ICIC Express Letters
Volume **15**, Number **10**, October **2021**
 ISSN 1881-803X
pp. **1067–1074**

RESEARCH ON CHANNEL PRICING OF NEW E-COMMERCE PRODUCTS UNDER CONSUMER PREFERENCE

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Received February 2021; accepted April 2021

Abstract. *Under the speed of incubation of new e-commerce products driven by the economic effects of Internet celebrities, due to the constraints of offline retail, the experience of consumers' preferred needs cannot be provided, which will cause a lack of experience. We study channel strategies under different distribution bilateral matching, establish a profit model, and obtain the relationship between the optimal proportion of consumer preferences and channel preference and the corresponding optimal pricing under different strategies. The results show that in the supply chain of e-commerce incubating new products, the direct channel experience utility input cost and the retail channel sales effort are the key factors that affect channel selection. The cost advantage of direct channels can easily be offset by the promotion of retail stores. It is necessary to open up retail channels. Only under certain conditions, dual-channel operation is the best choice for the manufacturer, and the same price strategy and price matching strategy may not always be the best for the manufacturer.*
Keywords: Fan economy, Consumer behavior, Supply chain channels, Pricing

1. **Introduction.** In 2018, more than 200,000 brands from all over the world launched more than 50 million new products on Tmall, which shows that the new power of online retail has a strong incubation capacity for new products. With the effect of online celebrity traffic carrying goods, independent petty bourgeoisie brands open up a new brand image through network traffic and form a vertical supply chain system integrating supply and marketing in the form of "husband and wife". With the formation of scale, they continue to expand limited to the direct selling cost of retail physical stores and the influence of offline consumer brand recognition, and maximize their profits by not opening their own physical retail stores. Under the dual influence of the economic experience utility of online celebrities generated by consumers' purchasing behavior preferences and the service experience utility of offline retailers, this kind of supply chain coordination strategy will be constrained by the convenience of channels, which is not conducive to the overall supply chain efficiency.

In order to establish a suitable model, here we divide the consumer into three factions. a) In part, due to factors such as actual product experience, network security, and product quality trust, they will not use direct channels at normal prices. b) Part of the experience utility and channel convenience due to their own experience of chasing the real-time Internet celebrity leaders' speeches will only purchase from direct online channels. c) Other consumers belong to the mixed market segment and can purchase from direct channels or retail channels. And we assume that mixed consumers have different preferences for direct sales and retail channels.

DOI: 10.24507/icicel.15.10.1067

Our findings indicate that there are three factors that influence the choice of the best channel. The first is the distribution of consumers in pure retail and mixed market segments. The second is the channel preference of consumers. The third is the relative value of the variable cost per unit of product in the direct channel and the retail channel. For a vertically integrated supply chain, these three factors interact to create the best strategy for different allocation strategies within its feasible range.

2. **Literature Review.** There is a lot of research on channel coordination and pricing in the supply chain, and we will focus on the model where independent retailers in contact with manufacturers participate. Shi et al. [1] found that consumer experience has a greater impact on supply chain optimization from the perspectives of online platforms and offline physical stores through questionnaires. The issue of coordinated pricing in a dual-channel supply chain has always been a hot topic for domestic and foreign scholars. Xu and Li [2] proposed four channel structures based on consumer behavior considerations to analyze the influencing factors of dual-channel efficiency. Cao et al. [3] analyzed channel competition based on the inconsistency of consumers' preferences for traditional retail and online direct sales channels, and used the combination of price mechanism to achieve the perfect coordination of the dual-channel closed-loop supply chain. Ding et al. [4] considered the hierarchical pricing decision process and found the joint optimal strategy of three prices. Deng et al. [5] constructed a two-stage game model considering the consumer distribution function of channel price comparison behavior. Rodríguez-Torrico et al. [6] studied consumer port selection from the perspective of consumer channel preferences. Some scholars also consider the impact of channel operating costs on the decision-making of multi-channel retailers in the supply chain channel structure. Wang et al. [7] introduced the role of channel operating costs and found that the gap between online and offline channel operating costs is a key factor that affects retailers' channel selection strategies. Li et al. [8] studied the impact of product substitution and relative channel status on pricing decisions. Mutlu and Bish [9] combined e-commerce with the channel selection of individual consumers to simulate the reference effect of retailers' previous decisions on consumer decision-making in a multi-period environment. Zhao et al. [10] studied the single and comprehensive effects of reference prices and price matching on consumers' purchasing behaviors, considering strategic consumers. Zhang and Sun [11] considered the retail sales efforts of retailers to compete in the dual-channel supply chain and found the impact between price and market demand in the two decision-making modes.

Looking back on previous literature studies, it did not consider the existence of independent retailers under consumer preferences. Under different consumer channel preferences, we consider independent retailer factors to establish a channel portfolio pricing equilibrium model. The establishment of the model structure is similar to the strategy analysis of Li et al. [8]. From basic direct sales to advance to complex dual-channel channels, stage modeling analysis. In addition, we explored more sophisticated marketing alternatives that have received little or no attention in the literature. Specifically, we analyzed the channel selection of a vertically integrated supply chain. In addition to selling through a manufacturer-owned store, manufacturers can also use the Internet for direct sales.

3. Model Building.

3.1. Model scenarios and parameter settings.

Considering the influence of consumer experience and channel preference behavior, new product manufacturers incubated by e-commerce are limited by offline retailer channels, and the available distribution strategy service combinations can be as follows.

1) Products have only dedicated direct e-commerce channels. For example, modern fast-hand Internet celebrity Simba creates the brand "XinXuan" by his own celebrity effect and other products can only be obtained through direct e-commerce channels. Other

examples include pure clothing stores, and the possible reason for not providing products through independent retailers is to fully control the price and image of the products.

2) There are direct e-commerce channels and its own offline retail channels. For example, some domestic fast-moving clothing brands (Uniqlo, etc.) operate factory stores to attract retail consumers, but they also sell products directly on the Internet. There are also retail brands that are incubated on the Internet, such as "Liangpin" Shop and "Baicaowei".

Use θ to measure the channel preferences of mixed channel consumers, the partition is set to be uniformly distributed $[-1, 1]$, the negative semi-axis of the interval indicates that some mixed consumers prefer retail channels, and the positive semi-axis b is the opposite, and the channel preference selection impact is less than or equal to the consumption utility estimate. We assume that θ is uniformly distributed in $[a, b]$, and θ does not have a deterministic value, which is calculated by the distribution function and determined according to the distribution on the probability density function of $[a, b]$.

The psychological valuation of products is different in consumers, $\rho \in [0, 1]$ reserves prices for consumer products. In a market with a demand scale of 1, if the price is p, the demand is $(1-p)$. The market demand under the market segment size α is $\alpha(1-p)$. The specific parameter settings are shown in Table 1.

Table 1. Model related parameter table

$I = r, d, h$, of which r said retail channels, d table direct channel and h mixed channels	The size of the consumer segment i, $\alpha_i =$ consumers
$W =$ Wholesale price of products with independent retailers (assuming zero manufacturing cost)	$\theta =$ direct channel intensity relative to the retail channel preference
$c_i =$ Additional cost of selling products through different channels	$F(\theta) = \theta$ probability density function of uniform distribution on $[-1, 1]$, $f(\theta) = \theta$ cumulative distribution function
c_r represents the offline sales effort service cost, c_d represents the online experience utility cost	$A =$ preferred direct selling $[-1, 0]$, $b =$ partial retail $[0, 1]$
$q_i =$ Through channel i products demand	N is the distribution strategy: A is open only to the exclusive direct distributors, B is open to both channels of direct selling, and C is open to third-party retail
$p_i =$ The price of the product sold through channel i	K channel structure: L for no third-party retailers, retailers Γ have a third party

3.2. **Channel distribution strategies.**

3.2.1. *E-commerce direct sales channel strategy (A).* In the e-commerce environment, the brands incubated by Internet traffic stars start from online direct marketing. When only e-commerce direct sales channels are available, the demand function of consumers who prefer direct sales groups, that is, consumers who chase traffic stars, is

$$q_d = \alpha_d(1 - p_d), \quad p_d < \rho \tag{1}$$

From the probability density function $f(\theta)$ of the channel preference factor θ, and $p' = \theta^*(\theta)$, $p + p' = \mathrm{E}\left(\int F(\theta)\right)$, neutral consumer $(\theta = 0)$, $p = F(0)$. Suppose the mixed preference consumers with uniform preference distribution are x_n $(n = 1, 2, 3, \ldots, \alpha_h)$, the expected proportion of mixed consumers who prefer direct sales channels or neutral channels is

$$\gamma = \frac{\sum_n^{\alpha_h} p(\theta_n \geq 0)}{\alpha_h} = \frac{\alpha_h[1 - F(0)]}{\alpha_h} = \frac{-a}{b-a} \tag{2}$$

The demand function of consumers who prefer direct sales channels and neutral hybrids is

$$q_{dh}^{+} = \gamma\alpha_d(1 - p_d), \quad p_d < \rho \tag{3}$$

The expected proportion of mixed consumers who prefer retail channels ($\theta > 0$) is $1 - \gamma = b/(b-a)$. Because these consumers prefer retail channels, they now have to move to direct sales channels to obtain products and services, so they get less utility from purchases (price increase), and the expected demand for this segment is based on the effective price of $p_r + \theta^*$, expressed by the following formula:

$$q_{dh}^{-} = (1-\gamma)\alpha_d[1 - (p_d + \theta^*)], \quad (-\theta^* \leq p_d < 1 - \theta^*) \tag{4}$$

$$\theta^* = -\int_a^0 \theta f(\theta|\theta < 0)\mathrm{d}\theta = -a/2 \tag{5}$$

At this time, the total demand of the manufacturer's preference is

$$q_T = q_d + q_{dh}^{+} + q_{dh}^{-} \tag{6}$$

In a vertical supply chain consisting of a manufacturer and its own direct online channels, the manufacturer's profit is expressed as

$$\pi_{(L,A)}^{M} = (p_d - c_d)q_T = (p_d - c_d)(\alpha_d + \alpha_h)[1 - (p_d + (1-\gamma)(\alpha_h/(\alpha_d + \alpha_h))\theta^*)] \tag{7}$$

The second derivative of this total profit formula is obtained to meet sufficient conditions for the optimal price:

$$\partial^2\pi_{(L,A)}^{M}/\partial p_d^2 = -2(\alpha_d + \alpha_h) < 0 \tag{8}$$

Thus, the optimal product price can be obtained:

$$p_d^{*(L,A)} = \frac{1}{2}[(1 + c_d) - (1-\gamma)(\alpha_h/(\alpha_d + \alpha_h))\theta^*] \tag{9}$$

It is convenient to analyze the influence of channel preference and separate the fractional order with θ.

$$\Delta = \frac{1}{2}(1-\gamma)(\alpha_h/(\alpha_d + \alpha_h))\theta^* \tag{10}$$

Because $a < 0$, $\Delta > 0$, the value of $p_d^{*(L,A)}$ is lower than the optimal price at which mixed consumers dislike retail channels. Therefore, the existence of preference for mixed channels reduces the price of products in the consumer market, and the Δ expression shows that the price discount of mixed consumer is proportional to the size of their market segments and their preference for retail channels. As prices fall, consumers with retail constraints benefit from the existence of mixed consumers. Inversely, the optimal profit function of the manufacturer is

$$\pi_{(L,A)}^{*M} = (\alpha_d + \alpha_h)(1 - c_d - 2\Delta)^2/4 \tag{11}$$

Lemma 3.1. *The increase of mixed in proportion of consumers will make direct selling experience flow cost c_d to ascend, and reduce the manufacturer profits, non-linear trend.*

Proof: From the optimal equilibrium price expression Δ formula, it can be seen that the mixed consumer market proportion α_h has an effect on the entire pricing strategy and the optimal profit. Its impact has a large range of fluctuations, because there is a possibility that consumers belong to a mixed market segment and prefer direct sales channels. This cost increase is equal to the expected loss of consumer surplus when preferences and market segments are unknown.

3.2.2. *Dual-channel opening strategy (B).* When both channels are open, consumers will give priority to the diminishing function $G(p)$ for the price difference of the homogeneous products of the two channels, and the purchase decision will also be affected by channel preferences. Consumers compare retail and e-commerce direct sales price differences and channel experience preferences as follows: If $G \geq \theta$, for any preference in $\theta \in [a, b]$ consumers decide to use direct sales channels; otherwise, direct sales are used channel. This is why we set the dual-channel price difference $(p_r - p_d)$ to transform the influence of channel preference. If $a < G < b$, this situation is that the impact of the price difference on the consumer experience cannot completely push all consumers in the hybrid market segment to a single channel, and the hybrid segment will form two sub-segments: a partial retail hybrid channel, another mixed channel that is partial to direct sales. At this time, the expected proportion of mixed consumers who prefer retail channels or are indifferent is: $\gamma = (b-G)/(b-a)$. We construct a distribution strategy model in which manufacturers induce consumers to choose channels based on price differences.

The price difference will produce two boundary conditions, which depend on the preference demand function and the manufacturer's channel cost under the channel preference. There may be three sub-strategies in the dual-channel strategy: a simple dual-channel strategy, a dual-channel strategy that favors retail, and a dual strategy that favors direct sales. Set the retail price and direct sales price to maximize the manufacturer's profit:

$$\pi^M_{(L,B)} = (p_r - c_r)(q_r + \gamma\alpha_h(1 - p_r)) + (1 - \gamma)\alpha_h(1 - p_d)(p_d - c_d) \tag{12}$$

The profit function $\pi^M_{(L,B)}$ is distinguishable in each strategy price setting area, expressed as (PB, RB, DB), which represents one of the three dual-channel strategy area distribution ranges. The optimal profit function is

$$\pi^M_{(L,PB)} = (\alpha_r + \gamma\alpha_h)(1 - p_r)(p_r - c_r) + (1 - \gamma)\alpha_h(1 - p_d)(p_d - c_d) \tag{13}$$

$$\pi^M_{(L,RB)} = (\alpha_r + \alpha_h)(1 - p_r)(p_r - c_r) \tag{14}$$

$$\pi^M_{(L,DB)} = \alpha_r(1 - p_r)(p_r - c_r) + \alpha_h(1 - p_d)(p_d - c_d) \tag{15}$$

$$\pi^M_{(L,B)} \in MAX\left(\pi^M_{(L,PB)}, \pi^M_{(L,RB)}, \pi^M_{(L,DB)}\right) \tag{16}$$

$\pi^M_{(L,RB)}$ and $\pi^M_{(L,DB)}$ have concave curve characteristics in the price setting range, and it is simple to find the global optimal value. If $p_d = p_r - a$, $\pi^M_{(L,PB)} = \pi^M_{(L,RB)}$; $p_r = p_d + b$, $\pi^M_{(L,PB)} = \pi^M_{(L,DB)}$. Then the following Propositions 3.1 and 3.2 respectively show the optimal conditions for the dual strategies of partial e-commerce direct sales strategy and partial offline retail stores.

Proposition 3.1. *When $c_d + b \leq c_r$, the manufacturer should adopt the e-commerce direct sales dual-channel strategy as the best.*

Proof: To facilitate analysis, we abstract price and cost as a generalized function: $\pi(P, C) = (1 - P)(P - C)$, $P \in (0, \rho)$. This formula is a concave function. When $C < P$ has a maximum value $P(C) = \frac{1}{2}(1 + C)$, $\pi(C) = \frac{(1-C)^2}{4}$, at this time $\pi^M_{(L,DB)} = \alpha_r\pi(p_r, c_r) + \alpha_h\pi(p_d, c_d)$, because $c_r \geq c_d + 2b$, $p_d^{*(L,DB)} - p_r^{*(L,DB)} \geq b$. Assume that θ^t is the optimal proportion of mixed consumers that prioritize retail channels in dual, and $c_r \geq c_d + 2b$, $p_r^{*(L,DB)} = p^*(c_d)$, as a result

$$\pi^M_{*(L,DB)} = (\alpha_r + \theta^t\alpha_h)\pi(c_d) \tag{17}$$

$$\pi^M_{*(L,PB)} = (\alpha_r + \theta^t\alpha_h)\pi\left(p_r^{*(L,DB)}, c_r\right) + (1 - \theta^t)\alpha_h\pi\left(p_d^{*(L,DB)}, c_d\right) \tag{18}$$

$$\rightarrow \pi^M_{*(L,DB)} > \pi^M_{*(L,PB)}$$

At this time, the manufacturer's optimal pricing for direct sales and retail is

$$p_d^{*(L,DB)} = \frac{1}{2}(1 + c_d) \text{ and } p_r^{*(L,DB)} = \frac{1}{2}(1 + c_r) \tag{19}$$

The maximum profit of the manufacturer is

$$\pi^M_{*(L,DB)} = \frac{\alpha_r(1 - c_r)^2 + \alpha_h(1 - c_d)^2}{4} \tag{20}$$

Proposition 3.1 shows that if the sales service effort cost of the retail channel is greater than the flow experience cost of the direct channel and exceeds the partial retail intensity ($c_d + 2b \leq c_r$), independent pricing is the best choice, and the price of direct sales and retail channels should be determined independently. Because retail channels are large enough for third-party distribution costs, manufacturers prefer to use e-commerce direct sales channels to provide services to all hybrid consumers.

Proposition 3.2. *If $c_d > c_r$, the dual-channel strategy of partial retail is the best choice for the manufacturer's distribution channels.*

Proof: $\pi^M_{(L,RB)}$ is a concave function, and the maximum value can be obtained by derivation.

Find the second derivative of the profit function: $\partial^2\pi^M_{(L,RB)}/\partial p_r^2 = -2(\alpha_r + \alpha_h) < 0$.

Its first derivative $\partial\pi^M_{(L,RB)}/\partial p_r = 0$, $\pi^M_{(L,RB)}$'s optimal solution is $p_r^{*(L,RB)} = \frac{1}{2}(1 + c_r)$. $p_r^{*(L,RB)} - p_d^{*(L,RB)} < a$. Add slack variable ε. Use the intermediate function set when proving Proposition 3.1, maxed profit: $\pi^M_{*(L,RB)} = (\alpha_r + \alpha_h)\pi\left(p_r^{*(L,RB)}, c_r\right)$. Assume that θ^t is the optimal proportion of mixed consumers serving the retail channel with the best pure dual channels, because $c_d > c_r$, $\pi^*(c_r) \geq \pi^*(c_d)$, $p_r^{*(L,RB)} = p^*(c_r)$, there are inequalities here:

$$\begin{aligned} \pi^M_{*(L,RB)} &= (\alpha_r + \theta^t\alpha_h)\pi^*(c_r) + (1 - \theta^t)\alpha_h\pi^*(c_r) \\ \geq \pi^M_{*(L,PB)} &= (\alpha_r + \theta^t\alpha_h)\pi\left(p_r^{*(L,PB)}, c_r\right) + (1 - \theta^t)\alpha_h\pi\left(p_d^{*(L,PB)}, c_d\right) \end{aligned} \tag{21}$$

Similarly, $\pi^M_{*(L,RB)} \geq \pi^M_{*(L,PB)}$, $\theta^t = 0$. At this time the manufacturer sets the price:

$$p_d^{*(L,RB)} = (1 + c_r)/2 \text{ and } p_d^{*(L,RB)} = p_r^{*(L,RB)} - (\alpha_r + \alpha_h) + \varepsilon \tag{22}$$

The maximum profit is

$$\pi^M_{*(L,RB)} = \frac{(\alpha_r + \alpha_h)(1 - c_r)^2}{4} \tag{23}$$

Proposition 3.2 shows that if the flow experience cost of the direct channel is greater than the cost of the retail channel sales service effort, the manufacturer should set the direct selling price to the extent that consumers prefer the retail store service channel. The manufacturer's strategy is to first set the best retail price to ensure the maximum profit, so that consumers will flood into the retail store, and then set a price that exceeds the maximum consumer preference intensity of the direct channel, and determine the direct sales price based on the retail price.

In addition, it should be pointed out that if the retail channel's sales effort and service cost are relatively large, as long as the marginal profit of the direct channel is greater than the mixed consumer's maximum preference for the retail channel. If $p_d - c_d \geq b$, direct channels will offset priority the price increase imposed by mixed consumers who choose retail, manufacturers try to transfer these consumers to direct channels. Manufacturers attract consumers who prefer retail by setting direct prices lower than independent pricing.

3.3. **Discussion and numerical examples.** We use digital examples to illustrate the strategy of no independent retailer, and then study independent retailers to discuss more difficult strategies. Consider manufacturers with the following parameters to meet the needs and consumer preferences to verify the correctness of the model. First we set $\alpha_r = 0.3$, $\alpha_h = 0.3$, $a = -0.2$, and $b = 0.2$. If $c_r = 0.5$, $c_d = 0.6$, then the dual retail-oriented strategy is the best, followed by the exclusive retail strategy. If $c_r = 0.5$, $c_d = 0.5$, then the retail-focused and pure dual strategies are both optimal, and the profit is 0.0625. If $c_r = 0.5$, $c_d = 0.05$, $c_d + 2b \leq c_r$, according to Proposition 3.1, the direct selling strategy with the directly determined optimal price and the optimal profit of 0.176 is optimal. This numerical example does not consider the fixed costs of operating retail or direct channels. As a result, the proprietary retail channel strategy and the proprietary direct channel strategy have always been inferior to the dual-channel strategy.

4. **Conclusion.** The research results show that network traffic drives demand and breaks the previous market behavior that dominated consumer behavior with price differences, and has a greater impact on the "leader's opinion" under the expansion of new product market channels incubated by e-commerce. In the channel distribution strategy, the optimal conditions for exclusive direct retail channels are not common, and the choice of dual-channel or exclusive direct sales channels is more likely to be the best. Analysis shows that the cost advantage of direct channels can easily be offset by the loss of retail stores, which requires opening up retail channels. Even if the perceived cost and the cost of sales effort are equal, a dual strategy centered on e-commerce direct sales may be preferable to a pure dual channel strategy, because opening retail channels with low demand is usually more costly than opening direct sales channels with slightly higher demand. This means that many e-commerce incubating new products are only keen on investing in network traffic costs, and enjoying temporary e-commerce direct sales profits is not conducive to the long-term market position of new products, and cannot obtain more consumer surplus. The market size will soon be affected. Subsequent homogenous entrants are replaced, and this situation will continue to repeat, affecting consumers' aversion to the entire product market and turning to offline retail stores to gain experience loyalty.

However, there are still many shortcomings in the research of this article. We have proposed the influence of independent retailers; however, we have not established a model of combination of multiple channel strategies with the participation of independent retailers, the expansion of supply chain members to multi-channel marketing portfolio strategies, etc. It is the direction of future research.

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