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Research article

When should manufacturers introduce live broadcast channels? Impact of asymmetry network externality

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Abstract: The emergence of new distribution channels presents both opportunities and challenges for manufacturers. We compare the live broadcast dual channel with the agency dual channel in the presence of information symmetric and information asymmetric of network externalities. Our analysis shows that the manufacturer's optimal channel strategy is related to the network externality, the proportion of potential consumers in the direct channel and spillover effects. The manufacturer may adopt the live broadcast channel only if the proportion of potential consumers is small and the network externality is strong. Moreover, stronger positive spillover effects will incentivize the manufacturer to choose the live broadcast channel, while stronger negative spillover effects will drive the manufacturer to use the agency channel. This suggests that the direction of spillover effects also affect manufacturers' preferences. By comparing profits under different information structures, we show that the asymmetry of network externality can weaken the manufacturer's incentives to adopt the live broadcast channel. These new findings underscore the need for manufacturers to take various factors into account when selecting a distribution channel. These findings offer novel insights into the adoption of the live broadcast channel by manufacturers.

Keywords: channel selection; live broadcast channel; network externality; information asymmetry; spillover effect
Mathematics Subject Classification: 90B06

1. Introduction

Live broadcast commerce has developed rapidly with the development of the Internet and digital economy [1,2]. By 2023, China's live broadcast e-commerce transaction volume reached 4.92 trillion yuan, representing a 40.48% year-on-year increase. The user base of live broadcast e-commerce reached 540 million, marking a 14.16% year-on-year increase [3]. Major e-commerce platforms such as Taobao, Amazon, Twitter, and JD have also opened live broadcast services. In the live broadcast channel, influential streamers show and sell products via virtual showrooms and engage with consumers in real time, which enhances the overall consumer experience [4]. The huge potential of the live broadcast market has attracted many manufacturers and has become a powerful tool for many manufacturers to expand their markets [5].

While live broadcast holds great potential, there are still associated risks. The costs of selling products through live broadcast are relatively higher. Streamers usually charge a higher commission than other channels. Due to high commission rates, some manufacturers struggle to achieve anticipated benefits. For instance, Mendale collaborated with a renowned top streamer for six live broadcast sessions, resulting in a total sales volume of 12.8137 million yuan. However, the cumulative payment to the streamer amounted to 3.1746 million yuan [6]. After deducting the commission fee, the actual profit for the enterprise fell short of expectations. Thus, opening live broadcast channels is not always a beneficial option for manufacturers.

Moreover, the live broadcast channel has significant network externalities. Characterized by high interactivity and real-time engagement, consumer behaviors during live broadcasts mutually influence one another. For instance, metrics such as viewer counts, live comments, likes, and instant transactions can affect the purchase intentions of other consumers, thereby generating typical positive network externalities. In contrast, consumer decisions in traditional channels (e.g., direct sales) are generally more independent and lack observable real-time group interactions. However, some streamers resort to purchasing fake traffic to boost revenue. This deceptive practice can mislead manufacturers, as they lack authentic information on the network externality. For example, in a live broadcast of web celebrity Li Xueqin, the number of viewers at the end of the broadcast was 3.11 million, but less than 110,000 were real, and the rest of the viewers were paid to artificially inflate the volume [7]. Such instances are prevalent in the live broadcast channel [8]. When streamers engage in such irregular practices, it creates an information asymmetry between them and the manufacturers. Currently, the impact of network asymmetry on channel selection has received limited attention in the literature, which may challenge or revise existing conclusions.

Due to the two-sided structure of the live broadcast channel, some manufacturers may opt for other distribution channel. One of the common distribution channels is the agency channel. Although the agency channel lacks significant network externalities, it is relatively inexpensive to establish. How to choose sales channels is an important issue for manufacturers. Since most manufacturers already possess an established traditional channel, the introduction of a new channel can generate either positive or negative spillover effects, impacting overall profitability [9,10]. For example, the live broadcast channel may draw consumers away from a traditional channel due to stronger network effects, resulting in demand cannibalization and intensified competition between channels. On the other hand, the live broadcast channel may also acquire new consumers via market expansion effects, thereby enhancing overall demand. The existence of spillover effects adds complexity to the channel selection problem.

Motivated by this practice, we explore the following research questions in this paper. (1) What is the optimal channel selection strategy for the manufacturer under different information structures? (2) How does network externality and spillover effects affect the manufacturer's channel selection? (3) With different consumer channel preferences, how do consumer preferences affect channel selection strategies?

To solve the above problems, we establish models under different information structures. Through analysis and comparison, we draw some conclusions. First, the manufacturer does not have a single strategy that is always optimal. Manufacturer's channel choice depends on the network externality, the proportion of potential consumers in the direct channel and spillover effects. When the proportion of potential consumers in the direct channel is relatively small, the manufacturer should adopt the live broadcast channel if the network externality is strong. Conversely, when network externality is weak, the agency channel becomes the preferable choice. On the other hand, when the proportion of potential consumers in the direct channel is sufficiently large, the manufacturer always adopts the agency channel. Furthermore, the spillover effects can extend the benefits of the live broadcast channel. Therefore, as the cross-channel spillover effects increases, the incentive for manufacturers to adopt the live broadcast channel strengthens. Second, information asymmetry affects channel selection by affecting the prices of different channels. When the manufacturer has a larger valuation of network externality, he is more willing to adopt the live broadcast channel. However, the existence of information asymmetry weakens the motivation of the manufacturer to choose the live broadcast channel. Third, the difference in channel preference affects the pricing of different channels and then changes the scope of different channel choices.

Our main contributions are the following:

(1) We take the manufacturer's perspective and compare the live broadcast dual channel with the agency dual channel. Previous literature has examined more comparisons between resale and agency channels, with little consideration of the live broadcast channel. The direct channel and the agency channel are commonly adopted distribution strategies, and by comparing and analyzing these two channels, we can recommend appropriate sales strategies for manufacturers.

(2) To the best of our knowledge, there is little literature that considers the information asymmetry of network externalities in the live broadcast channel. However, this issue is also prevalent in real-world business practices. Therefore, this paper examines models under both symmetric and asymmetric information about network externalities to explore the impact of information structure on channel choice.

(3) We further consider the impact of spillover effects on channel choice. The introduction of new channels has spillover effects on existing ones, and it remains unclear whether, and in what ways, such effects influence manufacturers' decisions to adopt the live broadcast channel. Therefore, we incorporate spillover effects into the model, accounting for both positive and negative spillover effects.

The rest of the paper is organized as follows. Section 2 provides a literature review and highlights our innovation. In Section 3, we present the production structure and market structure. In Section 4, we consider channel selection strategies under different information structures. In Section 5, we further expand the benchmark model and focus on analyzing the impact of consumer channel preference differences on pricing and channel selection. In Section 6, we put forward management recommendations and conclusions. In the Appendix, we give the necessary analytical proofs.

2. Literature review

This paper focuses on three areas of literature: sales channel selection, live broadcast selling, and network externality.

2.1. Sales channel selection

Earlier studies primarily focused on traditional channel structure choices, such as agency channels and reselling channels. Tian et al. [11] studied channel selection from the perspective of order execution cost and upstream competition intensity. They found that when the order execution cost is high and the upstream competition is strong, the online retailer may choose the pure resale mode. Pu et al. [12] took the operating cost and the commission in an agency channel as the standard to measure different channels, and found the optimal sales channel under different conditions. Zennyo [13] found that, in competitive environments, when the degree of substitutability is at an intermediate level, only low-capacity suppliers choose agency contracts, whereas high-quality suppliers prefer reselling contracts. Hu et al. [14] showed that all supply chain members may benefit from the reselling channel. In addition, Alaei et al. [15] and Gilbert et al. [16] examined manufacturers' channel choice decisions from the perspectives of return policies and the number of traditional distributors, respectively. Beyond traditional channels, an increasing number of firms have introduced live broadcast channels to expand their distribution structures. Although Pan et al. [4] and Wang et al. [17] also studied the choice of the live broadcast channel, they did not consider the characteristics of network externality.

While the above studies were conducted under symmetric information, some subsequent research extended the analysis to asymmetric information settings to investigate the role of information structures in channel choice decisions. Kwark et al. [18] showed that when third-party platforms provide highly accurate information, retailers may benefit from adopting wholesale contracts. Zhang and Zhang [19] analyzed how suppliers open a direct channel in combination with agency mode or resale mode, and whether the online retailer shares information. Tsunoda and Zennyo [20] found that a platform's information-sharing capability could incentivize supply chain members to adopt the agency model. Beyond demand-side information asymmetry, Zhou et al. [21] and Bian et al. [22] also examined the impact of asymmetric service information on channel choice decisions. Furthermore, Lu et al. [23] showed that retailers could strategically share demand information to either deter or encourage manufacturers to establish live broadcast channels. However, few studies have conducted a comparative analysis between live broadcast channels and agency channels, and have not yet considered the impact of asymmetric network externality in live broadcast channels on channel selection.

2.2. Live broadcast selling

The rapid emergence of live broadcast e-commerce attracted considerable attention from the academic community. A stream of studies employed empirical methods to investigate the determinants and feasibility of adopting live broadcast channels. Rafdinal et al. [24] and Rehman et al. [25] investigated the mechanisms through which consumers' impulse purchasing behavior affected live broadcast commerce. Tedjakusuma et al. [26] and Xu et al. [27] primarily examined how streamer characteristics influenced consumers' purchase decisions and, in turn, live broadcast sales performance.

With the development of artificial intelligence, Wang et al. [28] and Ma et al. [29] analyzed the effects of introducing virtual streamers on the efficiency of live broadcast channels. In addition, some studies adopted quantitative approaches to examine live broadcast channels. As the problem of returns on live broadcast is more significant, Zhang et al. [30] studied the role of return freight insurance in channel coordination and applied it to trade processing. Liu and Wang [31] explored how enterprises collaborate with influential streamers. Cui et al. [32] pointed out that live broadcast can reduce the uncertainty of product matching, revealing the different preferences of platforms and sellers for the live broadcast channel.

To date, there is no unified conclusion in the literature regarding whether firms should introduce live broadcast channels [33]. Liu et al. [34] found that providing live broadcast services becomes profitable for retailers only when the effectiveness of the live broadcast channel exceeds a certain threshold, that is, when a sufficiently large number of consumers enter the live broadcast room to watch and purchase products. Mao et al. [35] decomposed the effects of live broadcast into two dimensions emotional support, and informational support and examined how these dimensions influence the choice of cooperation modes as well as the profit-sharing arrangements between retailers and streamers. Niu et al. [36] incorporated product returns and network externalities into the analysis of brands' decisions to introduce live broadcast channels, showing that stronger network externalities are not necessarily beneficial and may even reduce brand profits. Liu and Wang [31] analyzed two business models a short-term window model oriented toward influencers and a long-term window model oriented toward the market and demonstrated that firms should not indiscriminately collaborate with successful influencers. Zhang et al. [37] showed that introducing live broadcast services is always beneficial for both e-commerce platforms and live broadcast service providers. When considering the type of influencer, Ye et al. [38] found the seller prefers to cooperate with the top influencer if the bargaining power and fixed rewards are less than a certain threshold. Yu and Liu [39] investigated the governance of the platform over the streamer, giving the conditions under which the platform chooses to introduce live broadcast. In contrast to the above studies, we compare the live broadcast channel with the agency channel, and examine how asymmetries in network externalities affect the choice of the live broadcast channel.

2.3. Network externality

The network externality is defined as consumers' utility that increases as the number of products or service they purchase increases [40,41]. The previous literature focused on the effects of network externality in the platform [42]. When discussing the factors affecting the profit growth of the platform, Chu and Manchanda [43] found that there is no essential role for direct network effects in the platform's growth, while the positive cross network effect played a key role. However, the role of network externality is no longer limited to platforms, and the existing literature has applied this effect to other fields. Parker and Van Alstyne [44] creatively incorporated the network externality into the bundling model when studying product sales, and found that the network effect can be improved through ingenious product design. Further, Xu et al. [45] explored the impact of service network externality on the pricing of bundled channels. At the same time, the network externality also affects the release of products. Yi et al. [46] found that developers will release product trial versions when the network effect is strong enough to attract more users and enhance positive externality.

The above literature has made some achievements in the research of the network externality, which is relatively rich. In terms of live broadcast, Niu et al. [36] and Mao et al. [35] highlighted the characteristics of network externality of the live broadcast channel. However, the existing literature has not considered the information asymmetry of network externality. Particularly in live broadcast channels, network externality serves as a critical factor for evaluating streamers' influence. However, this information is asymmetric between streamers and manufacturers, which may distort manufacturers' decision-making and consequently affect their profitability. Building upon existing literature, this study incorporates asymmetric information of network externality into the analytical framework to systematically examine its impact on manufacturers' channel selection strategies. Table 1 presents a comparison between this paper and related literature.

Table 1. Comparison between previous studies with this paper.

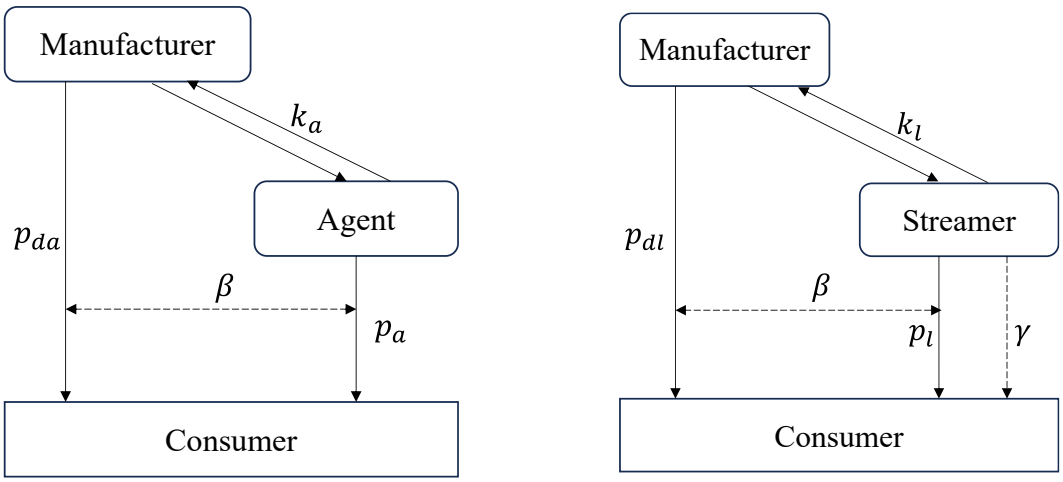
Literature	Dual-channel	Network externality	Information asymmetry	Live broadcast channel	Spillover effect
Alaei et al. [15]	√	–	–	–	√
Abhishek et al. [47]	√	–	√	–	√
Tian et al. [11]	√	–	–	–	–
Liu et al. [34]	√	–	–	√	–
Pan et al. [4]	√	–	–	√	√
Wang et al. [17]	√	–	√	√	–
Cui et al. [32]	–	–	–	√	–
Niu et al. [36]	√	√	–	√	–
Song et al. [48]	√	–	–	√	√
This study	√	√	√	√	√

3. Model setup

3.1. Production structure

We construct a dual-channel supply chain consisting of a manufacturer and an online agent (streamer). The manufacturer sells through a direct channel and a distribution channel. We consider two distribution channel strategies in this paper: One is the agency channel. The manufacturer sells products directly to consumers through the agent's website or platform [15]. After the sale is completed, the manufacturer shares the sales revenue with the agent at a commission rate. The other strategy is the live broadcast channel. The streamer sells products in the live broadcast, and the manufacturer pays the streamer a commission fee. After introducing distribution channels, the two distribution channels and direct channel form two dual-channel supply chains, namely, the agency dual channel and live broadcast dual channel, as shown in Figure 1.

Since this paper focuses on channel introduction for the small- and medium-sized manufacturer, such the manufacturer has less market visibility and is often at a disadvantage when negotiating with the downstream agent (streamer). Therefore, we assume that the agent (streamer) has some pricing power [49–51]. For example, prominent streamers such as Li Jiaqi possess significant pricing power and hold a dominant position in negotiations with brands. The following is the decision-making process under the two channel structure models.



(a) Agency dual channel (b) Live broadcast dual channel

Figure 1. Structure diagram of different channels.

Agency dual channel (DA): The manufacturer introduces the agency channel based on the direct channel, and sells products through the agency dual channel. First, the manufacturer decides on the price p_{da}^I of the direct channel. Then, the agent decides the price p_a^I of the agency channel. When the sale is completed, the manufacturer shares the sales revenue with the agent at a commission rate k_a, as shown in Figure 1(a).

Live broadcast dual channel (DL): The manufacturer introduces the live broadcast channel based on the direct channel, and sells products through the live broadcast dual channel. In the live broadcast channel, information asymmetry exists between the manufacturer and the streamer. To investigate the influence of information structure on decision-making, we first analyze the strategy under information symmetry in Case I and later expand the model to information asymmetry (Case II). First, the manufacturer decides on the p_{dl}^I (p_{dl}^{II}) of the direct channel. Then, the streamer decides the price p_l^I (p_l^{II}) of the live broadcast channel. When the sale is completed, the manufacturer shares the sales revenue with the streamer at a commission rate k_l, as shown in Figure 1(b).

The decision sequence is given in Figure 2.

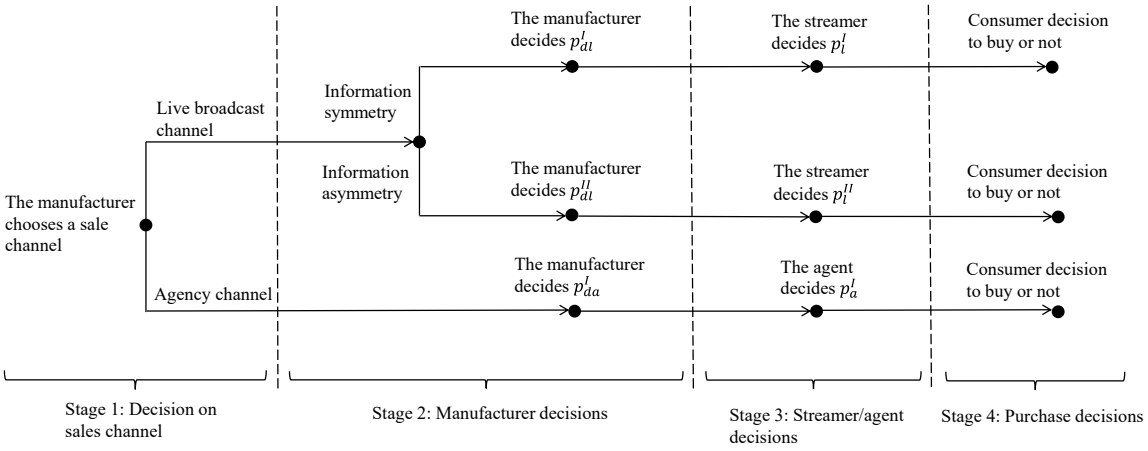


Figure 2. The sequence of events.

To simplify the problem and highlight the research focus, without loss of generality, we assume that the production cost of products and the operation cost of channels are zero [4,47].

3.2. Market structure

We assume that all customers have the same willingness to pay, v, for a single use of the product. The utility function of consumers in the direct channel is: $U_{di} = v - p_{di} + \beta N_i - x_{di}, (i = a, l)$, where the subscript $i = a, l$ represents the two distribution channels. The subscript a represents the agency channel and l represents the live broadcast channel. N_a, N_l is the demand for the agency channel and the live broadcast channel, respectively. βN_i is the spillover utility brought to consumers after introducing distribution channels. β is the cross-channel spillover utility coefficient. Referring to Song et al. [48] and Yang et al. [52], we assume $-1 < \beta < 1$. When $\beta > 0$, the demand for the distribution channel has a positive effect on the direct channel; when $\beta < 0$, it has a negative impact on the direct channel; when $\beta = 0$, the opening of distribution channels does not affect the sales of the direct channel. x_{di} represents the search cost of consumers, which is uniformly distributed over the range $[0,1]$.

The utility function of consumers in the live broadcast channel is: $U_l = \theta v - p_l + \gamma N_l - x_l$. θ is the preference coefficient of consumers for the live broadcast channel. Compared to the direct channel, consumers are relatively unfamiliar with the distribution channels and have a lower dependence on it. Therefore, referring to Pu et al. [12] and Zhou et al. [21], we assume that consumers prefer the direct channel, that is, $0 < \theta < 1$. On the other hand, the live broadcast channel has stronger interactivity and comprehensive product display functions, and it can reduce the information asymmetry of consumers. Thus, we also analyze the case of $\theta_l > 1$ in Section 5. p_l is the price of the live broadcast channel. γ is the coefficient of network externality. In the live broadcast channel, the cluster effect is significant. The number of people watching a live broadcast can reach hundreds of millions, and consumers have interactivity in the live broadcast room. Referring to Niu et al. 36, we assume that there is a positive network externality in the live broadcast channel (i.e., $0 < \gamma < 1$). γN_l indicates that as the demand for the live broadcast channel increases, the utility of network externality gained by consumers increases. x_l means the viewing cost of consumers in the live broadcast channel, which is also uniformly distributed over the range $[0,1]$.

The utility function of consumers in the agency channel is: $U_a = \theta v - p_a - x_a$. Since the network externality of the agency channel is not obvious, most literature does not consider the network externality [12,47]. Thus, we assume that γ in the agency channel meets $\gamma = 0$. In the base model, we assume that consumers have the same preference for the live broadcast channel and the agency channel, both of which are θ. However, in reality, there are significant differences among distribution channels, and consumers have varying preferences for different distribution channels. Therefore, in Section 5, we also further investigate the effect of differences in distribution channel preferences on equilibrium strategies.

Assuming that the total number of consumers in the market is 1, it can be divided into two types: One is consumers who tend to shop in the direct channel, and the proportion is ϕ. The other type is consumers who tend to shop in distribution channels, with the proportion of $1 - \phi$.

When $U_d \geq 0$, consumers who prefer the direct channel will buy products. When $U_d = 0$, we get the location of indifferent consumers x_d^0. Combined with the number of consumers who prefer the direct channel ϕ, the demand realized by the direct channel is ϕx_d^0, as shown in Figure 3.

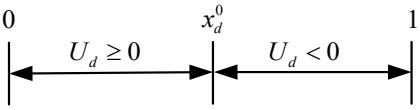


Figure 3. Diagram of products purchased by consumers through direct channels.

Similarly, when $U_i(i = l, a) \geq 0$, consumers who prefer distribution channels will buy products. When $U_i(i = l, a) = 0$, we get the location of indifferent consumers x_i^0. Combined with the number of consumers who prefer distribution channels $1 - \phi$, the demand realized by distribution channels is $(1 - \phi)x_i^0$.

The parameters and variables of the model in this paper are given in Table 2.

Table 2. Parameters and related variables.

Index	***Descriptions***
i	Subscripts, representing the index of the direct channel *d*, agency channel *a*, live broadcast channel *l*, *i=d, a, l*
I	Superscript, representing decision-making in Case I
II	Superscript, representing decision-making in Case II
III	Superscript, representing decision-making in the Expansion
Parameters	
β	Cross-channel spillover effect coefficient
γ	The network externality coefficient, $0 < \gamma < 1$
v	Consumer's valuation of the products
x_i	Travel cost and search cost of different channels
N_i	Demand for products at different channels
k_a, k_l	The commission ratio of two distribution channels
ϕ	Proportion of consumers who prefer the direct channel
θ_i	Consumer preference for distribution channels
ε	The upper bound of a uniform distribution
Decision variables	
p_{di}	The per-unit price of the direct channel
p_l	The per-unit price of the live broadcast channel
p_a	The per-unit price of the agency channel
Profit function	
π_m	The manufacturer's profit
π_l	The streamer's profit
π_a	The agent's profit

4. Equilibrium analysis

In this section, we first analyze the channel selection strategy under the information symmetry of network externality. We constructed the models of the agency dual channel and the live broadcast dual channel, respectively. The optimal strategy is determined by comparing equilibrium solutions. Then,

we consider the model under information asymmetry and study the optimal channel selection strategy of the manufacturer.

4.1. Case I: Symmetric information of network externality

4.1.1. Agency dual channel

In the agency dual channel model, the manufacturer first decides the price p_{da}^I for the direct channel. Then, the agent decides the price p_a^I. When the demand is realized, the manufacturer pays part k_a of the revenue to the agent. We use the subscript "da" to denote the direct channel and "a" to denote the agency channel in the agency dual channel.

The utility functions of consumers in the direct channel and agency channel are as follows:

$$U_{da}^I = v - p_{da}^I + \beta N_a^I - x_{da}, \tag{1}$$

$$U_a^I = \theta v - p_a^I - x_a. \tag{2}$$

According to the analysis of consumers' utility and demand in Section 3.2, the demand realized by the two channels can be obtained:

$$N_{da}^I = \phi\Big(v - p_{da}^I + \beta(1-\phi)(\theta v - p_a^I)\Big), \tag{3}$$

$$N_a^I = (1-\phi)(\theta v - p_a^I). \tag{4}$$

Next, we give the manufacturer's and agent's profit functions:

$$\pi_{ma}^I = (1-k_a)p_a^I N_a^I + p_{da}^I N_{da}^I, \tag{5}$$

$$\pi_a^I = k_a p_a^I N_a^I. \tag{6}$$

The manufacturer and the agent make decisions to maximize profit. We use reverse induction to drive the equilibrium solution. The solution results are in Table 3. The proof is shown in Appendix A.1.

4.1.2. Live broadcast dual channel

In the live broadcast channel, the manufacturer and the streamer cooperate through commission. The manufacturer first decides the price p_{dl}^I for the direct channel. Then, the streamer decides the price p_l^I. When the demand is realized, the manufacturer pays part k_l of the revenue to the streamer. We use the subscript "dl" to denote the direct channel and "l" to denote the live broadcast channel in the live broadcast dual channel.

The utility functions of consumers in the direct channel and live broadcast channel are as follows:

$$U_{dl}^I = v - p_{dl}^I + \beta N_l^I - x_{dl}, \tag{7}$$

$$U_l^I = \theta v - p_l^I + \gamma N_l^I - x_l. \tag{8}$$

According to the analysis of consumers' utility and demand in Section 3.2, the demand realized by the two channels can be obtained:

$$N_l^I = \frac{(1-\phi)(\theta v - p_l^I)}{1-\gamma+\phi\gamma}, \tag{9}$$

$$N_{dl}^I = \phi(v - p_{dl}^I) + \phi\beta\frac{(1-\phi)(\theta v - p_l^I)}{1-\gamma+\phi\gamma}. \tag{10}$$

The profit function of the manufacturer and streamer are given by the following:

$$\pi_{ml}^I = (1-k_l)p_l^I N_l^I + p_{dl}^I N_{dl}^I, \tag{11}$$

$$\pi_l^I = k_l p_l^I N_l^I. \tag{12}$$

The manufacturer and the streamer make decisions to maximize profit. We use reverse induction to find the equilibrium solution consistent with the agency dual channel. The solution results are in Table 3.

Lemma 1. In the live broadcast dual channel, γ has the following effects on equilibrium outcomes: (i) When $0<\beta<1$, $\frac{\partial p_{dl}^{I*}}{\partial\gamma}>0$, $\frac{\partial N_{dl}^{I*}}{\partial\gamma}>0$, $\frac{\partial N_l^{I*}}{\partial\gamma}>0$, $\frac{\partial p_l^{I*}}{\partial\gamma}=0$; when $-1<\beta<0$, $\frac{\partial p_{dl}^{I*}}{\partial\gamma}<0$, $\frac{\partial N_{dl}^{I*}}{\partial\gamma}<0$, $\frac{\partial N_l^{I*}}{\partial\gamma}<0$, $\frac{\partial p_l^{I*}}{\partial\gamma}=0$; (ii) $\frac{\partial \pi_{ml}^{I*}}{\partial\gamma}>0$, $\frac{\partial \pi_l^{I*}}{\partial\gamma}>0$.

The proof is shown in Appendix A.1.

Lemma 1(i) shows that when the spillover effects are positive, the price and the demand for the two channels increase with the network externality; when the spillover effects are negative, the price and the demand for the two channels are negatively correlated with the network externality. However, regardless of the spillover effects, the price in the live broadcast channel is irrelevant to the network externality.

Lemma 2. The price relationship between the agency dual channel and live broadcast dual channel is as follows:

(i) When $0<\beta<1$, $p_{dl}^{I*}>p_{da}^{I*}$, $p_l^{I*}=p_a^{I*}$; when $-1<\beta<0$, $p_{dl}^{I*}<p_{da}^{I*}$, $p_l^{I*}=p_a^{I*}$;

(ii) When $max\left\{\frac{2\theta-2}{\theta(1-\phi)},-1\right\}<\beta<1$, $p_{da}^{I*}>p_a^{I*}$; when $-1\le\beta\le max\left\{\frac{2\theta-2}{\theta(1-\phi)},-1\right\}$, $p_{da}^{I*}<p_a^{I*}$. When $max\left\{\frac{(2\theta-2)(1-\gamma+\phi\gamma)}{\theta(1-\phi)},-1\right\}<\beta<1$, $p_{dl}^{I*}>p_l^{I*}$; when $-1\le\beta\le max\left\{\frac{(2\theta-2)(1-\gamma+\phi\gamma)}{\theta(1-\phi)},-1\right\}$, $p_{dl}^{I*}<p_l^{I*}$.

The proof is shown in Appendix A.2.

Lemma 2(i) shows that when the spillover effects are positive, the price of the direct channel in the live broadcast dual channel is higher than that in the agency dual channel. However, when the spillover effects are negative, the price of the direct channel in the live broadcast dual channel is lower than those in the agency dual channel. Regardless of the spillover effects, the prices of distribution channels in the two-channel structures are the same. Compared with the agency channel, the live broadcast has a better effect of attracting traffic. Opening the live broadcast channel can bring more demand to the direct channel, and the positive spillover effects are more significant. The advantage of demand enables the manufacturer to set higher prices in the direct channel. However, the negative spillover effects of the live broadcast channel may also be stronger. Because the interactivity and the network externality of the live broadcast channel may attract more consumers, so as to seize more traffic. Currently, the manufacturer is better off by reducing the price of the direct channel.

Without considering other factors such as cost, the prices of these two distribution channels are only related to consumers' valuation and channel preference, and are not affected by spillover effects. Therefore, the prices of the distribution channel are consistent. In Section 5, we subdivide distribution channel preference to further explore the impact of channel preference differences on channel selection.

According to Lemma 2(ii), we can find that when the spillover effects of the distribution channel to the direct channel are larger, the demand for the direct channel then increases. The manufacturer will set a higher price in the direct channel to obtain higher unit revenue. This explains why many brands' products have higher prices in the direct channel and set lower prices in the live broadcast channel. Therefore, the manufacturer can set higher prices in the direct channel than in the distribution channels as long as the distribution channels do not have a significant negative effect on the direct channel.

4.1.3. Channel selection analysis

First, we analyze the simplest case, assuming that opening the distribution channel does not affect the direct channel. When the cross-channel spillover effects are not considered, the equilibrium solutions under different channel structures are shown in Table 3.

Table 3. Equilibrium solutions under different cases.

	Without cross-channel spillover effect		With cross-channel spillover effect	
	Agency dual channel	Live broadcast dual channel	Agency dual channel	Live broadcast dual channel
$\boldsymbol{p_d}$	$\frac{v}{2}$	$\frac{v}{2}$	$\frac{v}{2}+\frac{\beta(1-\phi)\theta v}{4}$	$\frac{v}{2}+\frac{(1-\phi)\beta\theta v}{4(1-\gamma+\phi\gamma)}$
$\boldsymbol{p_i}$	$\frac{\theta v}{2}$	$\frac{\theta v}{2}$	$\frac{\theta v}{2}$	$\frac{\theta v}{2}$
$\boldsymbol{N_d}$	$\frac{v\phi}{2}$	$\frac{v\phi}{2}$	$\frac{v}{2}\phi+\frac{\beta(1-\phi)\phi\theta v}{4}$	$\frac{v}{2}\phi+\frac{(1-\phi)\phi\beta\theta v}{4(1-\gamma+\phi\gamma)}$
$\boldsymbol{N_i}$	$\frac{\theta v}{2}(1-\phi)$	$\frac{(1-\phi)\theta v}{2(1-\gamma+\phi\gamma)}$	$\frac{\theta v}{2}(1-\phi)$	$\frac{(1-\phi)\theta v}{2(1-\gamma+\phi\gamma)}$

Proposition 1. Without considering the spillover effects, the manufacturer's optimal channel selection strategy is influenced by ϕ, γ.

(i) If $0<\phi\le\phi^*$, when $\gamma^*<\gamma<1$, $\pi_{ml}^{I*}>\pi_{ma}^{I*}$; when $0<\gamma\le\gamma^*$, $\pi_{ml}^{I*}<\pi_{ma}^{I*}$;

(ii) If $\phi^*<\phi<1$, $\pi_{ml}^{I*}<\pi_{ma}^{I*}$.

Where $\gamma^*=\frac{k_l-k_a}{(1-k_a)(1-\phi)}$, $\phi^*=\frac{1-k_l}{1-k_a}$. The proof is shown in Appendix A.3.

Proposition 1(i) shows that when loyal consumers in the direct channel are fewer (i.e., $0<\phi\le\phi^*$), we find that if the network effect of the live broadcast channel is large enough to exceed the threshold γ^* ($\gamma^*<\gamma<1$), the manufacturer will prefer the live broadcast channel. On the contrary, if the network effect of the live broadcast channel is weak ($0<\gamma\le\gamma^*$), it can be seen from $N_l^I-N_a^I=\theta v(1-\phi)^2\gamma/2(1-\gamma+\phi\gamma)$ that the difference in sales volume between the two distribution channels is small. The higher commission of the live broadcast channel weakens the manufacturer's

profit, so the manufacturer will choose the agency channel. For example, the streamer is a novice, and his sales ability, personal appeal and fan base are relatively weak. This makes it difficult to realize the network effect of the live broadcast channel, so the manufacturer will open the agency channel to make more profit. As illustrated in Figure 4, when the proportion of potential consumers in the direct channel is sufficiently large $(\phi > \phi^*)$, the manufacturer optimally chooses the agency channel. The underlying reason is that a larger ϕ implies a broader existing consumer base for the manufacturer, which weakens the incentive to rely on network externalities from the live broadcast channel to further expand demand. Moreover, the relatively high commission rate charged by the live broadcast channel reduces the manufacturer's profitability under this channel structure, thereby making the agency channel the preferred option.

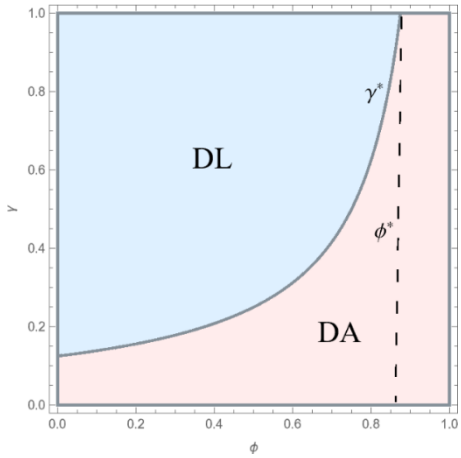


Figure 4. Channel selection strategy without considering cross-channel spillover effects.

Proposition 1 states that manufacturer's channel choice depends on the network externality and the proportion of potential consumers in the direct channel. For start-up manufacturers (ϕ is smaller), the live broadcast channel is preferable only if the network externality is strong; otherwise, they should opt for the agency channel. In contrast, for established manufacturers (ϕ is larger), the agency channel is the optimal choice.

Proposition 2. When considering the spillover effects, we analyze the impact of positive spillover effects and negative spillover effects on channel selection, respectively:

(i) If $0 < \phi \leq \phi^*$, when $\gamma_1^* < \gamma < 1$, $\pi_{ml}^{I*} > \pi_{ma}^{I*}$; when $0 < \gamma \leq \gamma_1^*$, $\pi_{ml}^{I*} < \pi_{ma}^{I*}$;

(ii) If $\phi^* < \phi < 1$, $\pi_{ml}^{I*} < \pi_{ma}^{I*}$. The proof is shown in Appendix A.4.

Similar to the conclusions of Proposition 1, when considering cross-channel spillovers, the manufacturer's choice of the live broadcast channel is affected by the proportion of consumers as well as the network externality. When the proportion of potential consumers in the direct channel is not very high, the manufacturer is more willing to open the live broadcast channel if the network externality is large. When the network externality is small, the difference between the agency channel and the live broadcast channel decreases, and the lower commission cost of the agency channel makes the manufacturer willing to open the agency channel. In addition, as the proportion of potential consumers increases in the direct channel, the manufacturer is more willing to introduce the agency channel.

Compared to Figures 5(a) and 5(b), the manufacturer's incentive to choose the live broadcast channel is enhanced when the positive spillover effects are strengthened. The network externality further reinforces the spillover effects while attracting traffic to the live broadcast channel. This dual

benefit also widens the difference between the live broadcast channel and the agency channel, increasing the manufacturer's inclination to adopt the live broadcast channel.

On the contrary, comparing Figures 5(c) and 5(d), the enhanced negative spillover effects instead increase manufacturers' willingness to choose the agency channel. This is mainly due to the fact that when the negative spillover effects are large, the live broadcast channel will capture more consumers from the direct channel. These negative spillover effects are also enhanced by the existence of network externality, which weakens manufacturers' incentives to choose the live broadcast channel. For instance, when manufacturers collaborate with top-tier streamers, the live broadcast channel often offers more appealing pricing and promotional campaigns, thereby enticing consumers to shift purchases from direct channels to live broadcast channels. Consequently, this leads to a decline in sales volume within the direct channels. This phenomenon compels manufacturers to become increasingly reliant on streamers, thereby eroding their own brand value. Consequently, leading brands such as Apple avoid heavy investment in live broadcast and instead adopt the agency channel.

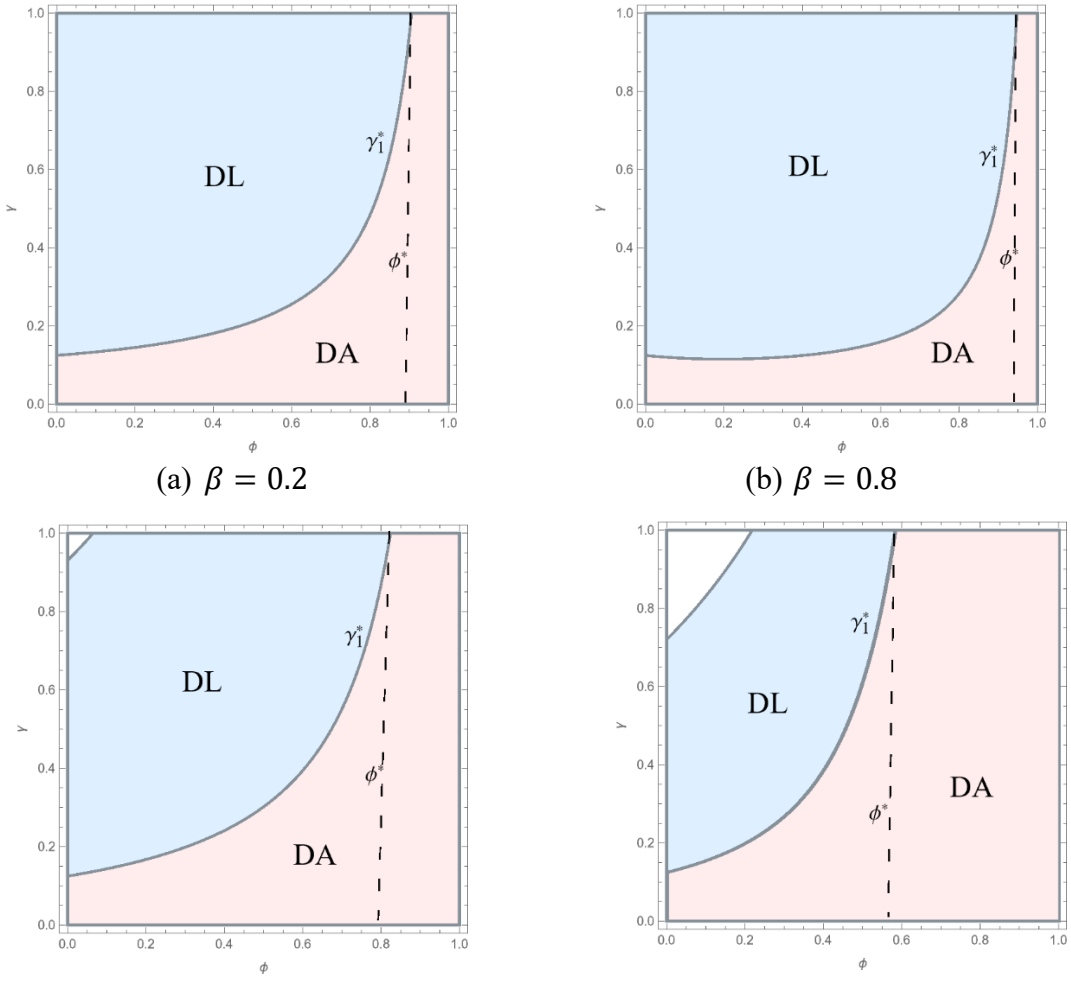


Figure 5. Channel selection strategy of cross-channel positive spillover effects.

4.2. Case II: Asymmetric information of network externality

In reality, the streamer is closer to consumers and has the information advantage of network externality. There is also a possibility that the streamer may falsify the data in the live broadcast room. On the other hand, manufacturers lack accurate market information and face information disadvantages, resulting in an information asymmetry between the two parties. This situation only occurs on the live broadcast channel. Therefore, this section focuses on analyzing the channel selection strategy under the information asymmetry of network externality.

4.2.1. Live broadcast dual channel

We suppose the streamer knows the network externality coefficient γ, but the manufacturer does not. However, the manufacturer can estimate the network externality based on experience. Assuming the manufacturer is risk-neutral, the manufacturer will choose to estimate conservatively, anticipating every possibility with equal probability. Thus, we assume that the network externality γ follows a uniform distribution on $(0, \varepsilon)$, and its probability density is $f(\gamma)$. In the case of asymmetric information, the manufacturer aims to maximize its expected profit, and the expected profit function of the manufacturer is:

$$E(\pi_{ml}^{II}) = (1 - k_l)p_l^{II}E(N_l^{II}) + p_{dl}^{II}E(N_{dl}^{II}). \tag{13}$$

The profit function of the streamer does not change and by calculation, the optimal price is as follows：

$$p_{dl}^{II*} = \frac{v}{2} - \frac{\beta\theta v\, ln(1-\varepsilon+\varepsilon\phi)}{4\varepsilon},\ p_l^{II*} = \frac{\theta v}{2}. \tag{14}$$

Lemma 3. The network externality information asymmetry has the following effects on price and demand: (1) When $0 < \beta < 1$, $\frac{\partial p_{dl}^{II*}}{\partial \varepsilon} > 0$, $\frac{\partial N_{dl}^{II*}}{\partial \varepsilon} > 0$; when $-1 < \beta < 0$, $\frac{\partial p_{dl}^{II*}}{\partial \varepsilon} < 0$, $\frac{\partial N_{dl}^{II*}}{\partial \varepsilon} < 0$; (ii) $\frac{\partial p_l^{II*}}{\partial \varepsilon} = 0$, $\frac{\partial N_l^{II*}}{\partial \varepsilon} = 0$.

The proof is shown in Appendix A.5.

Lemma 3 shows the effect of the manufacturer's valuation of network externality on prices and demand in different channels. First, positive and negative spillover effects directly affect ε. When the spillover effects are positive, as valuation increases, the manufacturer tends to raise prices in the direct channel. This occurs primarily because the manufacturer perceives the live broadcast channel as having superior traffic acquisition capabilities, which indirectly stimulates additional demand for traditional channels. With rising demand, the manufacturer is incentivized to increase prices in the direct channel. However, when the spillover effects are negative, higher valuation leads the manufacturer to reduce direct prices to maintain competitiveness.

Lemma 4. Under information asymmetry, the price relationship between the agency dual channel and the live broadcast dual channel is as follows: (i) When $\beta[z_2 + (1-\phi)\varepsilon] < 0$, $p_{dl}^{II*} > p_{da}^{II*}$; $p_l^{II*} = p_a^{II*}$; (ii) when $\beta[z_2 + (1-\phi)\varepsilon] > 0$, $p_{dl}^{II*} < p_{da}^{II*}$; $p_l^{II*} = p_a^{II*}$.

The proof is shown in Appendix A.6.

When information asymmetry is considered, the pricing strategy of the direct channel is influenced by the network externality in addition to cross-channel spillover effects. When the network externality is stronger, the direct channel's price is also higher. When the network externality is

stronger than a certain value, the price of the direct channel will be higher in the live broadcast dual channel. Since the price of the distribution channel is only related to the consumer's valuation of the product and the channel preference, the price of the distribution channel is the same in different channel structures.

4.2.2. Channel selection analysis

Proposition 3. Without considering the spillover effects, the manufacturer's optimal channel selection strategy is influenced by ϕ, ε.

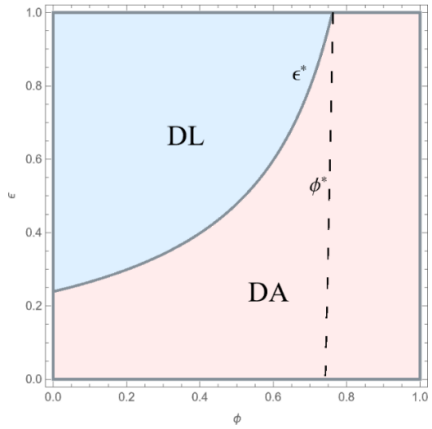


Figure 6. Channel selection strategies under information asymmetry without the spillover effects.

Proposition 3 reveals that the information valuation parameter ε has a significant influence on the manufacturer's channel selection strategy. When the manufacturer assigns a higher valuation to the live broadcast channel, it perceives this channel as possessing superior attractiveness, thereby exhibiting greater propensity to adopt the live broadcast channel. Conversely, under lower valuation scenarios, the manufacturer rationally opts for the agency channel.

Comparative analysis with Proposition 1 reveals that the manufacturer's willingness to adopt the live broadcast channel progressively diminishes, as shown in Figure 6. This suggests that information asymmetry significantly weakens the manufacturer's motivation for live broadcast channel selection. Excessive information concealment by streamers may readily induce suboptimal manufacturer decisions, thereby impeding successful cooperation establishment. Consequently, streamers should proactively enhance information transparency to incentivize more manufacturers to adopt live broadcast channels.

Proposition 4. When considering the spillover effects, we get the conditions of the optimal channel strategy as follows:

(i) If $0 < \phi \le \phi^*$, when $\epsilon_1^* < \gamma < 1$, $\pi_{ml}^{II*} > \pi_{ma}^{I*}$; when $0 < \gamma \le \epsilon_1^*$, $\pi_{ml}^{II*} < \pi_{ma}^{I*}$;

(ii) If $\phi^* < \phi < 1$, $\pi_{ml}^{II*} < \pi_{ma}^{I*}$.

Proposition 4 characterizes the impact of information asymmetry on manufacturers' channel selection decisions under the cross-channel spillover effects. Consistent with the aforementioned analytical results, the manufacturer has a strong preference for adopting the live broadcast channel when the channel valuation exceeds a critical threshold. Conversely, they rationally revert to the agency channel when the valuation falls below this threshold.

As illustrated in Figure 7, the manufacturer exhibits stronger motivation to adopt the live broadcast channel when the cross-channel spillover effects reach a significant magnitude. This is because spillover effects multiplicatively enhance the positive utility of the live broadcast channel, consequently strengthening the manufacturer's adoption willingness proportionally to spillover intensity.

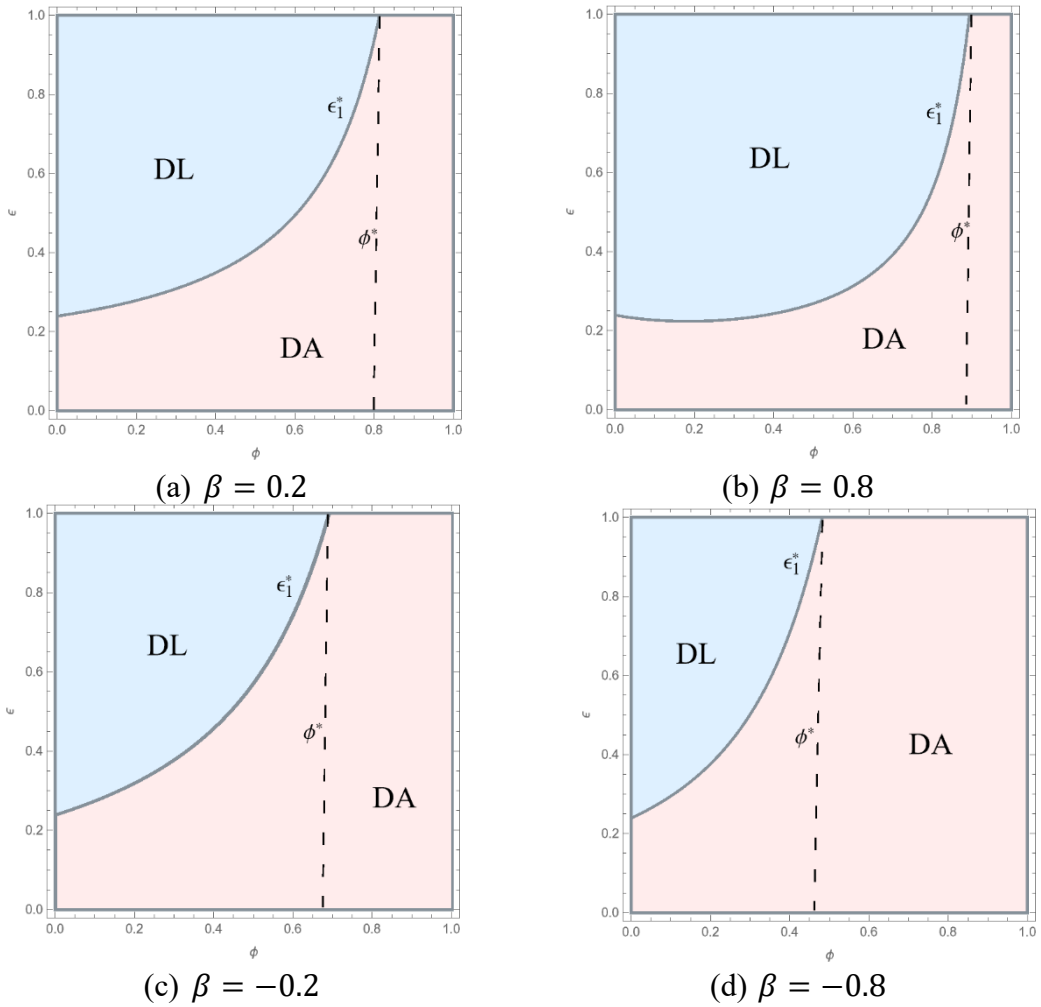


Figure 7. Channel selection strategy under asymmetric information with the spillover effects.

Proposition 5. When considering the spillover effects, $\pi_l^{II*} < \pi_l^{I*}$ always holds.

Proposition 5 examines the impact of information asymmetry on the streamer's profit. The results show that when information asymmetry exists between the streamer and the manufacturer, the streamer does not necessarily earn a higher profit even if it possesses an informational advantage over the manufacturer. When the streamer has superior information about market demand, he can adjust the live broadcast price more accurately. However, because demand substitution exists between the direct sales channel and the live broadcast channel, the streamer's pricing decision indirectly affects the manufacturer's optimal pricing decision in the direct channel through channel competition. Anticipating the streamer's informational advantage, the manufacturer strategically responds by adjusting the direct-channel price, which endogenously offsets the potential profit gains from the streamer's information advantage in equilibrium. Furthermore, since the commission rate received by the streamer is exogenously given, the streamer's profit mainly depends on the sales volume in the live

broadcast channel rather than on price markups. Under dual-channel competition, price adjustments based on the streamer's information advantage are likely to trigger price responses in the direct channel, which partially crowds out demand from the live broadcast channel and thereby constrains the commission revenue available to the streamer. As a result, although information advantage improves the accuracy of the streamer's pricing decisions, it does not translate into higher equilibrium profits.

These findings also generate important managerial implications for streamers. In a dual-channel live broadcast environment, relying solely on informational advantages and adjusting live broadcast prices to increase profits is not an optimal strategy. When formulating their operational strategies, streamers should establish deeper cooperative relationships with manufacturers and maintain information transparency to mitigate competition between channels. In addition, streamers can seek more flexible contractual arrangements such as tiered commission schemes, long-term cooperation agreements, or joint promotional campaigns to transform their informational advantages into bargaining power rather than using them merely for short-term pricing decisions.

4.3. Case II: Asymmetric information of network externality

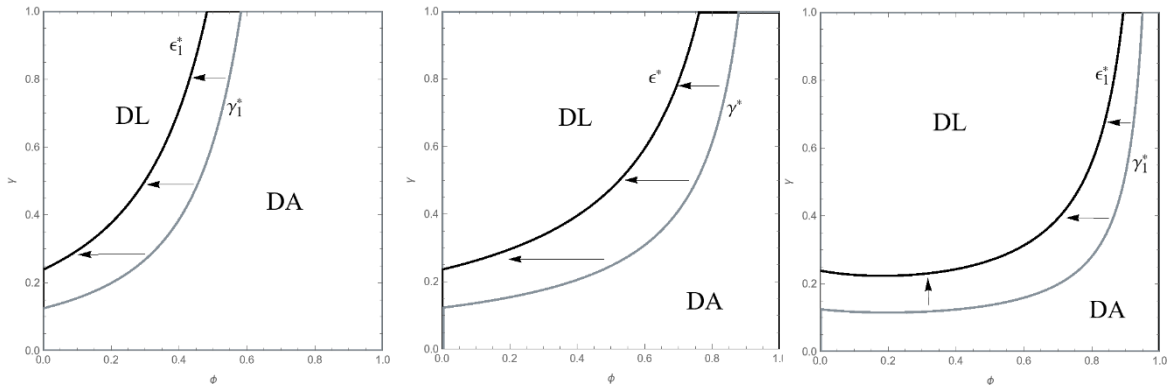
Corollary 1. Under different information structures, the following relationship exists between price and demand for the live broadcast dual channel: (i) When $\beta[z_1 z_2 + (1-\phi)\varepsilon] > 0$, $p_{dl}^{II*} < p_{dl}^{I*}$, $p_l^{II*} = p_l^{I*}$; $N_{dl}^{II*} > N_{dl}^{I*}$, $N_l^{II*} = N_l^{I*}$; (ii) when $\beta[z_1 z_2 + (1-\phi)\varepsilon] < 0$, $p_{dl}^{II*} > p_{dl}^{I*}$, $p_l^{II*} = p_l^{I*}$; $N_{dl}^{II*} < N_{dl}^{I*}$, $N_l^{II*} = N_l^{I*}$.

The proof is shown in Appendix A.7.

It can be seen from Corollary 1 that prices and demand in the direct channel move in the opposite direction. Corollary 1(i) shows that under information asymmetry, prices in the direct channel are lower when the network externality and cross-channel spillover effects are in a specific range. This is relatively easy to understand. A manufacturer at an information disadvantage will attract more consumers through a low-price strategy. However, the results of Corollary 1(ii) show that under this condition, the manufacturer should set a higher price for the direct channel with information asymmetry. This is contrary to our intuition. In general, when the manufacturer has less information, he prefers to attract more consumers with a low-price strategy. We conclude, on the contrary, that when the manufacturer is at an information disadvantage, he may set a higher price. The main reasons behind it are as follows. First, the manufacturer setting a high price can fully exploit the network externality of live broadcast. Consumers are more willing to buy products from the live broadcast channel when the price of the direct channel is higher. From a crowd psychology perspective, the higher the sales volume, the more consumers will be attracted to buy the product. Brand awareness gradually increases with the sales of the products. On the other hand, higher prices can achieve higher revenue per unit. When the live broadcast ends, the consumer can no longer complete the purchase from this channel. Some of the consumers who like the brand switch to the direct channel to purchase, thus achieving diversion for the direct channel. However, compared to information symmetry, the demand decreases gradually with increasing price, resulting in lower demand for the direct channel in the information asymmetry. Consistent with the previous findings, the price of the live broadcast channel is independent of the network externality. Therefore, the prices are the same for different information structures.

Corollary 2. Information asymmetry reduces the manufacturer's motivation to adopt the live broadcast channel, i.e., $\gamma_1^* < \varepsilon_1^*$.

Corollary 2 demonstrates that information asymmetry between the manufacturer and streamer significantly reduces the manufacturer's willingness to adopt the live broadcast channel. As shown in Figure 8, the feasible region for the live broadcast channel adoption substantially contracts under asymmetric information conditions.



(a) $\beta = -0.8$ (b) $\beta = 0$ (c) $\beta = 0.8$

Figure 8. Changes in the range of channel selection.

For the streamer, withholding information is not always beneficial. Although having an informational advantage grants streamers greater control, it may also lead to cooperation failure. In practice, data falsification by streamers is a prevalent issue. For instance, some popular streamers deliberately purchase fake traffic to inflate their live-stream viewership numbers. However, once such practices are exposed, consumers lose trust in them, prompting some brands to terminate their partnerships with these streamers. Therefore, we recommend that streamers should take a long-term perspective. They should proactively disclose truthful information to manufacturers to establish more reliable partnerships.

4.4. Management insights

Based on the above analysis, we provide several managerial insights into the channel selection strategy of the supply chain.

First, manufacturers at different stages of development or with different sizes should adopt differentiated channel strategies. For small and medium-sized manufacturers in the early stages of development, introducing the live broadcast channel can leverage the influence of streamers to attract traffic more quickly and enhance brand awareness. For manufacturers in the mid-development stage, with a larger pool of potential consumers, they can choose to open agency channels to reduce costs when the channel spillover effects are moderate. In practice, compared to the agency channel, the live broadcast channel is not available 24/7, and some consumers may miss the live broadcast due to time differences. These consumers are likely to shift to direct channels, bringing more sales to direct channels. If the newly introduced channels can more easily drive traffic to direct channels, manufacturers should consider open the live broadcast channel.

Second, from an informational perspective, information advantage is not always beneficial for either firms or the streamers. If the streamers utilize tactics that result in a large information gap, it may prompt manufacturers to opt for alternative channel models, potentially leading to the failure of

the collaboration. Therefore, we recommend that streamers present accurate sales data and minimize fraudulent traffic metrics to enhance their credibility within the industry. In addition, upstream and downstream companies can use some technical means, such as blockchain technology, to improve the transparency of cooperation. Mutual trust between both parties is essential for achieving a win-win outcome.

Finally, for downstream agents or streamers, their own traffic and influence represent the strongest competitive advantage. We prove the significant role of network externality in influencing channel selection. Both streamers and downstream retailers should focus not only on selling products but also on enhancing their own visibility. Streamers can leverage their influence to bargain more effectively with upstream firms.

5. Extension

In this section, we further relax the assumptions of the main model. In the previous analysis, we assume that consumers' preference for both distribution channels is θ, and the preference of the two distribution channels is less than that of the direct channel ($0 < \theta < 1$). However, by observing real-world conditions, we find that consumers' preference for distribution channels of some products is higher than that of the direct channel. The high-quality shopping experience of the live broadcast channel has gradually improved consumers' preferences. Due to the different sales modes of the two distribution channels, consumers also have different channel preferences. Therefore, we study the impact of different channel preferences on decision-making.

5.1. Channel preference differences analysis

In the previous model, we assume that consumers' preferences for the agency channel and the live broadcast channel are less than the direct channel, and the preferences of the two distribution channels are the same. However, in the live broadcast channel, the streamer can introduce and display products for consumers, similar to the role of shopping guides in the offline channel. Consumers can stay at home and enjoy the shopping experience of real-time interaction with "shopping guides" and large-scale consumers. Therefore, consumers' preference for the live broadcast channel may be higher than the direct channel, i.e., $\theta_l > 1$.

It should not be ignored that the delivery time of the products may be longer than the promised time due to the explosion of orders in the live broadcast channel. In addition, there are also some quality fraud problems in the live broadcast channel, such as the fake bird's nest event on the Kwai platform. The quality control of some streamers is not strict, which reduces consumers' shopping experience. Therefore, consumers' preference for the live broadcast channels may also be lower than the direct channel, i.e., $\theta_l < 1$. Currently, we subdivide into two scenarios: The preference of the live broadcast channel is higher than that of the agency channel, but lower than that of the direct channel, i.e., $\theta_a < \theta_l < 1$; the preference of the live broadcast channel is lower than that of the agency channel, i.e., $\theta_l < \theta_a < 1$. The corresponding solution is similar to Table 3, but consumers have different preferences for the live broadcast channel and the agency channel.

It can be seen from the results in Table 3 that $\frac{\partial p_d^*}{\partial \theta} > 0$, $\frac{\partial p_i^*}{\partial \theta} > 0$, $\frac{\partial N_i^*}{\partial \theta} > 0$, $\frac{\partial N_d^*}{\partial \theta} > 0$, $(i = a, l)$ exist in DA and DL Models. When consumers have different channel preferences for the live broadcast channel and the agency channel, it should be noted that if the high-quality service experience

of the live broadcast channel makes $\theta_l > 1$, In the DL Model, the price of the live broadcast channel and the direct channel increase. Due to the streamer's strict control of product quality and in-depth understanding of product functions in product selection, consumers enjoy a higher shopping experience and the corresponding price is higher.

5.2. Channel selection analysis under information symmetry

The solution under information symmetry is similar to the results of Section 4.1. The difference is that consumers have different preferences for different distribution channels. By comparing the profit of the manufacturer in different distribution channels, the following proposition can be obtained.

Proposition 6. Under information symmetry, the effect of channel preference differences on the manufacturer's channel choice is shown as follows:

(i) If $\theta_a < \theta_l$, when $\underline{\beta_3} \le \beta \le \overline{\beta_3}$, $\pi_{ml}^{III*} < \pi_{ma}^{III*}$; when $\left(-\infty, \underline{\beta_3}\right)$ or $\left(\overline{\beta_3}, +\infty\right)$, $\pi_{ml}^{III*} > \pi_{ma}^{III*}$;

(ii) If $\theta_a > \theta_l$, when $\underline{\beta_3} \le \beta \le \overline{\beta_3}$, $\pi_{ml}^{III*} > \pi_{ma}^{III*}$; when $\left(-\infty, \underline{\beta_3}\right)$ or $\left(\overline{\beta_3}, +\infty\right)$, $\pi_{ml}^{III*} < \pi_{ma}^{III*}$.

The proof can be seen in Appendix B.1.

Proposition 6 gives interesting results. In contrast to the previous findings, the factors affecting channel choice in Proposition 6 are mainly channel preference and cross-channel spillover effects. When consumer preference for a particular channel is high, that channel tends to attract more traffic. Consequently, the more effective that channel is at diverting traffic for the direct channel, the more willing the manufacturer will be to introduce that channel. In Proposition 6, the network externality and consumer size no longer play a role in the conclusion.

Consumers' preference for different channels directly affects the potential demand for different channels, which then affects the strength of cross-channel spillover effects, and finally acts on the manufacturer's channel selection strategy. By comparing with Case I, it can also be found that it is necessary to consider the preference differences of different channels. From the perspective of manufacturers, when expanding distribution channels, they should first observe the channel demand for similar products, grasp consumers' preferences for different channels, and explore distribution channels with greater potential guided by market demand.

5.3. Channel selection analysis under information asymmetry

The solution under information asymmetry is similar to that in Section 4.2. Differences in consumer channel preferences will cause demand changes, which in turn will affect other effects. Proposition 7 mainly analyzes the influence of differences in consumers' channel preferences on channel selection under information asymmetry.

Proposition 7. Under information asymmetry, the effect of differences in channel preferences on the manufacturer's channel choice is shown as follows:

(i) If $H_3 > 0$, when $\left[\underline{\beta_4}, \overline{\beta_4}\right]$, $\pi_{ml}^{III*} < \pi_{ma}^{III*}$; when $\left(-\infty, \underline{\beta_4}\right)$ or $\left(\overline{\beta_4}, +\infty\right)$, $\pi_{ml}^{III*} > \pi_{ma}^{III*}$;

(ii) If $H_3 < 0$, when $\left[\underline{\beta_4}, \overline{\beta_4}\right]$, $\pi_{ml}^{III*} > \pi_{ma}^{III*}$; when $\left(-\infty, \underline{\beta_4}\right)$ or $\left(\overline{\beta_4}, +\infty\right)$, $\pi_{ml}^{III*} < \pi_{ma}^{III*}$.

The proof can be seen in Appendix B.2.

Compared with the results under information symmetry, the results under the network externality information asymmetry are more complex. Due to the different preferences of the two distribution channels, the threshold of spillover effects also changes. We find that whether the information is symmetrical or not, when the spillover effects are in the middle range, the optimal choice of the manufacturer is opening the agency channel. Otherwise, the manufacturer should choose to open the live broadcast channel.

Similar to the conclusion of Case II, when the cross-channel spillover effects are small, it is always optimal for the manufacturer to choose the agency channel. When the spillover effects are obvious, the live broadcast channel is the optimal choice. Consumers' preference for different channels only affects the threshold of spillover effects, and does not change the overall choice direction.

6. Conclusion

To study the channel selection strategy of the manufacturers, we built the new live broadcast dual channel model considering the existence of the network externality and the agency dual channel model. Moreover, we investigated in the case of symmetric and asymmetric information of network externality. By comparing and analyzing the models under different information structures, we give optimal channel selection strategies of the manufacturer.

Interestingly, we find that there is no absolute optimal strategy for the manufacturer. The network externality, the proportion of potential consumers in the direct channel, and spillover effects jointly influence channel selection. For start-up manufacturers, when the network externality is strong, they should adopt the live broadcast dual channel; otherwise, they can adopt the agency channel. In contrast, for established manufacturers, the agency channel is the optimal choice. In addition, positive spillover effects enhance the advantages of the live broadcast channel and encourage the manufacturer to select the live broadcast channel, while stronger negative spillover effects drive them toward the agency channel.

In addition, information asymmetry affects channel selection by affecting the prices of different channels. In most cases, the existence of information asymmetry weakens the motivation of the manufacturer to choose the live broadcast channel. Therefore, we recommend that streamers present accurate sales data and minimize fraudulent traffic metrics to enhance their credibility within the industry. In the long run, increased trust on both sides ensures the sustainability of the cooperation. Finally, we subdivide consumers' preferences for different distribution channels, and analyze the impact of channel preference difference on channel selection. The difference in channel preference affects the pricing of different channels, and then changes the scope of different channel choices.

Limitations and future research opportunities: The results obtained in this paper point out some potential directions for future research on live broadcast supply chains. First, this paper only considers the supply chain consisting of single upstream and downstream enterprises, and does not consider the competition between supply chain and supply chain. However, the competition in the live broadcast market is gradually becoming fiercer. Therefore, the channel selection under external competition can be considered in future research. Second, we did not study other factors such as publicity efforts and cost, which are also the key factors to be considered in channel selection. Finally, exploring the contract choices among supply chain members is also interesting.

Author contributions

Fengzhi Liu: Methodology, Software, Formal analysis, Writing–original draft. **Chunqiu Xu:** Conceptualization, Writing–original draft, Writing–review and editing, Validation, Supervision.

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Use of Generative–AI tools declaration

The authors declare that they did not utilize any artificial intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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