A Study of Dual-Channel Supply Chain Promotion Strategies

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Abstract. With the development of e-commerce, the e-promotion and dual-channel supply chains has become a common phenomenon in society. And the promotional strategies of dual-channel supply chain members have become a popular studying topic. In this paper, a Nash equilibrium model is used to investigate the optimal promotion strategies of each member of the dual-channel supply chain when they are simultaneous and independent. By analysing the profit of joint promotions, it can be concluded that the profit is independent of both wholesale price and daily sales price. As commission increases, the profitability of the whole supply chain and of the platform provider increases, while the profitability of the supplier decreases. Therefore, in order to maximise the profits of each supply chain member, suppliers should strive for an equal share of the overall supply chain profits, while platform providers should refuse to share the overall profit of the supply chain equally with supply chain members.

Keywords: dual-channel supply chain · promotional strategy · e-promotion · optimal strategy

1 Introduction

The Internet era has changed people's lives, and the development of e-commerce has changed the market structure, and the influence of e-commerce to create festive promotions has expanded in the face of increasingly fierce price competition. During the "Double Eleven" period, when Tmall's platform created festivals, Jing dong's platform placed 349.1 billion yuan in merchandise orders, up 29% year-on-year. With the development of the platform economy, promotional festivals are no longer just the exclusive domain of a single company or platform, as companies have laid out their online dual-channel supply chains on e-commerce platforms. And how should they develop promotional strategies to optimize their profits is the question that this paper hopes to address through this study.

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2 Literature Review

Early research on promotions focused on the impact of promotions themselves on profits, for example, Kurniawan Adji Candra et al. [1] study uses an agent-based simulation approach to retail pricing complexity modelling and analyzing retail pricing strategies, providing insights into pricing decision strategies associated with price promotions. Ozgun Caliskan Demirag et al. [2] studied the incentives of retailers to offer consumer discounts in the presence of competition. Liu Jun et al. [3] found that retailers were able to reduce their benefit loss by promoting common products. Many scholars have studied the optimal offer strategy to obtain the best profit from a promotional perspective. For example, E Erjiang et al. [4] studied the decision of cooperative promotion and cost sharing between a pair of competing supply chains under an e-commerce platform, and Qin Geng et al. [5] investigated the optimal decision of a manufacturer and a retailer when they jointly developed a mail-in rebate form of discount promotion under the scenario of random customer demand using a multi-stage game model. Jiang Xuan et al. [6] studied joint promotion strategies based on revenue sharing contracts from a single two-level supply chain. Li Yuefeng et al. [7] studied the strategy problem of coupon rebate promotions in a supply chain system with retailers as the dominant players. Yang Wensheng et al. [8] explored coupon and price combination strategies from the perspective of information sharing. Unlike current research, this paper is based on the common phenomenon that e-commerce platforms frequently launch promotional activities during large festivals and shopping holidays (e.g. 3.8 Women's Day, Christmas, Chinese New Year and "Taobao's Double 11" and "Jingdong's 618", etc.). This paper innovatively investigates the promotion strategies of dual-channel supply chain members, with a view to providing theoretical suggestions for the promotion activities of dual-channel supply chain members.

3 Model and Solution

This paper studies a two-channel, two-level supply chain consisting of only suppliers (S) and platform merchants (P) (as shown in Fig. 1); in the model, channel one suppliers sell goods at wholesale prices w to platform-owned shops, which in turn offer goods to consumers at pricing p. Channel two of the model is for suppliers to display information about goods for sale through the platform merchant (making it a platform other shop), and for each successful sale, the platform will charge a commission of λ per unit of goods priced at p. (This paper does not consider fixed costs such as platform construction).

Integrating the profits of suppliers and traders in both channels yields the total profit earned by suppliers and traders in this supply chain:

$$\pi_s = \left[(w - r_s - c) + (p - r_s - c) - \lambda(p - r_s)\right] * D \tag{1}$$

$$\pi_p = \left[\left(p - r_p - w\right) + \lambda(p - r_s) - r_p\right] * D \tag{2}$$

To simplify the model, the following assumptions are made in this paper. Citing common model market demand assumptions (citing Jiang Xuan et al. [6]) assumes that

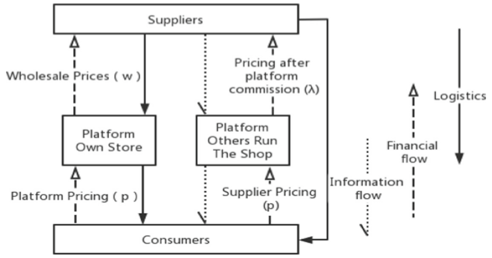

Fig. 1. Dual-channel supply chain operational structure

the demand function of the market is $D = a - b\big(p - r_s - r_p\big)$ Linear demand function. During the promotion period, suppliers and flat vendors will only develop strategies to promote on the basis that the daily sales price p remains stable and unchanged. The costs in the model only consider the unit cost of the product sold itself, c. All other sunk costs incurred in the operation are not considered. The actual final price payable by the consumer for goods purchased during the promotional period of the goods is $p - r_s - r_p \geq 0(r_s, r_p \geq 0)$. Demand functions for products $D = a - b\big(p - r_s - r_p\big)$; a is the market size of the product; b is the consumer price sensitivity factor; Commission $\lambda \in (0, 1)$, which is an exogenous variable; w the price at which platform traders buy goods from suppliers, which is wholesale prices; $r_s, r_p, r, \pi_s, \pi_p, \pi$ represents price concessions and profits offered to customers by suppliers, platform merchants and the overall supply chain respectively, $r_s, r_p \geq 0$; $p \geq r_s + r_p$;

3.1 Analysis of Promotional Motivations

Firstly a promotional motivation analysis is carried out here (citing Jiang Xuan et al. [6]), assuming that suppliers and flat traders make promotional decisions uniformly as a common interest and that the overall supply chain offers a coupon of $r(r \geq 0)$ on the basis of the daily selling price p of the product, so that the optimal profit of the overall supply chain can be expressed as $\max\limits_{r} \pi_c = (p - c - r)\big[a - b(p - r)\big]$. The system optimal total discount can be found as $r = \frac{2bp-a-bc}{2b}$, Optimal profit is $\pi = \frac{(a-bc)^2}{4b}$. Thus, when $p \in \left(\frac{a+bc}{2b}, \frac{a}{b}\right)$, overall supply chain has the incentive to make more profit by offering promotional offers.

3.2 Analysis of the Optimal Preference Strategy Based on the Nash Game

Based on the characteristics of the Nash game model, there is no prior party to the promotion activities in this model, and both the supplier and the platform vendor make decisions independently at the same time whether or not to offer the promotion strategy.

The profit optimisation problems for suppliers and platform merchants are as follows in Eqs. (3) and (4) respectively:

$$\pi_s^N = \big[(w - r_s - c) + (p - r_s - c) - \lambda(p - r_s)\big] * \big[a - b\big(p - r_s - r_p\big)\big] \tag{3}$$

$$s.t.\{r_s \geq 0, (w - r_s - c) + (p - r_s - c) - \lambda(p - r_s) \geq 0, a - b(p - r_s - r_p) \geq 0\}$$

$$\pi_p^N = [(p - r_p - w) + \lambda(p - r_s) - r_p]*[a - b(p - r_s - r_p)] \tag{4}$$

$$s.t.\{r_p \geq 0, (p - r_p - w) + \lambda(p - r_s) - r_p \geq 0, a - b(p - r_s - r_p) \geq 0\}$$

In order to find the Nash equilibrium solution, we need to solve Eq. (3)(4) jointly, and we can get their second order derivatives are less than zero: $\begin{cases} \frac{\partial^2 \pi_s^{30}}{\partial^2 \gamma_s^3} = -2b(2-\lambda) < 0 \\ \frac{\partial^2 \pi_p^{30}}{\partial^2 \gamma_p^3} = -2b < 0 \end{cases}$, Then solve for the maximum profit and equilibrium solution for the supplier and the flat trader. Let $N^S = a\lambda - 2a - 2bp\lambda + 3bp - 2bc + bw$, $N^P = 3bp - 2a - bw + bp\lambda$. In order for the Nash equilibrium solution to exist, the model assumes that the parameters satisfy the conditions $N^S \geq 0$ and $N^P \geq 0$, and the response equation for the optimal promotion decision is as follows, and the reaction equation curve is shown in Fig. 2:

$$\begin{cases} r_s^N = \frac{N^s - b(2-\lambda)r_p}{2b(2-\lambda)}, r_s \geq 0 \\ r_p^N = \frac{N^p - b(2+\lambda)r_s}{4b}, r_p \geq 0 \end{cases} \tag{5}$$

Proposition 1. (1) when $d_1 \leq d_2$ and $l_1 \geq l_2$, $r_s^{N*} = \frac{(2-\lambda)N^P - 4N^S}{b(2-\lambda)(\lambda-6)}$, $r_p^{N*} = \frac{(\lambda+2)N^S - 2(2-\lambda)N^P}{b(2-\lambda)(\lambda-6)}$; (2) when $d_1 \geq d_2$ and $l_1 \geq l_2$, $r_s^{N*} = \frac{N^S}{2b(2-\lambda)}$, $r_p^{N*} = 0$; (3) when $d_1 \leq d_2$ and $l_1 \leq l_2$, $r_s^{N*} = 0$, $r_p^{N*} = \frac{N^P}{4b}$; (4) As $\lambda \in (0, 1)$, So there is no case when $d_1 \geq d_2$ and $l_1 \leq l_2$.

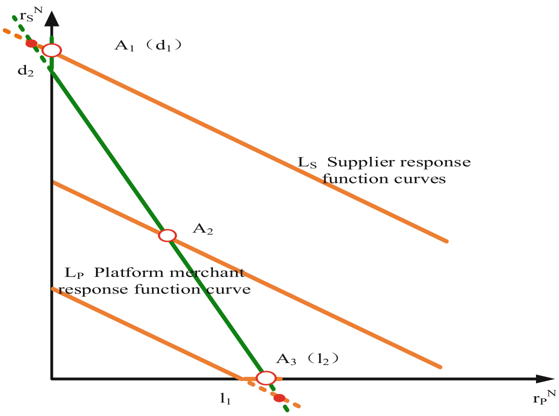

Fig. 2. Response function curves for suppliers and platform merchants under the Nash game

Table 1. Profits of different subjects in joint promotions

Gaming model	Supplier profit	Platform merchant profits	Total supply chain profit
Nash Gaming	$\frac{4(2-\lambda)(a-bc)^2}{b(\lambda-6)^2}$	$\frac{8(a-bc)^2}{b(\lambda-6)^2}$	$\frac{4(4-\lambda)(a-bc)^2}{b(\lambda-6)^2}$

4 Comparative Analysis of Joint Promotional Strategies

4.1 Profits of Different Subjects in Joint Promotions

The next part of this paper will compare and analyse the profits of the supplier, the platform provider and the supply chain as a whole in an optimal joint promotion strategy based on the Nash game. This is shown in Table1.

Proposition 2. In the optimal joint promotion strategy, the profits of the supplier and the platformer are independent of the daily selling price p and the wholesale price w of the goods purchased by the platformer from the supplier.

4.2 Cross-Sectional Comparison of the Profits of Different Entities

Proposition 3. Cross-sectional analysis of suppliers' and platforms' profits, we can obtain the following profit size relationship: $\pi_P^{N*} > \frac{\pi_C^{N*}}{2} > \pi_S^{N*}$; ($\frac{\pi_C^{N*}}{2}$ is the profit gained when the joint promotion optimal strategy under the Nash game is shared equally between the supply chain and the flat traders in terms of the overall supply chain profit).

Proposition 4. Under the Nash game, when the two promote together, the platform provider gains profit at a greater rate than the supplier gains profit at a reduced rate as commissions increase.

5 Conclusion

This paper investigates optimal promotional strategies for dual-channel supply chain members in the context of promotional festivals on e-commerce platforms. A Nash model in which suppliers and platform vendors simultaneously initiate promotions independently is considered. There are three main scenarios, i.e., only the supplier or the platform vendor initiates the promotion strategy and the two jointly initiate the promotion strategy. A comparison of the profits of each supply chain entity based on the promotional efforts of both parties in the joint promotion leads to: (i) The profits of both parties in the joint promotion are independent of the wholesale price and daily sales price. (ii) Shows that the profits of the entire supply chain and the platform operator increase monotonically with commission, while the profits of the suppliers tend to decrease with commission. It is inferred that the profit capture rate of the platform operator is greater than the decreasing profit capture rate of the supplier. (iii) In a joint promotion strategy, the supplier should strive for an equal share of overall profits with supply chain members, while platform providers do the opposite. The platform providers should refuse to share overall profits equally with supply chain members.

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