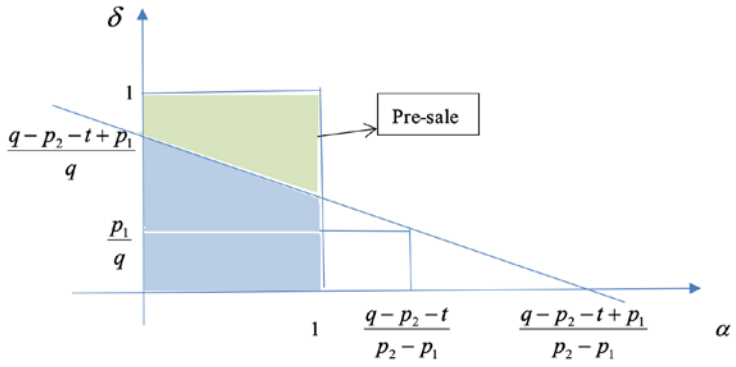

Figure. 3

When parameters satisfy the condition: $p_1 < p_2 < q - t$, $2p_2 - p_1 < q - t$, The pre-sale and spot market shares are shown in the figure 3. After two periods of sales, the retailer occupied the whole market share. The retailer's profit is:

$$\pi_2 = \frac{(1 - \frac{q - p_2 - t + p_1}{q}) + (1 - \frac{q - 2p_2 - t + 2p_1}{q})}{2} * (p_1 - c_1)$$
$$+ \frac{\frac{q - p_2 - t + p_1}{q} + \frac{q - 2p_2 - t + 2p_1}{q}}{2} * (p_2 - c_2)$$
$$= \frac{3p_2 + 2t - 3p_1}{2q}(p_1 - c_1) + \frac{3p_1 - 3p_2 + 2q - 2t}{2q}(p_2 - c_2)$$

The optimal price and the optimal profit are obtained by using the Lagrange multiplier method,

$$p_1^* = \frac{3(c_1 - c_2) - t + 5q}{3},\ p_2^* = \frac{3(c_1 - c_2) - 4t + 8q}{6}$$

$$\pi_2^* = \frac{2(5q - 3c_2 - t)(2t - 2q - 3c_1 + 3c_2) + (3c_1 - 3c_2 + 6q)(8q - 4t + 3c_1 - 9c_2)}{24q}$$

Market 3:

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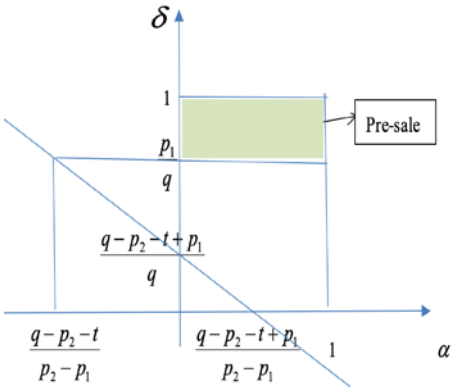

Figure. 4

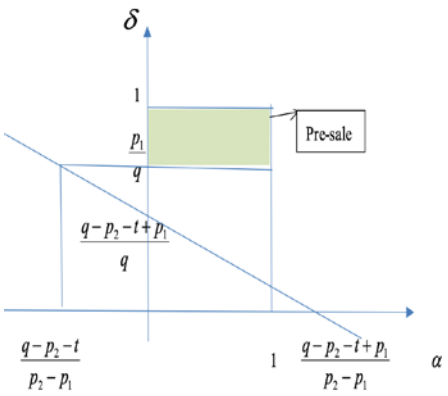

Figure. 5

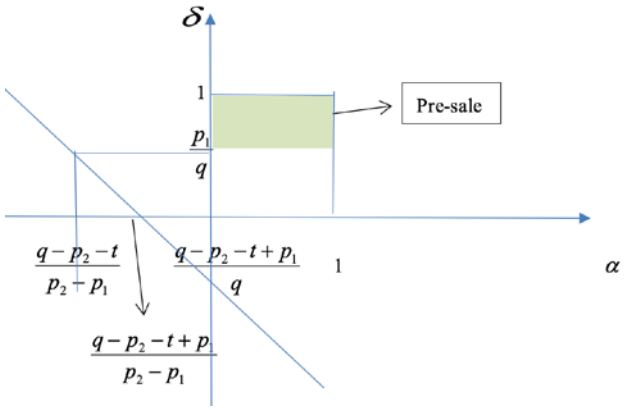

Figure. 6

When parameters satisfy the conditions: $0 < p_1 < q-t$, $p_2 > q-t$, $\frac{q-t}{2} < p_2 - p_1 < q-t$ (figure 4), $0 < p_1 < q-t$, $p_2 > q-t$, $p_2 - p_1 < \frac{q-t}{2}$ (figure 5) and $p_1 < q$, $p_2 - p_1 > q-t$ (figure 6). The retailer's profit is: $\pi_3 = (1-p_1/q)(p_1-c_1)$. Set $\partial\pi_3/\partial p_1 = 1+(c_1-2p_1)/q = 0$. According to $\partial^2\pi_3/\partial p_1^2 = -2/q = 0$, This function is convex and has a maximum. From the situation discussed in the classification, it can be found that p_1 should be

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satisfied $0 < p_1 < q$. Therefore, when parameters satisfy the condition: $(q+c_1)/2 < q$, the pre-sale price is $p_1^* = (q+c_1)/2$, the maximum profit of the retailer is $\pi_3^* = (q-c_1)^2/4q$, when parameters satisfy the condition: $(q+c_1)/2 > q$, the pre-sale price is $p_1^* = q$, the maximum profit of the retailer is $\pi_3^* = 0$.

4. Analysis

4.1 The effect of quality changes on retailer's choice of sales channels

Setting the value of parameters: $t = 0, c_1 = 20, c_2 = 79$. When product quality is low, retailer should choose the business model of market 3 and only open online sales. This is because consumers buy online and cannot see the real products, resulting in a higher valuation of product quality than the actual quality of the product. Therefore, it is beneficial for retailer to only open online channels.

With the improvement of product quality, retailer begins to choose the business model of market 2, which combines online channels with offline channels. On the one hand, retailer can make profits through online channels，on the other hand, consumers have a more intuitive experience of products through offline channels, and they are willing to pay a higher price for products. So retailers can also make more profits through offline channels.

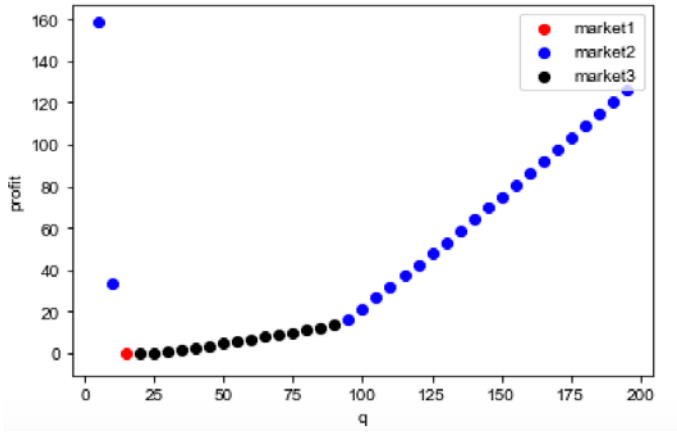

Figure. 7

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4.2 The effect of online sales cost changes on retailer's choice of sales channels

Setting the value of parameters: $q = 88, t = 0, c_2 = 79$. When the cost of online sales c_1 is low, retailer should choose the operation of market 3 and only open online sales channels. With the increase of online sales cost, the retailer open offline sales channels to integrate online operation with offline operation. This is because the cost of online sales is too high, and retailer hopes to attract more consumers to buy through offline channels. It can also be seen from figure 8 that the combined operation helps retailer achieve higher profits.

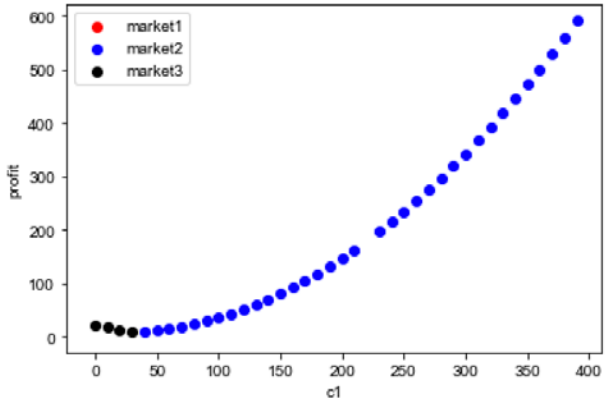

Figure. 8

4.3 The effect of changes in product quality on retailer's pricing decisions and profits in market 2

Setting the value of parameters: $t = 0, c_1 = 21, c_2 = 79$. With the increase of quality, both the pre-sale price and the spot price increase, and the pre-sale price increase is greater than the spot price. Thus, a slight increase in product quality is more conducive for retailers to raise the price of online sales. As can be seen from the figure 9, the total profits of retailer are increasing. The profit of online sales is decreasing, while the profit of offline sales is increasing. Therefore, the improvement of product quality is conducive to the increase of offline channel revenue, but not conducive to the increase of online channel revenue.

In the process of operation management, when the product quality is high, retailers should pay more attention to the operation of offline channels and try to attract more consumers to buy through offline channels. Online channels can be used as the media for product promotion, let more consumers have a preliminary understanding of the product.

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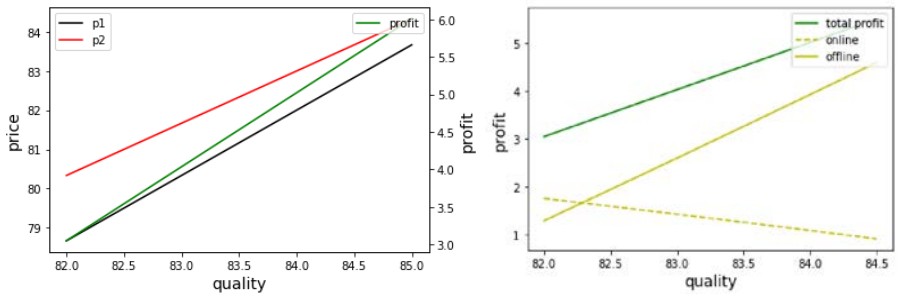

Figure. 9

4.4 The effect of changes in online sales cost on retailer's pricing decisions and profits in market 2

Setting the value of parameters: $q = 88, t = 0, c_2 = 79$. As the cost of online sales c_1 increases, the price of both online and offline channels will increase. This is because, on the one hand, when the cost of online sales increases, online price set by retailer will increase correspondingly, on the other hand, due to the existence of reference prices, retailers will also appropriately raise the price of offline channels to obtain more profits. It can also be seen from the figure 10 that retailers' online channel profits are decreasing while the offline channel profits are increasing. In general, although the total profit of retailer is decreasing, it is still larger than profits of any one channel. Therefore, the dual-channel operation is still the best choice for retailer.

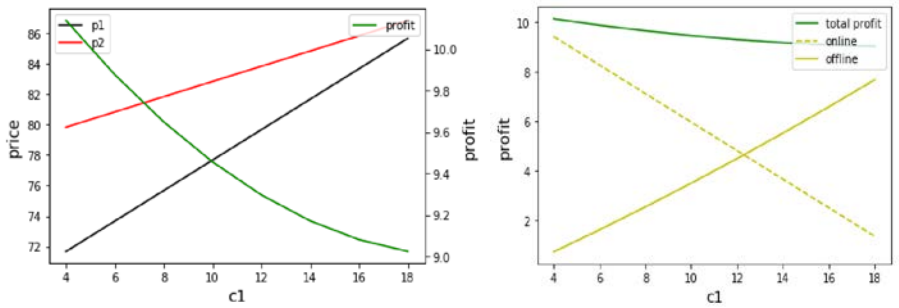

Figure. 10

5. Conclusion

Based on the perspective of retailers, this paper studies how to determine the

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optimal sales channel selection and pricing decision in the pre-sale strategy. This paper also verified the effectiveness of the model through numerical analysis, and provided corresponding management insights for enterprises to formulate pre-sale strategy. There are still some directions for the future. This article assumes that the market size is fixed, but in practice retailers often face market size uncertainties. In the future research, we can consider the case of uncertain market size. In addition, this paper assumes that the capacity is infinite. In future studies, it is also possible to consider how retailers should choose the optimal capacity if the capacity is endogenous.

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