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Research on the Sales Strategy of Online Brand Owners Expanding to Offline Channels Based on The Online Agent Mode

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Abstract: This paper studies the supply chain system composed of online brand owners based on pure network sales to offline expansion, takes the single network channel model, establishes two dual-channel structure models of offline direct selling model and offline distribution model, and compares and analyzes the influence of different channel structures on the pricing, demand and optimal profit of supply chain members. Research shows that online brands in the offline sales development strategy choice and open offline stores fixed cost and consumer channel preference, when open offline stores fixed cost is very low, or when the fixed cost centered and consumer offline channel preference over a certain threshold, the optimal strategy for offline direct sales model, otherwise for offline distribution model. In order to improve the cooperation efficiency of the supply chain members in the offline distribution model, a bilateral contract mechanism is designed to coordinate the supply chain. When the fixed transfer payment fee is within a certain range, the mechanism can optimize the members of the supply chain and the overall profit.

Keywords: Online brand owners, Dual-channel supply chain, Pricing decision-making, Channel selection, Coordination mechanism.

1. Introduction

In recent years, e-commerce platforms have attracted many brands to start first through online channels for business with their strong customer flow and low construction costs. The online market is becoming increasingly saturated, and the sustainable development space of Internet e-commerce is limited, and some online brands have begun to join the offline retail market. Some large foreign online brands began to expand offline channels, such as Bauble Bar, Bonobos, Kidd care and so on. Domestic Xiaomi's single network channel strategy for launching its original products was successful, but its phone sales were hit hard after other manufacturers flooded the online market, with shipments tumbling 36% in 2016. In 2017, Xiaomi launched the strategic layout of offline and online dual channels, and its market share gradually increased. Different online brands may adopt different offline expansion modes. For example, Perfect Diary, an Internet beauty brand, sells products in offline stores (offline direct selling mode), and Internet home appliance brand Bear sells products through cooperation with existing large department stores (offline distribution mode). However, new channels may occupy the market of existing channels, leading to channel conflicts. At the same time, considering the dynamic consumer preference and the cost growth [1] of opening physical stores, online brands' how to make appropriate choices is an important problem in the face of various offline expansion modes.

From the existing research, the dual-channel structure provides huge business opportunities for brand owners. Cai [2] noted that the dual-channel structure is superior to any single-channel structure without competition. Yong-Shi Hu[3] points out that under the monopoly competition, the expected profits of experiential customers cannot be maximized, and a single online channel is not the dominant choice of monopolies. Based on industry data, some scholars have found that dual-channel retailers can improve customer satisfaction compared to single-channel retailers, so multi-channel retail is a useful strategy to build customer loyalty [4], which also helps improve the "barriers" to new market entry and enhance the competitive position of retailers. Rodriguez [5] and Aydin found that the manufacturer's dual-channel structure can attract more customers, so manufacturers can always benefit from the dual-channel structure. Shankar [6] Research has found that the annual consumption of multi-channel consumers who meet their shopping needs through online channels, physical channels and catalog sales channels is four times that of single-channel shopping consumers.

At present, the research on dual channel mainly focuses on the necessity of online channel introduction and the decision-making of online channel model. Chiang [7] And analyzed the impact of manufacturers' opening of online direct channels on offline sales channels, and pointed out that the opening of direct channels is helpful to improve the efficiency of offline retail channels. Tsay [8] and Agrawal analyzed the impact of manufacturers' introduction of direct sales channels on the pricing decisions of offline channels, and the research showed that the introduction of online channels is beneficial to enterprises. Puxujin [9] and others consider the two dual-channel modes of resale and commission sales, and discuss the impact of the fair concern psychology of physical stores on manufacturers' online intrusion decisions. Xu Lei [10] and Li Yongjian studied the pricing decision and channel model selection of centralized decision-making, retailers responsible for dual-channel sales, offline sales manufacturers, retailers responsible for offline sales manufacturers responsible for online sales, and offline sales manufacturers. Among the three dual-channel structures of online direct sales, online distribution and online commission sales, Liang Xi [11] and others have studied the channel selection and pricing strategies of manufacturers. Cao Yu [12] and others consider the dual-channel mode of online direct selling and online distribution, and discuss the optimal pricing and service decision of supply chain as well as the choice of online sales mode of manufacturers. Sun Zilai [13] and others considered direct selling costs and platform transaction fees, and built three sales models: online direct selling, platform flagship store and wholesale sales, and studied the decision basis of manufacturers' online sales mode selection.

The research on the expansion of online brand owners to offline focuses on the necessity and influencing factors of introducing offline channels. A recent study by Ryu [14] et al showed that in the small-scale clothing and fashion industry, omni-channel retailers are 17% more technology-efficient than pure online retailers. Bell [15] et al. conducted quasi-experiments to study the effects of showroom introduction, and the authors found that showrooms could improve the profitability of e-retailers by increasing demand and reducing online return rates. Xiaojun Fan [16] et al. studied the strategic choice of e-commerce on the physical store model under the competitive environment, and found that taking the physical store as the most ideal is not the exhibition hall. Therefore, it is of great significance to study the impact of physical stores combining product experience and product trading function on corporate decision-making. Feng Wei [17] O2O supply chain decision model with demand transfer and no demand transfer. Research shows that offline channels adopt self-management or franchise mode, and the profit of the whole system will increase. Arya [18] and Mittendorf analyzed online retailers' access into physical stores based on consumer sales taxes. The authors confirm that the consumer sales tax has a significant impact on business decisions to set up physical stores.

To sum up, the existing literature mainly studies the impact of manufacturers' new online channels on offline channel operation on the basis of having offline retail channels, as well as the decision-making of online channel model. Few scholars quantitatively study the pricing decision and model selection of dual-channel structure based on the perspective of online brand owners expanding to offline. Based on this, this paper establishes a model of different offline channel models, analyzes the impact of key factors such as fixed cost of offline direct stores and consumer channel preference on the pricing decision of dual-channel and channel selection of online brand owners, so as to provide reference for the channel development strategy of online brand owners.

2. Problem Description and Model Building

Online brands sell products through agents on e-retailers' online platforms. The online sales mode is that the brand owner directly sells products to customers through the sales platform of the e-retailer. By the brand owners decide the online sales price, and only need to pay a certain proportion of commission to the e-retailer, such as Tmall flagship store.

In this paper, a single network channel model is taken as the benchmark model, and online brand owners only launch and sell products through online channels. In the dual-channel model, the online brand owners will have the original single network channel to launch and sell products into online and offline two channels to launch and sell products. In the industry areas studied in this paper, the channel demand function is influenced by the combination of e-retailer profit sharing ratio, consumer channel preferences and cross-price elasticity coefficient. This paper considers two dual-channel structure models, which are the dual-channel models composed of online consignment and offline direct sales, online consignment and offline distribution.

In the two dual-channel modes, the same experiential products are sold. Assuming that the potential total market demand of the product is a, consumers have channel preference, that is, the channel preferred by consumers in information search, α indicates the proportion of consumers preferring offline channel, then $1-\alpha$ indicates the proportion of consumers preferring online channel, $0<\alpha<1$. β represents the channel cross-price elasticity coefficient, it represents the price competition intensity between channels, $0<\beta<1/2$. λ represents the profit-sharing ratio that e-retailers charge to online brands, without loss of generality, $0<\lambda<1/2$. If the brand owner chooses to open offline direct stores, referring to the research of Huang et al. [19], it is assumed that the fixed cost of the brand owner to open offline direct stores is 5,6. Therefore, the demand functions of the two dual-channel modes can be established by referring to Chiang[7] et al., Tsay [8] and Agrawal, and Liang Xi [20], etc. For convenience, we use the upper standard to indicate different sales models, in which $i=0$ represents the single network channel model; $i=1$ represents the offline direct sales model, and $i=2$ represents the offline distribution model. The specific structure of the three channel structure models is shown in Figure Figure 1 below.

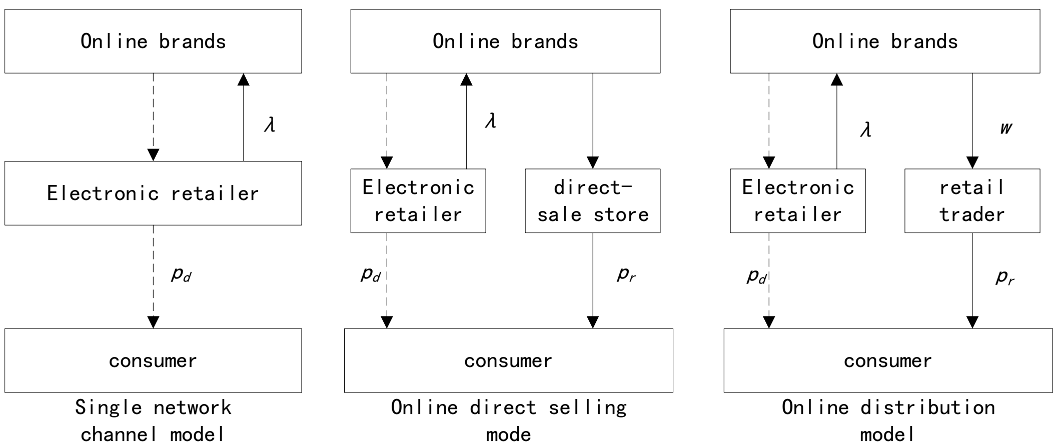

Figure 1. Three channel structures led by online brand owners

3. Pricing Strategies Under Different Sales Models

3.1. Single network channel model

Online brands only sell their products through online channels through e-retailer agents. Thus, the demand and profit functions of the online channel are:

Single network channel demand function:

$$D_d = (1-\alpha)a - p_d$$

Online brand owner profit:

$$\pi_m = (1-\lambda) p_d D_d$$

E-retailer profit:

$$\pi_e = \lambda p_d D_d$$

Theorem 1 In the single network channel model, the optimal online sales price, demand and profit of online brand owners and the optimal profit of e-retailers are as follows:

$$p_d^0 = \frac{1}{2}a(1-\alpha)$$

$$D_d^0 = \frac{1}{2}a(1-\alpha)$$

$$\pi_m^0 = \frac{1}{4}a^2(-1+\alpha)^2(1-\lambda)$$

$$\pi_e^0 = \frac{1}{4}a^2(-1+\alpha)^2\lambda$$

Proof: π_m^0 to p_d to find the first order partial derivative and make it equal to zero can obtain

the optimal p_d is:

$$p_{\mathrm{d}}^0 = -\frac{1}{2}a(\alpha-1)$$

Replacing p_{d}^0 into $\pi_m^0, \pi_e^0, \pi_s^0$ can get the optimal online brands, e-retailers and supply chain profits.

3.2. Offline direct selling model

Offline direct selling mode refers to the online brand owners open offline stores to sell products on the basis of the original online channels. Online brand owners take online channels and offline channels as a decision-making whole, and pursue the maximization of the overall profit of the supply chain. In the offline direct selling model, the online brand owners also decide the online direct selling price and the offline retail price. Therefore, the demand and profit functions of online channels and offline channels are respectively:

Online channel and offline channel demand function:

$$\begin{cases} D_d = (1-\alpha)a - p_d + \beta p_r \\ D_r = \alpha a - p_r + \beta p_d \end{cases}$$

Online brand owner profit:

$$\pi_m^1 = (1-\lambda) p_d D_d + p_r D_r - F$$

E-retailer profit:

$$\pi_e^1 = \lambda p_d D_d$$

Theorem 2 In the offline direct selling mode, the optimal decisions of the online and offline channels of the dual-channel supply chain are respectively:

$$p_d^1 = \frac{a(\alpha(\beta(\lambda-2)-2\lambda+2)+2(\lambda-1))}{\beta^2(\lambda-2)^2+4(\lambda-1)}$$

$$p_r^1 = \frac{a(\lambda-1)(\alpha(\beta(\lambda-2)+2)-\beta(\lambda-2))}{\beta^2(\lambda-2)^2+4(\lambda-1)}$$

At this point, the optimal demand of online and offline channels is respectively:

$$D_d^1 = \frac{a\left(\alpha(\beta-1)(\beta(\lambda-2)+2(\lambda-1))+\beta^2(-(\lambda-2))+2(\lambda-1)\right)}{\beta^2(\lambda-2)^2+4(\lambda-1)}$$

$$D_r^1 = \frac{a(\lambda-1)(\alpha(\beta-1)(\beta(\lambda-2)-2)+\beta\lambda)}{\beta^2(\lambda-2)^2+4(\lambda-1)}$$

The best profits for online brands and e-retailers are respectively:

$$\pi_m^1 = \frac{a^2(\lambda-1)\left(\alpha^2(\beta-1)(\lambda-2)+\alpha(\beta(-\lambda)+2\beta+2\lambda-2)-\lambda+1\right)}{\beta^2(\lambda-2)^2+4(\lambda-1)} - F$$

$$\pi_e^1 = \frac{a^2\lambda(\alpha(\beta(\lambda-2)-2\lambda+2)+2(\lambda-1))\left(\alpha(\beta-1)(\beta(\lambda-2)+2(\lambda-1))+\beta^2(-(\lambda-2))+2(\lambda-1)\right)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2}$$

Total profit of the supply chain is:

$$\pi_s^1 = \frac{a^2\begin{pmatrix}\alpha^2\left(\beta^3(\lambda-2)^2\left(\lambda^2-2\lambda+2\right)-\beta^2(\lambda-2)^2\left(\lambda^2-2\lambda+2\right)-8\beta(\lambda-1)^2+8(\lambda-1)^2\right)\\ +\alpha\left(\beta^3\left(-(\lambda-2)^2\right)\left(\lambda^2-2\lambda+2\right)+2\beta^2\left(\lambda^4-4\lambda^3+7\lambda^2-8\lambda+4\right)+8\beta(\lambda-1)^2-8(\lambda-1)^2\right)\\ -(\lambda-1)\left(\beta^2\left(\lambda^3-3\lambda^2+4\lambda-4\right)-4\lambda+4\right)\end{pmatrix}}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2} - F$$

Proof: use the sea plug matrix to prove that p_d^1 and p_r^1 obtained under the first derivative of profit formula π_m^1 are the optimal solution. First, find the second order partial derivative for π_m^1 about p_d^1 and p_r^1, and obtain the following sea plug matrix:

$$\begin{pmatrix} 2(\lambda-1) & -\beta(\lambda-2) \\ -\beta(\lambda-2) & -2 \end{pmatrix}$$

Easy to know, $\frac{\partial^2 \pi_m^1}{\partial {p_d}^2} = 2(\lambda-1) < 0$; because $0 < \beta < \frac{1}{2}$ know $4 - 4\beta^2 - 4\lambda + 4\beta^2\lambda - \beta^2\lambda^2 > 0$. Therefore, the sea matrix is a negative matrix, and the function π_m^1 has an optimal solution at point (p_d^1, p_r^1). By proof.

3.3. Offline distribution model

In the offline distribution model, online brand owners sell products to distributors through offline channels. In this model, a sequential Stackelberg game will be played between online brands and distributors, and both online brands and distributors will make decisions with the goal of their own profit maximization. The online brand is the leader and the distributor is the follower. The online brand first decides the wholesale price w for the distributor and the online channel sales price p_d, and then the distributor decides the offline sales price p_r. Therefore, the demand and profit functions of online brand owners and distributors are respectively:

Online channel and offline channel demand function:

$$\begin{cases} D_d = (1-\alpha)a - p_d + \beta p_r \\ D_r = \alpha a - p_r + \beta p_d \end{cases}$$

Online brand owner profit:

$$\pi_m^2 = (1-\lambda) p_d D_d + w_r D_r$$

Distributor Profits:

$$\pi_m^2 = (p_r - w_r)D_r$$

E-retailer profit:

$$\pi_e^2 = \lambda p_d D_d$$

Theorem 3 In the offline distribution model, the optimal pricing decisions of online brands and distributors are as follows:

$$p_d^2 = \frac{a(\alpha(\beta(3\lambda-4)-4\lambda+4)+4(\lambda-1))}{\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)}$$

$$w_r^2 = -\frac{a(\lambda-1)\left(\alpha\left(\beta^2\lambda-2\beta(\lambda-2)-4\right)+2\beta(\lambda-2)\right)}{\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)}$$

$$p_r^2 = \frac{a(\lambda-1)\left(\alpha\left(-2\beta^2+\beta(\lambda-4)+6\right)-\beta(\lambda-4)\right)}{\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)}$$

At this point, the optimal demand of online and offline channels is respectively:

$$D_d^2 = -\frac{a\left(\alpha(\beta-1)\left(2\beta^2(\lambda-1)-\beta(\lambda-2)-4\lambda+4\right)+\beta^2(3\lambda-4)-4\lambda+4\right)}{\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)}$$

$$D_r^2 = \frac{a(\lambda-1)(\alpha(\beta-1)(\beta(\lambda-2)-2)+\beta\lambda)}{\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)}$$

The best profits of online brands, e-retailers and distributors are:

$$\pi_m^2 = -\frac{a^2(\lambda-1)\left(\alpha^2(\beta-1)(\beta(\lambda-1)-2\lambda+3)+\alpha(\beta(3\lambda-4)-4\lambda+4)+2(\lambda-1)\right)}{\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)}$$

$$\pi_e^2 = -\frac{a^2\lambda\left(\alpha(\beta-1)\left(2\beta^2(\lambda-1)-\beta(\lambda-2)-4\lambda+4\right)+\beta^2(3\lambda-4)-4\lambda+4\right)(\alpha(\beta(3\lambda-4)-4\lambda+4)+4(\lambda-1))}{\left(\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)\right)^2}$$

$$\pi_r^2 = \frac{a^2(\lambda-1)^2(\alpha(\beta-1)(\beta(\lambda-2)-2)+\beta\lambda)^2}{\left(\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)\right)^2}$$

Total profit of the supply chain is:

$$\pi_s^2 = -\frac{a^2\begin{pmatrix}\alpha^2\begin{pmatrix}2\beta^4\left(\lambda^3-\lambda^2-2\lambda+2\right)-\beta^3\left(\lambda^4-6\lambda^3+34\lambda^2-60\lambda+32\right)+\beta^2\left(\lambda^4-12\lambda^3+40\lambda^2-52\lambda+24\right)\\+4\beta(\lambda-1)^2(\lambda+8)-28(\lambda-1)^2\end{pmatrix}\\+\alpha\left(\beta^3\left(\lambda^4-6\lambda^3+34\lambda^2-60\lambda+32\right)-2\beta^2\left(\lambda^4-6\lambda^3+21\lambda^2-32\lambda+16\right)-4\beta(\lambda-1)^2(\lambda+8)+32(\lambda-1)^2\right)\\+(\lambda-1)\left(\beta^2\left(\lambda^3-5\lambda^2+16\lambda-16\right)-16(\lambda-1)\right)\end{pmatrix}}{\left(\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)\right)^2}$$

Proof: the reaction function of optimal p_r obtained from π_r^2 to p_r and making it equal to zero is:

$$p_r^2 = \frac{1}{2}\left(w_r + a\alpha + p_d\beta\right)$$

Put p_r^2 into π_m^2, and then find the first partial derivative of π_m^2 for p_d and w:

$$\begin{cases}\dfrac{\delta\pi_m^2}{\delta p_d} = \dfrac{1}{2}\left(-w_r\beta(-2+\lambda)-a\left(2+\alpha(-2+\beta)\right)(-1+\lambda)-2p_d\left(-2+\beta^2\right)(-1+\lambda)\right)\\ \dfrac{\delta\pi_m^2}{\delta w_r} = \dfrac{1}{2}\left(-2w_r + a\alpha - p_d\beta(-2+\lambda)\right)\end{cases}$$

At this time, the sea plug matrix $H = \begin{pmatrix}\left(-2+\beta^2\right)(1-\lambda) & \frac{1}{2}\beta(2-\lambda)\\ \frac{1}{2}\beta(2-\lambda) & -1\end{pmatrix}$ of π_m^2, and since $\left(-2+\beta^2\right)(1-\lambda)<0$ and $2-2\beta^2-2\lambda+2\beta^2\lambda-\frac{\beta^2\lambda^2}{4}>0$, the sea plug matrix H is a negative fixed matrix. Therefore, the optimal solution p_d^2 and w_r^2 can be obtained for order $\frac{\delta\pi_m^2}{\delta p_d}$、$\frac{\delta\pi_m^2}{\delta w_r}=0$, and then the optimal offline sales price can be obtained, further substituting π_m^2, π_e^2 and π_r^2 to obtain the optimal profit of online brands, electronic retailers and distributors. The sum of π_m^2, π_e^2 and π_r^2 is the optimal total profit of the supply chain of offline distribution mode.

4. Comparative Analysis

Proposition 1 The relationship between the single network channel model and the sales price of the two dual-channel structures is as follows: $p_d^1 > p_d^2 > p_d^0$; $p_r^2 > p_r^1$.

Proposition 1 shows that in terms of online sales price, the dual-channel model is always higher than the single network channel model, and the offline direct selling model is always higher than the offline distribution model, which has nothing to do with other factors. Compared with the offline direct selling model, the offline distribution model will set higher sales prices, because the offline distribution model has more supply chain members than the offline direct selling model.

Proposition 2 The single network channel model and the profit of online brand owners with two dual-channel structures meet the following relationships:

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(1) when $0 < F \le F_1$, or when $F_1 < F < F_2$ and $\alpha_1 < \alpha < 1$, $\pi_m^1 > \pi_m^0$; when $F_1 < F \le F_2$ and $0 < \alpha < \alpha_1$, or when $F > F_2$, $\pi_m^1 < \pi_m^0$.

(2) when $0 < F \le F_3$, or when $F_3 < F < F_4$ and $\alpha_{12} < \alpha < 1$, $\pi_m^1 > \pi_m^2$; when $F_3 < F \le F_4$ and $0 < \alpha < \alpha_{12}$, or when $F > F_4$, $\pi_m^1 < \pi_m^2$.

(3) $\pi_m^2 > \pi_m^0$.

Among, $F_1 = \frac{a^2\beta^2(\lambda-2)^2(\lambda-1)}{4\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)}$;

$$F_2 = \frac{a^2(\lambda-1)}{\beta^2(\lambda-2)^2+4(\lambda-1)};$$

$$\alpha_1 = 2\sqrt{\frac{\beta^2F\lambda^2-4\beta^2F\lambda+4\beta^2F+4F\lambda-4F}{a^2(\lambda-1)(\beta\lambda-2\beta+2)^2}}+\frac{\beta(\lambda-2)}{\beta(\lambda-2)+2};$$

$$F_3 = \frac{a^2\beta^2(\lambda-1)^2\lambda^2}{\beta^4(\lambda-2)^2\left(\lambda^2-8\lambda+8\right)+4\beta^2\left(3\lambda^3-19\lambda^2+32\lambda-16\right)+32(\lambda-1)^2};$$

$$F_4 = \frac{a^2(\lambda-1)^2\left(\beta^2(\lambda-2)+2\right)^2}{\beta^4\lambda^4-12\beta^4\lambda^3+44\beta^4\lambda^2-64\beta^4\lambda+32\beta^4+12\beta^2\lambda^3-76\beta^2\lambda^2+128\beta^2\lambda-64\beta^2+32\lambda^2-64\lambda+32};$$

$$\alpha_2 = \sqrt{\frac{F(\beta^4(\lambda^4-12\lambda^3+44\lambda^2-64\lambda+32)+\beta^2(12\lambda^3-76\lambda^2+128\lambda-64)+32\lambda^2-64\lambda+32)}{a^2(\lambda-1)^2\left(\beta^2\lambda-2\beta^2-\beta\lambda+2\right)^2}}-\frac{\beta\lambda}{(\beta-1)(\beta(\lambda-2)-2)}.$$

Proposition 2 indicates that when the fixed cost is small, the online brands will choose the offline direct selling mode into the offline channel; when the fixed cost is in the middle, if the offline direct selling mode, the proportion of consumers should exceed a certain threshold, otherwise they will choose the offline distribution mode; when the fixed cost is high, the online brands will expand to the offline distribution mode. When the fixed cost exceeds the threshold, the profits of online brands in the offline direct selling model will be damaged compared to the original single network channel model. In short, because the dual-channel model meets the needs of offline channels' preferred consumers, whether online brands choose offline distribution mode or offline direct selling mode that meets certain conditions to expand offline channels can increase profits. Therefore, online brand owners are bound to expand to offline channels, and the optimal offline expansion mode is related to the fixed cost of opening direct stores, consumer channel preference and other factors.

Proposition 3 The single network channel model and the profits of two e-retailers with two dual-channel structures meet the following relationship:

When $0<\alpha<\alpha_3$, $\pi_e^2>\pi_e^1>\pi_e^0$; when $\alpha_3<\alpha<1$, $\pi_e^2>\pi_e^0>\pi_e^1$.

Among, $\alpha_3=\dfrac{\beta^2(\lambda-2)^3+8(\lambda-1)^2}{\beta^2(\lambda-2)^3-2\beta\lambda(\lambda-2)+8(\lambda-1)^2}$.

Proposition 3 shows that the profits of e-retailers in offline distribution mode are always higher than those of offline direct selling mode, and e-retailers are more inclined to online brand owners to enter offline channels in offline distribution mode. Compared with a single network channel mode, electronic retailers online brands choose offline distribution model can always benefit, when consumers offline channel preference is low, online brands choose offline direct sales model is good for electronic retailers, when consumers offline channel preference is higher, online brands to offline direct model into offline channels for electronic retailers is bad.

Proposition 4 The single network channel model and the total supply chain profit of the two dual-channel structures meet the following relationships:

(1) When $0<F\le F_5$, or when $F_5<F<F_6$ and $\alpha_4<\alpha<1$, $\pi_s^1>\pi_s^0$; when $F_5<F<F_6$ and $0<\alpha<\alpha_4$, or when $F>F_6$, $\pi_s^1<\pi_s^0$.

(2) When $0<F<F_7$ and $\alpha_5<\alpha<1$, $\pi_s^1>\pi_s^2$.

(3) $\pi_s^2>\pi_s^0$.

Among, $F_5=-\dfrac{a^2\beta^2(\lambda-2)\left(\beta^2(\lambda-2)^3+4\left(\lambda^3-3\lambda+2\right)\right)}{4\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2}$;

$$F_6=\frac{a^2\left(\beta^2\left(2\lambda^3-7\lambda^2+8\lambda-4\right)+4(\lambda-1)^2\right)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2};$$

$$F_7=\frac{2a^2\begin{pmatrix}\beta^8(\lambda-2)^4\left(\lambda^3-\lambda^2-2\lambda+2\right)-2\beta^6\left(\lambda^7-11\lambda^6+33\lambda^5-11\lambda^4-120\lambda^3+252\lambda^2-208\lambda+64\right)\\-4\beta^4\left(3\lambda^6-9\lambda^5-26\lambda^4+140\lambda^3-228\lambda^2+168\lambda-48\right)-8\beta^2(\lambda-1)^2\left(15\lambda^2-28\lambda+16\right)+32(\lambda-1)^4\end{pmatrix}}{\left(\beta^4(\lambda-2)^2\left(\lambda^2-8\lambda+8\right)+4\beta^2\left(3\lambda^3-19\lambda^2+32\lambda-16\right)+32(\lambda-1)^2\right)^2};$$

$\alpha_4=V_1+V_2$, $\alpha_5=V_3+V_4$.

Among,

$$V_1=\frac{\beta\left(\beta^3(\lambda-2)^4-2\beta^2\left(\lambda^2-2\lambda+2\right)(\lambda-2)^2+4\beta(\lambda-1)^2\left(\lambda^2-4\right)+16(\lambda-1)^2\right)}{\beta^4(\lambda-2)^4-4\beta^3\left(\lambda^2-2\lambda+2\right)(\lambda-2)^2+4\beta^2\lambda^2(\lambda-2)^2+32\beta(\lambda-1)^2-16(\lambda-1)^2};$$

$$V_2=2\sqrt{\frac{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2\left(a^2\beta^2(\lambda-1)^2\lambda^2-Fj_3\right)}{a^2\left(j_3\right)^2}};$$

$$V_3=\frac{\beta\lambda\begin{pmatrix}\beta^5\left(-(\lambda-2)^2\right)\left(2\lambda^3-11\lambda^2+14\lambda-4\right)+\beta^4\left(\lambda^5-7\lambda^4+4\lambda^3+32\lambda^2-48\lambda+16\right)\\+2\beta^3\left(2\lambda^5-23\lambda^4+77\lambda^3-112\lambda^2+72\lambda-16\right)\\+4\beta^2\left(\lambda^4+3\lambda^3-20\lambda^2+24\lambda-8\right)+8\beta(\lambda-1)^3(3\lambda-2)-16(\lambda-1)^3\end{pmatrix}}{(\beta-1)j_3};$$

$$V_4=\frac{\sqrt{\dfrac{\left(\beta^4(\lambda-2)^2\left(\lambda^2-8\lambda+8\right)+4\beta^2\left(3\lambda^3-19\lambda^2+32\lambda-16\right)+32(\lambda-1)^2\right)^2\left(2a^2\beta^2(\beta+1)^2\lambda^2(\lambda-1)^3+Fj_4\right)}{a^2(\beta-1)^2(\lambda-1)\left(j_4\right)^2}}}{\sqrt{2}};$$

$$j_3=\beta^4(\lambda-2)^4-4\beta^3\left(\lambda^2-2\lambda+2\right)(\lambda-2)^2+4\beta^2\lambda^2(\lambda-2)^2+32\beta(\lambda-1)^2-16(\lambda-1)^2;$$

$$j_4=\beta^6(\lambda-2)^4\left(\lambda^2-2\right)-2\beta^5(\lambda-2)^2\left(\lambda^4-7\lambda^3+12\lambda^2-12\lambda+8\right)$$
$$-2\beta^4(\lambda-2)^2\left(2\lambda^4-15\lambda^3+19\lambda^2-4\right)-8\beta^3\left(\lambda^5-5\lambda^4+18\lambda^3-38\lambda^2+40\lambda-16\right)$$
$$-8\beta^2\left(3\lambda^5-17\lambda^4+36\lambda^3-34\lambda^2+16\lambda-4\right)+32\beta(\lambda-1)^3(\lambda+2)+32(\lambda-1)^3$$

.

Proposition 4 shows that when the fixed cost is small and consumers' offline channel preference exceeds a certain threshold, the total profit of offline direct selling model is optimal, otherwise the offline distribution model is optimal. When the fixed cost is in the middle and the consumer offline channel does not exceed the threshold, or the fixed cost is higher than the threshold, the online brand owners using offline direct selling mode to expand to offline will reduce the total profit of the supply chain. In conclusion, due to the dual channel mode can meet the needs of various channels preference consumers, whether online brands choose offline distribution model or meet certain conditions of offline direct selling mode for offline channel expansion, are conducive to the whole supply chain system, and the optimal dual channel structure and open stores of fixed cost, consumer channel preference.

5. Supply-chain Coordination Mechanism

Since the participants of the supply chain follow the principle of profit maximization, in the offline distribution model, online brands and physical distributors produce "double marginal effect" in the process of pursuing their own profit maximization, so the Pareto optimal cannot be realized under the decentralized decision, which reduces the efficiency of the O2O supply chain system. Based on the above analysis, offline distribution mode will become the best choice for online brand owners under certain conditions, and offline distribution mode is the best choice for e-retailers. Therefore, the construction of bilateral contract mechanism can be considered to promote the coordination and cooperation among members of the supply chain, so as to realize the Pareto improvement of supply chain efficiency. In actual business operations, physical distributors pay franchise fees to coordinate members of the supply chain, and as consumer demand changes, eliminating or weakening the "double marginal effect" can be achieved through a bilateral contract mechanism in form (w_r^t, Q^t). Here, w_r^t represents the wholesale price of the products sold by the online brands to the physical distributors, and $Q^t\,(Q^t>0)$ is the fixed transfer fee paid by the physical dealers to the online brands.

The profits of online brand owners and physical dealers are:

$$\pi_m^t=(1-\lambda)p_dD_d+w_rD_r+Q^t$$

$$\pi_r^t=(p_d-w_r)D_r-Q^t$$

$$\pi_e^t=\lambda p_dD_d$$

Theorem 4 In the bilateral contract of offline distribution mode, when the contract parameters meet the conditions, the optimal pricing decision of online brands and distributors is:

$$p_d^t = -\frac{a\left(\alpha\left(\beta^3(\lambda-2)^2+4\beta(\lambda-1)^2-8(\lambda-1)^2\right)+8(\lambda-1)^2\right)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)\left(\left(\beta^2-4\right)\lambda+4\right)}$$

$$w_r^t = -\frac{a\beta(\lambda-1)\left(\alpha\left(\beta^3(\lambda-2)^2-2\beta^2(\lambda-2)\lambda-4\beta\left(\lambda^2-3\lambda+3\right)+8(\lambda-1)^2\right)+2\left(\beta^2-4\right)\lambda^2-4\left(\beta^2-4\right)\lambda-8\right)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)\left(\left(\beta^2-4\right)\lambda+4\right)}$$

$$p_r^t = \frac{a(\lambda-1)(\alpha(\beta(\lambda-2)+2)-\beta(\lambda-2))}{\beta^2(\lambda-2)^2+4(\lambda-1)}$$

At this point, the optimal demand of online and offline channels is respectively:

$$D_d^t = \frac{a\left(\alpha(\beta-1)\left(\beta^3(\lambda-2)\lambda+4\beta^2(\lambda-1)^2-4\beta(\lambda-1)^2-8(\lambda-1)^2\right)+\beta^4(-(\lambda-2))\lambda+8\beta^2(\lambda-1)^2-8(\lambda-1)^2\right)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)\left(\left(\beta^2-4\right)\lambda+4\right)}$$

$$D_r^t = \frac{a(\lambda-1)\left(\beta^2(\lambda-2)-4\lambda+4\right)(\alpha(\beta-1)(\beta(\lambda-2)-2)+\beta\lambda)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)\left(\left(\beta^2-4\right)\lambda+4\right)}$$

The best profits of online brands, e-retailers and distributors are:

$$\pi_m^t = \frac{Q^t\left(\beta^4\left(-(\lambda-2)^2\right)\lambda+4\beta^2(\lambda-4)(\lambda-1)^2+16(\lambda-1)^2\right)^2-a^2(\lambda-1)\left(\alpha^2H_1+\alpha H_2+H_3\right)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2\left(\left(\beta^2-4\right)\lambda+4\right)^2}$$

$$\pi_e^t = -\frac{a^2\lambda\left(\alpha\left(\beta^3(\lambda-2)^2+4\beta(\lambda-1)^2-8(\lambda-1)^2\right)+8(\lambda-1)^2\right)\begin{pmatrix}\alpha(\beta-1)\left(\beta^3(\lambda-2)\lambda+4\beta^2(\lambda-1)^2-4\beta(\lambda-1)^2-8(\lambda-1)^2\right)\\+\beta^4(-(\lambda-2))\lambda+8\beta^2(\lambda-1)^2-8(\lambda-1)^2\end{pmatrix}}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2\left(\left(\beta^2-4\right)\lambda+4\right)^2}$$

$$\pi_r^t = \frac{a^2(\lambda-1)^2\left(\beta^2(\lambda-2)-4\lambda+4\right)^2(\alpha(\beta-1)(\beta(\lambda-2)-2)+\beta\lambda)^2}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2\left(\left(\beta^2-4\right)\lambda+4\right)^2}-Q^t$$

Total profit of the supply chain is:

$$\pi_s^t = \frac{a^2\left(\alpha^2I_1+\alpha I_2+I_3\right)}{\left(\beta^2(\lambda-2)^2+4(\lambda-1)\right)^2\left(\left(\beta^2-4\right)\lambda+4\right)^2}$$

Among,

$$Q_1^t = -\frac{8a^2\left(\beta^2-2\right)(\lambda-1)^3\left(\beta^2(\lambda-2)-2\lambda+2\right)^2(\alpha(\beta-1)(\beta(\lambda-2)-2)+\beta\lambda)^2}{\left(\beta^4\left(-(\lambda-2)^2\right)\lambda+4\beta^2(\lambda-4)(\lambda-1)^2+16(\lambda-1)^2\right)^2\left(\beta^2\left(\lambda^2-8\lambda+8\right)+8(\lambda-1)\right)};$$

$$Q_2^t = -\frac{4a^2(\lambda-1)^3n_1(\alpha(\beta-1)(\beta(\lambda-2)-2)+\beta\lambda)^2}{n_2};$$

$$H_1 = (\beta-1)\begin{pmatrix}\beta^7(\lambda-2)^4(\lambda-1)-\beta^6(\lambda-2)^3\left(2\lambda^2+\lambda-2\right)-8\beta^5(\lambda-2)^3(\lambda-1)^2+8\beta^4(\lambda-2)^2\left(2\lambda^3-3\lambda^2-\lambda+2\right)\\+16\beta^3(\lambda-1)^3\left(\lambda^2-6\lambda+7\right)-16\beta^2(\lambda-1)^2\left(2\lambda^3-9\lambda^2+10\lambda-1\right)+64\beta(\lambda-1)^4-64(\lambda-1)^4\end{pmatrix};$$

$$\begin{aligned}H_2 &= \beta^7(\lambda-2)^3\lambda(3\lambda-2)-4\beta^6(\lambda-2)^2(\lambda-1)\lambda^2-8\beta^5(\lambda-2)^2\lambda\left(3\lambda^2-7\lambda+4\right)\\&+32\beta^4(\lambda-2)(\lambda-1)^3\lambda+16\beta^3(\lambda-1)^2\left(3\lambda^3-16\lambda^2+23\lambda-8\right)-64\beta^2(\lambda-2)(\lambda-1)^4+128\beta(\lambda-1)^4-128(\lambda-1)^4\end{aligned};$$

$$H_3 = 2\left(\beta^6(\lambda-2)^2(\lambda-1)\lambda^2-8\beta^4(\lambda-2)(\lambda-1)^3\lambda+16\beta^2(\lambda-2)(\lambda-1)^4+32(\lambda-1)^4\right);$$

$$I_1 = (\beta-1)\begin{pmatrix}\beta^6(\lambda-2)^4\lambda^2-4\beta^5\left(\lambda^2-3\lambda+2\right)^2-4\beta^4(\lambda-1)^2\left(2\lambda^4-12\lambda^3+27\lambda^2-24\lambda+4\right)\\-16\beta^3(\lambda-1)^3+16\beta^2(\lambda-1)^4\left(\lambda^2-4\lambda+9\right)-128(\lambda-1)^4\end{pmatrix};$$

$$\begin{aligned}I_2 &= \beta^7\left(-(\lambda-2)^4\right)\lambda^2+2\beta^6\lambda^2\left(\lambda^2-3\lambda+2\right)^2+8\beta^5(\lambda-1)^2\lambda\left(\lambda^3-6\lambda^2+13\lambda-10\right)\\&-16\beta^4(\lambda-1)^2\lambda\left(\lambda^3-4\lambda^2+6\lambda-4\right)-16\beta^3(\lambda-1)^3\left(\lambda^3-5\lambda^2+13\lambda-8\right)\\&+32\beta^2(\lambda-1)^4\left(\lambda^2-2\lambda+4\right)+128\beta(\lambda-1)^4-128(\lambda-1)^4\end{aligned};$$

$$I_3 = -(\lambda-1)^2\left(\beta^6(\lambda-2)^2\lambda^2-8\beta^4\lambda\left(\lambda^3-4\lambda^2+6\lambda-4\right)+16\beta^2(\lambda-1)^2\left(\lambda^2-2\lambda+4\right)-64(\lambda-1)^2\right);$$

$$\begin{aligned}n_1 &= \beta^8(\lambda-2)^2\left(3\lambda^2-16\lambda+16\right)+\beta^6\left(-22\lambda^4+216\lambda^3-680\lambda^2+864\lambda-384\right)\\&+12\beta^4\left(4\lambda^4-45\lambda^3+137\lambda^2-160\lambda+64\right)-32\beta^2(\lambda-1)^2\left(\lambda^2-15\lambda+20\right)-192(\lambda-1)^3\end{aligned};$$

$$n_2 = \begin{pmatrix}\beta^6\left(-(\lambda-2)^2\right)\lambda\left(\lambda^2-8\lambda+8\right)+4\beta^4\left(\lambda^5-16\lambda^4+75\lambda^3-140\lambda^2+112\lambda-32\right)\\+16\beta^2(\lambda-1)^2\left(3\lambda^2-18\lambda+16\right)+128(\lambda-1)^3\end{pmatrix}^2.$$

6. Conclusion

Based on the dual-channel supply chain, this paper builds a game model dominated by online brand owners, conducts comparative analysis, discusses the influence of online brand owners' offline expansion on supply chain pricing decision and profit balance, and verifies the proposition through numerical simulation. It is found that in the decision-making process of entering offline channels, online brands should fully consider the profit sharing ratio of e-retailers, consumers' channel preference for the product, price competition factors and the fixed cost of the opening of offline direct stores. The main conclusions are summarized as follows:

In terms of pricing strategy, the online selling price of offline direct selling model is the highest, followed by the offline distribution model, and the single network channel model is the lowest; and because the distribution is more than direct selling, the offline selling price of offline distribution model is always higher than that of offline direct selling. Based on balanced profit consideration, online brands in the offline sales development strategy choice and open offline stores fixed cost and consumer channel preference, when open offline stores fixed cost is very low, or when the fixed cost centered and consumer offline channel preference over a certain threshold, the optimal strategy for offline direct model, otherwise for offline distribution model. When the fixed cost exceeds a certain threshold, the offline direct selling model will damage the interests of online brands. Online brands to offline channel expansion form double channel structure is the inevitable choice, although brands may because of competition from offline channels and lose some advantages in online channels, but the online virtual economy and offline real economy integration is beneficial to expand the scale of the market, make the enterprise to adapt to the dynamic market environment.

In terms of supply chain coordination, compared with offline direct selling mode, e-retailers are more willing to accept online brand owners to choose offline distribution mode. The reason is that when consumers' offline channel preference exceeds a certain threshold, online brand owners opening offline direct stores will reduce the revenue of e-retailers. In addition, in order to improve the cooperation efficiency of supply chain members, this paper designed the bilateral contract mechanism of offline distribution model of supply chain coordination, when fixed transfer payments within a certain range, can guarantee the online brands and entity distributors income not less than the gains under the decentralized decision, also can ensure the interests of the offline channel expansion process, finally achieve online brands, entity dealers and electronic retailers coordinated operation and benefit win-win situation, improve the overall profit of the supply chain system, It provides a useful reference basis for the online brand owners to develop the offline market practice.

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References

[1] Zhang Chong, Liu Ying, Han Guanghua. Consider the choice of the sales model and the offline entry strategy for persuasive

advertising [J]. Computer integrated Manufacturing system: 1-24.

[2] Cai G. Channel selection and coordination in dual channel supply chains[J]. Journal of Retailing, 2010,86(1): 22-36.

[3] Hu Y S , Lin J , Su X L . Channel selection decision in a dual-channel supply chain: A consumer-driven perspective[J]. IEEE Access, 2020, PP(99):1-1.

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

[5] Rodriguez B, Aydin G. Pricing and assortment decisions for a manufacturer selling through dual channels[J]. European Journal of Operational Research, 2015,242: 901-909.

[6] Shankar V, Winer R S. Interactive marketing goes multichannel [J]. Journal of Interactive Marketing, 2005, 19(2): 2-3.

[7] Chiang W K, Chhajed D, Hess J D. Direct marketing, indirect profits: A strategic analysis of dual—channel supply-chain design[J]. Management Science, 2003,49(1): 1-20.

[8] Tsay AA, Agrawal N. Channel conflict and coordination in the ecommerce age[J]. Production and Operations Management, 2004b, 13(1): 93-110.

[9] Pu Xujin, Qin Xi Bai, Liu Ran. Manufacturers' online intrusion strategy research considering fair concerns in brick-and-mortar stores [J]. Management Science in China, 2021,29 (04): 149-157.

[10] Xu Lei, Li Yongjian. Study on the structure of supply chain mixed sales channels considering consumer behavior [J]. System Engineering Theory and Practice, 2013,33 (7): 1672-1681.

[11] Liang X, Jiang Q, Guo J. Pricing policy and channel selection of manufacturers under different dual channel structure[J]. Chinese Journal of Management Science, 2018, 26(7) : 97-107.

[12] Cao Yu, Yi Chaoqun, Wan Guangyu. Research on Dual-channel Supply Chain Pricing and Service Decision Based on Manufacturers' Network Channel Selection [J]. Journal of Management Engineering, 2021,35 (02): 189-199.

[13] Sun Zili, Wang Xuping, Ruan Junhu, Gao Yan. Manufacturers' sales model selection, considering direct selling costs and platform transaction fees[J]. Journal of Management, 2018,15 (01): 111-117.

[14] Ryu, M.H., Cho, Y., Lee, D. Should small-scale online retailers diversify distribution channels into offline channels? Focused on the clothing and fashion industry[J]. Journal of Retailing and Consumer Services, 2019,47: 74-77.

[15] Bell, D.R., Gallino, S., Moreno, A. Offline showrooms in omni-channel retail: demand and operational benefits[J]. Management Science , 2018, 64(4): 1629-1651.

[16] Xiaojun Fan, Jun bin Wang, Ting Zhang. For showing only, or for selling? The optimal physical store mode selection decision for e-tailers under competition[J]. International Transactions in Operational Research, 2019, 28(2): 1-20.

[17] Wei Feng and Zhu Yan and Stanimirović Predrag S. Self-Operated Store or Franchised Store? Optimal Decisions for Online-to-Offline Supply Chain with a Demand Shift[J]. Mathematical Problems in Engineering, 2020(11): 1-15.

[18] Arya, A., Mittendorf, B. Bricks-and-mortar entry by online retailers in the presence of consumer sales taxes[J]. Management Science, 2018, 64(11): 5220-5233.

[19] HUANG Song, GUAN Xu, CHEN Yingju. Retailer information sharing with supplier encroachment[J]. Production and Operations Management, 2018, 27(6): 1133-1147.

[20] Liang Xi, Liang Lunhai. Dual-channel supply chain pricing strategy and channel selection considering the difference in channel cost [J]. Industrial Engineering, 2021,24 (02): 1-9.