

# Research on Channel Encroachment Strategy and Contract Design of Manufacturers Based on Live Broadcast

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**Abstract:** This article constructs supply chain models after the manufacturer's live streaming channel encroachment. Through demand function models and Stackelberg game theory, the optimal decisions of each member in the supply chain are solved using reverse induction method. The impact of various parameters on invasion strategies such as quality investment, channel pricing, and profits of all parties is analyzed. The results indicate that when consumers have a high level of preference for the sales channels opened by manufacturers, manufacturers can gain higher profits by inviting internet celebrities to live stream and promote sales through channel encroachment. When the potential demand scale of manufacturers is low and the proportion of anchor sharing is higher, manufacturers should reduce quality costs by lowering the level of quality investment. When the potential demand scale of manufacturers is high, they should reduce product returns by increasing the quality investment level and incentivize broadcasters by raising live broadcast prices.

**Keywords:** Encroachment, Live e-commerce, Pricing decisions, Product return, Product quality.

## 1. Introduction

With the economic development and the substantial improvement of living standards, the scale of e-commerce transactions in China continues to expand. It is expected that by 2024, the transaction scale of e-commerce in China will exceed 55 trillion yuan. With the booming development of e-commerce, the competition between enterprises is becoming more and more fierce. In order to maintain an edge in the fierce market competition, more and more manufacturers have begun to establish their own online sales channels in addition to selling through online distribution. The opening of online direct selling makes manufacturers enter into the market competition with online retailers. In this process, manufacturers are faced with a series of problems, such as how to carry out online sales, how to attract consumers, expand the market scale, and how to balance the allocation of resources between online direct selling and retail. The solutions to these problems need to be further discussed.

With the continuous progress of live broadcasting technology and the improvement of the regulatory system, online live broadcasting applications have played a full role in the fields of marketing and entertainment, and various related formats of online live broadcasting have developed healthily and orderly. In the first three quarters of 2023, e-commerce has played a positive role in expanding domestic demand, stabilizing foreign trade and deepening international cooperation, with sales of live streaming e-commerce in China reaching 1.98 trillion yuan, up 60.6 percent year-on-year. In 2023, the total number of visiting users of Tmall in the whole cycle of "Double 11" exceeded 800 million, and the transaction volume of 402 brands exceeded 100 million yuan; Jingdong's sales of more than 60 brands exceeded 1 billion yuan, and the total number of viewers exceeded 380 million. Live streaming of e-commerce has played a significant role in promoting the rapid development of China's e-commerce industry. In order to expand the scale of online retail market and enhance the economic strength of the company, more and

more traditional brands have chosen to introduce online live broadcasting channels.

To sum up, in order to expand the market scale and improve the strength of enterprises, whether the manufacturers can obtain enough profits by inviting anchors to bring goods, how to make decisions on sales price and channel quality investment to maximize profits has strong theoretical and practical research significance. Based on this, this paper will study the impact of manufacturers' decision to introduce live streaming on the supply chain system by exploring the correlation between factors such as live streaming and quality input and market demand and return volume, and provide manufacturers with reasonable suggestions on channel encroachment.

## 2. Research on Channel Encroachment

The mode of opening up the market, changing the market sales structure and establishing new sales channels to adapt to the development trend of the market is usually called "Channel Encroachment". In this paper, the introduction of live broadcast by manufacturers is regarded as a new sales channel, which invades the original sales channel of retailers, and then forms a new supply chain channel competition. Scholars have also carried out a discussion on the channel encroachment, the motivation and strategy of channel encroachment, and the influence of channel encroachment on the decision-making of the participants have been studied. The study found that Arya<sup>[1]</sup> first studied the effects of manufacturer encroachment on manufacturers' profits, retailers' profits and consumers' surplus, and gave the conditions for manufacturer encroachment. The study showed that channel encroachment could reduce the dual marginalization degree under certain conditions, and manufacturer encroachment would benefit manufacturers, retailers and consumers at the same time. And Zhang Cuihua<sup>[2]</sup> believe that the channel competition brought by the invasion will increase the internal loss among the supply chains and reduce the total profit of the supply chain.

The study of consumer behavior in the context of live streaming e-commerce is one of the hot topics in the study of live streaming e-commerce, and there are many researches on this aspect. As e-commerce live streaming has its own characteristics of Internet celebrities, the research on its marketing is also a hot topic. Some scholars have carried out research on the sales of online celebrity live streaming from the perspective of supply chain, such as the quality effort strategy, the division of platform and online celebrity anchors. Wang Le<sup>[3]</sup> found that while the introduction of live streaming by manufacturers helped boost sales, it also generated a corresponding cost of trouble. Yu Tianyang<sup>[4]</sup> studied the influence of marketing efforts of Internet celebrities on decision-making of live streaming e-commerce under different power structures and held that consumers' purchase intention is closely related to the marketing efforts of anchors. Some literatures have studied the optimization of the incentive mechanism of anchors' efforts, such as Zheng Sengui<sup>[5]</sup>. This paper studies the problem of insufficient profitability of most live streaming platforms in China and puts forward the solution of optimal percentage of the reward income of live streaming platforms. Some scholars link live streaming e-commerce with dual-channel supply chain, and study the pricing decisions and channel strategies of supply chain members under the influence of livestreaming related factors. Cheng<sup>[6]</sup> through the study on the reputation of Taobao sellers, et al. found that the reputation of live streaming sellers is positively correlated with product prices. Xiong Hao<sup>[7]</sup>, Hu Jiao<sup>[8]</sup>. found that the prestige of anchors is positively correlated with the price of balanced live broadcasting.

In summary, the literature on channel encroachment mainly focuses on channel selection and sales mode selection, but pays little attention to the impact of quality decision on the supply chain system in the process of channel encroachment by manufacturers. There is a lack of literature on channel encroachment by means of carrying goods on live broadcast. Literature related to pricing decision studies the optimal pricing of dual channels from different perspectives such as differentiated pricing and reducing channel conflicts, but these papers do not consider the impact of external factors such as live streaming on channel encroachment prices. The existing studies on live streaming e-commerce mainly focus on the business model and marketing promotion of live streaming, but there is a lack of research on live streaming as a channel encroachment mode, and there is no research on the correlation between live streaming and channel quality differentiation decision.

At present, the rapid development of live broadcast sales channels of e-commerce is bound to have an important impact on the channel expansion strategies of traditional enterprises. This paper plans to build a mathematical model for manufacturers to implement channel encroachment on retailers by introducing live streaming goods, analyze the influence of factors related to live streaming on manufacturers' encroachment decisions and optimal profits, and study the influence of live streaming goods on manufacturers' demand expansion, revenue acquisition and competitive strength. In this paper, considering the differences in the characteristics of different channels in the actual situation, the quality of products sold is often different, and the quality decision is planned to be included in the study of manufacturers' live broadcast encroachment. By analyzing the interaction between the factors related to live broadcast

carry-on and quality decision, the paper explores the differentiated price decision and quality decision strategy of manufacturers' channel based on live broadcast.

### 3. Problem Description

This paper constructs a "live + retail" supply chain model considering returns, studies the quality and price decision-making problem of manufacturers' live broadcast encroachment into retail channels, analyzes the influence of various parameters on the quality decision of live broadcast channels and retail channels after encroachment, and the influence of variables such as quality input on the profits of all parties.

This paper studies the supply chain composed of a manufacturer, an online celebrity anchor and a retailer. The manufacturer is responsible for production and product quality control, considering that consumers will return the product when they are not satisfied with the product, and the returned product will be fully refunded to the consumer if it does not affect the secondary sales. The manufacturer decides the product quality level of the retail channel and the live broadcast encroachment according to the raw materials and manufacturing process of the product, and wholesale the products with the quality level to the retailers, who sell them. Subsequently, the manufacturer invades the retailer market by inviting the network celebrity anchors to open the live broadcast of the products with the quality level of sales.

### 4. Model Assumptions

This paper assumes that product demand is affected by price and anchor effort. Since only the audience entering the live broadcast room can be affected by anchor explanation and recommendation, anchor effort will not affect the demand of traditional retail channels, which is only affected by price. In live broadcast sales, the higher the level of effort of online celebrities to bring goods, the higher the consumer's willingness to consume. The online celebrity anchors invited by the manufacturers can livestream the sales volume of the channel products by improving their effort level. Therefore, the demand function of the manufacturer's live broadcast channel and the retailer's channel is established as

$$D_1^L = \alpha - P_1^L + \gamma P_2^L + e_1 \quad (1)$$

$$D_2^L = 1 - \alpha - P_2^L + \gamma P_1^L \quad (2)$$

Taking into account channel demand, price, return salvage value, and quality cost, the manufacturer's profit function is as follows:

$$\pi_m^L = (1 - \beta)(D_1^L - (z - \delta q_1^L))P_1^L + c(z - \delta q_1^L) + \omega D_2^L - \frac{b(q_1^L)^2 - b(q_2^L)^2}{2} \quad (3)$$

The profit of online celebrity anchors takes into account the sales revenue sharing of live channels and the effort cost, and the profit function of anchors is as follows:

$$\pi_a^L = \beta(D_1^L - (z - \delta q_1^L))P_1^L - \frac{e_1^2}{2} \quad (4)$$

The retailer's profit takes into account channel demand, price,

return salvage value and wholesale cost. The retailer's profit function is as follows:

$$\pi_r^L = P_2^L(D_2^L - (z - \delta q_2^L)) + c(z - \delta q_2^L) - \omega D_2^L \quad (5)$$

Retailers sell wholesale products from manufacturers through traditional channels. Manufacturers sell the same products of different quality levels by inviting online celebrity anchors to broadcast live. Manufacturers, retailers and online celebrity anchors all aim to maximize their own profits. The decision order of the game is that the manufacturer first decides the quality input level of the products in the two channels, and then the sales price of the manufacturer's live broadcast channel. Finally, the retailer decides the sales price of the products in the retail channel, and the network celebrity anchor decides the effort level of live broadcast. According to the above decision order, backward induction method is adopted to solve the game problem.

It can be obtained that the decision result and optimal profit of the manufacturer and retailer under the equilibrium state are as follows:

$$P_1^{L*} = \frac{-8bM(-2+2\beta+\gamma^2)+(-1+\beta)\delta(4K+V\gamma\delta+M(4+\gamma^2)\delta)}{2(-1+\beta)(-2+2\beta+\gamma^2)(-8b(-2+2\beta+\gamma^2)+(-1+\beta)(4+\gamma^2)\delta^2)} \quad (6)$$

$$P_2^{L*} = \frac{T}{2} + \frac{X+b(-1+\beta)\delta(-4K\gamma-M\gamma(4+\gamma^2)\delta+V(-4+4\beta+\gamma^2)\delta)}{2(2b(-1+\beta)(-2+2\beta+\gamma^2)(8b(-2+2\beta+\gamma^2)-(-1+\beta)(4+\gamma^2)\delta^2))} \quad (7)$$

$$e_1^* = \frac{T\beta}{2} + \frac{\beta X+b\beta(-1+\beta)\delta(-4K\gamma-M\gamma(4+\gamma^2)\delta+V(-4+4\beta+\gamma^2)\delta\beta)}{2(2b(-1+\beta)(-2+2\beta+\gamma^2)(8b(-2+2\beta+\gamma^2)-(-1+\beta)(4+\gamma^2)\delta^2))} \quad (8)$$

Among them,  $T = 1 - z - \alpha + \omega$ ,  $M = (-1 + \beta)(2z - 2\alpha - T\gamma) + \gamma\omega$ ,  $K = -\delta((-1 + \beta)(2z - 2\alpha - T\gamma) + 2c(-2 + 2\beta + \gamma^2) + \gamma\omega)$ ,  $V = (-1 + \beta)\gamma(-2z + 2\alpha + T\gamma) + (4 - 4\beta - 3\gamma^2)\omega$ ,  $X = 8b^2M\gamma(-2 + 2\beta + \gamma^2) + (-1 + \beta)^2\delta^3(K\gamma - V\delta)$

## 5. Decision analysis

**Corollary 1.** . When the potential demand scale of the manufacturer is low, the quality input level is negatively correlated with the anchor sharing ratio; When the potential demand scale of the manufacturer is high, the quality input level is positively correlated with the share ratio of the anchor. When the potential demand scale of the manufacturer is low, the higher the share ratio of the anchor, the lower the profit of the manufacturer, and the manufacturer is more inclined to reduce the quality cost by reducing the quality input level. When the potential demand scale of the manufacturer is high, the effort level of the anchor will increase with the increase of the share ratio, and the demand of the live broadcast channel will also increase. In order to obtain a higher profit level, the manufacturer will reduce the amount of product returns by improving the quality input level on the one hand, and reduce the sales price of the live broadcast channel on the other hand to maintain the market size of the live broadcast channel.

**Inference 2.** For Internet celebrity anchors, their live streaming effort level decreases with the decrease of sales price, so the greater the amount of basic product returns, the lower the anchor effort level.

**Inference 3.** The higher the potential demand scale of live broadcast channels, the greater the demand for live broadcast channels. In order to maximize profits, manufacturers are

more willing to increase the quality input level of live broadcast channels to reduce the amount of consumer returns. Meanwhile, the improvement of the quality of live broadcast channels will also prompt manufacturers to improve the quality level of retail channels to some extent. The increase in cost caused by the improvement of the quality of live broadcast channels will also be reflected in the pricing of live broadcast channels, and the increase in price will also encourage anchors to improve their efforts.

With the increase of potential demand scale of live streaming channels, the profits of manufacturers and Internet celebrity anchors in live streaming channels first decrease and then increase; the profits of manufacturers in retail channels increase, while the profits of retailers decrease. The profits of Internet celebrity anchors also show a trend of first increase and then decrease due to the dual effects of the potential demand scale of channels and product quality. However, as the quality input cost of the manufacturer in the retail channel increases with the increase of the potential demand scale of the live broadcast channel, so does the wholesale price. Therefore, the profit of the manufacturer in the retail channel increases with the increase of the potential demand scale of the live broadcast channel.

The profits of online celebrity anchors increase with the increase of the share ratio. The profits of the manufacturers in the live streaming channel increase with the increase of the share ratio of the anchors, and the profits of the manufacturers in the live streaming channel are higher than their profits in the retail channel. This is due to the fact that manufacturers invest higher quality in live channel products, and the return rate of live channel products is always lower than that of retail channel, so manufacturers obtain higher profits in live channel products. The profit of retailers increases with the increase of the share ratio of anchors, which is because the increase of the commission of anchors will make manufacturers take the decision of high price and high quality live streaming, which makes more consumers turn to the retail channel with lower price.

The manufacturer's profit decreases as a whole with the increase of quality cost coefficient. The profit of the manufacturer in the retail channel decreases with the increase of the quality cost coefficient, and the profit of the Internet celebrity increases with the increase of the quality cost coefficient. For Internet celebrities, the higher the quality cost, the higher the price of the product, and the higher their share of profits. For manufacturers, as the wholesale price is an exogenous variable, the higher the quality cost, the more it will affect their profits. However, the margin of profit change between the two decreases gradually, which is because with the improvement of quality cost, product reputation becomes better, and consumers' favorable impression of products increases. However, the continuous improvement of prices is also accompanied by the decrease of consumers' preference for broadcast room products.

With the increase in the volume of product base returns, the profit of influencer anchors decreases. This is due to the fact that Internet celebrities can only get commissions for the final products sold, and the higher the basic return rate of products, the more unfavorable it is for Internet celebrities. On the other hand, a high basic return rate may lead manufacturers to be less motivated to invest in product quality and prefer low-price competition. Therefore, for Internet celebrity anchors, the profits of live streaming channels decrease with the increase of basic return volume.

With the increase of the sensitivity coefficient of product quality level, the optimal profit of Internet celebrities in live streaming channels continues to increase. This is because manufacturers will adopt higher quality investment in the live broadcast channel, the price of the live broadcast channel will be higher than that of the retail channel, and the demand for the live broadcast channel will decrease with the increase of the sensitivity coefficient of the quality level, so the overall profit of the net celebrity in the live broadcast channel will be on the rise.

## 6. Conclusion

This chapter studies the problem of a manufacturer invading the supply chain decision by opening a live broadcast channel to invade the retailer's market. Through the derivation of various parameters affecting the decision-making of supply chain members and the simulation analysis of profits, the final conclusion is as follows:

After opening the direct selling channel, the optimal pricing of direct selling channel increases with the increase of the potential demand scale of direct selling channel, and the optimal pricing of retail channel is influenced by both the potential demand scale of direct selling channel and the quality cost coefficient. When the market share of the direct channel is low, the profits obtained by the manufacturer from the direct channel sales are not enough to offset the cost paid by the manufacturer on the quality input, so the profits of the manufacturer in the direct channel will be reduced. When the market share of the live broadcast channel exceeds a certain level, the profits of the manufacturer in the live broadcast channel begin to rise and exceed the profits of the retailer. The retailer's profit decreases with the increase of the market share of the live broadcast channel, but the quality input of the retail channel also increases with the increase of the market share of the live broadcast channel. Finally, the retailer's profit will also increase, but it is still lower than the manufacturer's profit in the live broadcast channel. The profit of network celebrity anchors also showed a trend of first increasing and then decreasing due to the dual effect of channel market share and product quality. However, since the quality of investment of manufacturers in retail channels is lower than that in live

channels in most cases, the profit of manufacturers in retail channels is mainly affected by the share of live channels, and the cost of investment in retail channel quality also increases with the increase of market share of live channels. Therefore, the profit of manufacturers in retail channels decreases with the increase of market share of live channels. When the potential demand scale of direct channel is high, manufacturers can appropriately increase the price of direct channel products.

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