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Research on Pricing Strategies for Two-sided Platform Business Expansion Considering Asymmetric Network Effects

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Abstract: Under the cross-market network effect characteristics of a platform, this study examines pricing strategies during business expansion by considering asymmetric cross-network effects on both sides of the platform. The findings reveal: (1) When cross-network effects are stronger on the original business's seller (buyer) side, the platform subsidizes the original business's buyer (seller); when cross-network effects are weaker on the original business's seller (buyer) side and cross-market network effects are also weak, the platform charges the original business's buyer (seller). (2) The platform consistently charges sellers in the new business segment. When cross-network effects for buyers in the new business segment are smaller than (larger than) those for sellers, the platform subsidizes (charges) buyers in the new business segment; (3) Profits from the new business segment and the platform's total profits remain consistently positive and are positively correlated with cross-market network effects, whereas profits from the original business segment are negatively correlated with cross-market network effects.

Keywords: Two-sided platform; Business expansion; Cross-market network effects; Cross-network effects; Platform pricing.

1. Introduction

In the digital economy era, internet platforms have become the core organizational form reshaping industrial ecosystems and value creation. By connecting both supply and demand sides, platforms leverage network effects to achieve exponential growth. However, as individual markets gradually reach saturation, business expansion has become an inevitable choice for platforms seeking new growth trajectories. Industry giants are crossing sector boundaries to build multi-market ecosystems resembling "platform envelopes": Alibaba expanded from traditional shelf e-commerce to content-driven e-commerce (Taobao Live), while Pinduoduo leveraged social relationship chains to penetrate lower-tier markets and venture into cross-border commerce (Temu). Behind these seemingly successful cross-border expansions lies the platforms' precise mastery of cross-market network effects. In multi-market operations, the platform economy is also profoundly influenced by asymmetric (cross) network effects. In traditional e-commerce, buyer-side network effects (sellers attracting buyers) typically lag behind seller-side effects (buyers attracting sellers). Consequently, platforms subsidize buyers while charging sellers. However, in live-streaming e-commerce, top hosts' "fan-attracting capabilities" generate exceptionally strong buyer-side network effects, fundamentally transforming platform pricing strategies. Platforms not only charge hosts (sellers) high technical service fees but also cede partial pricing power to hosts through "spot fees," while distributing live-stream coupons to buyers to maintain stickiness. This demonstrates that the relative strength of network effects varies significantly across different platform markets. Platforms should dynamically adjust their pricing structures during (cross-industry) operations to adapt to these changes.

Two-sided platform pricing has been a research hotspot in academic circles globally over the past decade. Armstrong [1] first proposed the concept of asymmetric pricing in platforms. Armstrong and Wright [2], along with Bolt and Tieman [3], subsequently confirmed the prevalence of asymmetric pricing through mathematical modeling and empirical studies, respectively. Furthermore, some scholars have explored the dynamic nature of two-sided platform pricing strategies [4-7]. Building upon this foundation, recent literature has developed game models to explore platform pricing in operational scenarios such as cross-industry mergers and acquisitions [8], platform upgrades [9], capacity sharing [10], aggregator platforms [11-12], shared manufacturing platforms [13], and sharing economy platforms [14]. However, none of these studies have considered the network effects inherent in platform pricing.

Network effects, proposed by economist Robert Metcalfe, describe how user value increases as the number of users grows. In two-sided markets, network effects also originate from users on the other side of the market. Eisenmann [15] further categorizes network effects into same-side and cross-side network effects. Sui [16] found that platforms subsidize users with relatively weaker cross-network strength during the initial stage. Li [17] found that platforms charge sellers when their cross-network effects are no less significant than those of buyers. While these studies explore platform pricing under network effects, they neglect issues arising when platforms simultaneously operate multiple related markets.

In recent years, cross-market network effects have entered the academic research landscape. Strauss [18] defined cross-market network effects and found manufacturers need to adopt marketing strategies such as bundling. Chen and Xie [19] investigated and discovered cross-market network effects exist across numerous industries. Recently, some scholars have further analyzed platform pricing strategies considering cross-market network effects under different operational scenarios. For instance, Xu [20] employed empirical methods to reveal that platform pricing depends on variations in government investment levels and cross-market network effects. Biplab [21] predicted the intensity of cross-market network effects within financial networks, while

Wang et al. [22] analyzed platform pricing strategies in multi-market competitive environments based on the Hotelling model. However, research examining pricing strategies for platform business expansion under cross-market network effects remains scarce. Currently, only Li Jing [23] and Qiao Yue & Yu Wenshi [24] have explored multi-market joint pricing strategies for two-sided platforms during business expansion under cross-market network effects. Yet neither study accounts for the asymmetric cross-network effects prevalent in two-sided platforms.

Therefore, this paper investigates pricing strategies for cross-market business expansion by platforms, accounting for cross-market network effects between the new and original markets and asymmetric cross-network effects on both sides of the platform, while integrating the characteristics of two-sided platforms.

2. Problem Description and Related Assumptions

2.1. Problem Description

Under a monopolistic two-sided market structure, the platform adopts a membership registration system. Leveraging the two-sided user base established through its original business, the platform implements business expansion strategies. Given the cross-side network externalities between the new and original businesses, the original user base exhibits a tendency to migrate toward the new business, manifesting as a certain proportion of user conversion. Considering that the new business does not start from scratch but leverages the "traffic" and "brand" of the original business, the platform's new business gains a certain degree of resistance to direct competition from new entrants. This paper investigates the following problem: In the context of platform business expansion, taking into account the cross-market network effects between the new and original businesses, and further incorporating the impact of asymmetric two-sided cross-network effects, it aims to explore how the platform should formulate an optimal pricing strategy for both business segments to achieve profit maximization.

2.2. Model Parameters and Assumptions

The platform generates revenue through membership fees (or registration fees). Assume the platform's existing business has accumulated a user base of X. During the business expansion phase, the platform sets the membership fee for users on both sides of the existing business at p_{1B}, p_{1S}, and the membership fee for users on both sides of the new business at p_{2B}, p_{2S}. Under this pricing strategy, the number of new users added to the existing business after expansion is denoted as N_{1B}, N_{1S}, and the number of new users added to the new business is denoted as N_{2B}, N_{2S}.

To better articulate the research questions, the following assumptions are made:

1) It is assumed that the platform implements only a membership fee (or registration fee) pricing strategy for newly onboarded users, with no other transaction fees involved. Furthermore, drawing from Li Jing [23] and Qiao Yue [43], the platform does not charge fees for users migrating from existing business lines to new ones. Simultaneously, for the sake of simplifying calculations, this study assumes that service costs and other operational expenses incurred during platform operations are negligible.

2) Cross-network effects on the buyer side (utility derived by buyers from sellers) and seller side (utility derived by sellers from buyers) are denoted as α_B and α_S, respectively $(0 < \alpha_B, \alpha_S < 1)$.

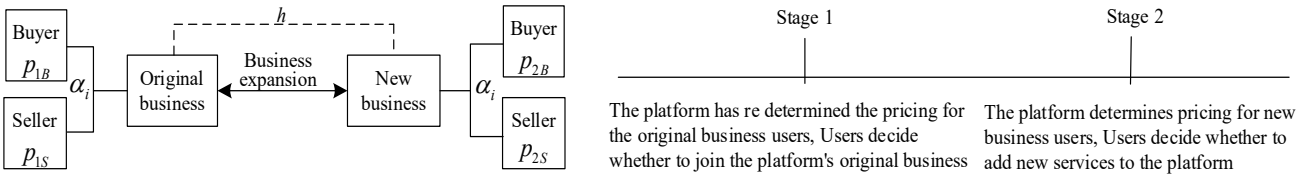
3) Cross-market network effects exist between new and existing businesses. A proportion h $(0 < h < 1)$ of users from the existing business constitutes the potential demand market for the new business.

4) Following Li Jing [23] and Wang Xiaofang [25], assume new users must undergo registration and verification procedures. The unit waiting cost incurred during this process is denoted as τ. Since τ is not the primary focus of this model, assume $\tau = 1$.

5) Following Li Jing [23] and Wang Xiaofang [25], assume the existing user base on both sides of the original business is X.

3. Model Development and Solution

The platform's action sequence constitutes a two-stage game: In the first stage, the platform sets the two-sided membership fees (or registration fees) p_{1B} and p_{1S} for its original business, and users decide whether to join the platform's original business. In the second stage, the platform sets the two-sided membership fees (or registration fees) p_{2B} and p_{2S} for a new business that exhibits cross-market network effects with the original business, and users decide whether to join the platform's new business. As shown in Figure 1.



a. Platform business expansion model $(i = B, S)$ b. Sequence of actions

Figure 1. Platform Expansion Model and Game Time Series

During the business expansion phase, the platform sets the pricing for existing two-sided users of the original business at p_{1B}, p_{1S}. Influenced by cross-network effects, the utility of newly added users in the original business is denoted as $\alpha_i(X + N_{1i}(i = B, S))$. Additionally, new users must undergo registration review for access, incurring a waiting cost $\tau N_{1i}(i = B, S)$. Referencing Li Jing's [23] research, the utility of new users joining the original business is expressed as:

$$\begin{cases} u_{1B} = \alpha_B(X + N_{1S}) - p_{1B} - \tau N_{1B} \\ u_{1S} = \alpha_S(X + N_{1B}) - p_{1S} - \tau N_{1S} \end{cases} \quad (1)$$

Cross-market network effects exist between the new and existing businesses. Based on the user base of the existing business, a certain proportion of users constitute the potential demand market for the new business, denoted as $h(2X + N_{1B} + N_{1S})$. Simultaneously, the cross-network effects

between the two markets generate utility values of $\alpha_B N_{2S}$ and $\alpha_S N_{2B}$ for new users on the new business side. Considering the waiting cost $\tau N_{2i}(i = B, S)$ incurred during the registration review process, the utility for new users joining the new business is expressed as:

$$\begin{cases} u_{2B} = \alpha_B N_{2S} - p_{2B} - \tau N_{2B} \\ u_{2S} = \alpha_S N_{2B} + h\left(2X + N_{1B} + N_{1S}\right) - p_{2S} - \tau N_{2S} \end{cases} \tag{2}$$

If a user does not join the platform's new business, their net utility is zero. From Equation (2) $u_{2B} = 0, u_{2S} = 0$, we obtain:

$$\begin{cases} N_{2B} = \dfrac{\left(\left(2X + N_{1B} + N_{1S}\right)h - p_{2S}\right)\alpha_B - p_{2B}}{1 - \alpha_B \alpha_S} \\ N_{2S} = \dfrac{\left(2X + N_{1B} + N_{1S}\right)h - p_{2B}\alpha_S - p_{2S}}{1 - \alpha_B \alpha_S} \end{cases} \tag{3}$$

The model for maximizing profits from new platform businesses is:

$$\pi_2 = \max_{p_{2B}, p_{2S}} \frac{\left(\left(2X + N_{1B} + N_{1S}\right)h - p_{2S}\right)\alpha_B - p_{2B}}{1 - \alpha_B \alpha_S} p_{2B} + \frac{\left(2X + N_{1B} + N_{1S}\right)h - p_{2B}\alpha_S - p_{2S}}{1 - \alpha_B \alpha_S} p_{2S}$$

$$s.t. \begin{cases} \dfrac{\left(\left(2X + N_{1B} + N_{1S}\right)h - p_{2S}\right)\alpha_B - p_{2B}}{1 - \alpha_B \alpha_S} \geq 0 \\ \dfrac{\left(2X + N_{1B} + N_{1S}\right)h - p_{2B}\alpha_S - p_{2S}}{1 - \alpha_B \alpha_S} \geq 0 \end{cases} \tag{4}$$

Solving equation (4) yields the optimal pricing, number of users on both sides, and profit for the platform's new service:

$$\begin{cases} p_{2B} = \dfrac{h\left(\alpha_B - \alpha_S\right)\left(2X + N_{1B} + N_{1S}\right)}{4 - \left(\alpha_B + \alpha_S\right)^2}, p_{2S} = \dfrac{h\left(2 - \alpha_B^2 - \alpha_B \alpha_S\right)\left(2X + N_{1B} + N_{1S}\right)}{4 - \left(\alpha_B + \alpha_S\right)^2} \\ N_{2B} = \dfrac{h\left(\alpha_B + \alpha_S\right)\left(2X + N_{1B} + N_{1S}\right)}{4 - \left(\alpha_B + \alpha_S\right)^2}, N_{2S} = \dfrac{2h\left(2X + N_{1B} + N_{1S}\right)}{4 - \left(\alpha_B + \alpha_S\right)^2} \\ \pi_2 = \dfrac{\left(2X + N_{1B} + N_{1S}\right)^2 h^2}{4 - \left(\alpha_B + \alpha_S\right)^2} \end{cases} \tag{5}$$

If a user does not join the platform's original business, their net utility is zero. From Equation (1) $u_{1B} = 0, u_{1S} = 0$, we obtain:

$$\begin{cases} N_{1B} = \dfrac{\left(X\alpha_S + X - p_{1S}\right)\alpha_B - p_{1B}}{1 - \alpha_B \alpha_S} \\ N_{1S} = \dfrac{\left(X\alpha_B + X - p_{1B}\right)\alpha_S - p_{1S}}{1 - \alpha_B \alpha_S} \end{cases} \tag{6}$$

Combining (6) yields the following model for maximizing platform profits at this point:

$$\pi = \max_{p_{1B}, p_{1S}} \frac{\left(X\alpha_S + X - p_{1S}\right)\alpha_B - p_{1B}}{1 - \alpha_B \alpha_S} p_{1B} + \frac{\left(X\alpha_B + X - p_{1B}\right)\alpha_S - p_{1S}}{1 - \alpha_B \alpha_S} p_{1S} + \pi_2$$

$$s.t. \begin{cases} \dfrac{\left(X\alpha_S + X - p_{1S}\right)\alpha_B - p_{1B}}{1 - \alpha_B \alpha_S} \geq 0 \\ \dfrac{\left(X\alpha_B + X - p_{1B}\right)\alpha_S - p_{1S}}{1 - \alpha_B \alpha_S} \geq 0 \end{cases} \tag{7}$$

Solving model (7) yields the optimal pricing p_{1B}^*, p_{1S}^* for the platform's original business's two-sided users, the equilibrium user count N_{1B}^*, N_{1S}^*, and the equilibrium total profit π^* (specific results omitted). Substituting these results back into equation (5) yields the optimal pricing p_{2B}^*, p_{2S}^* for the platform's new business's two-sided users, the equilibrium user count N_{2B}^*, N_{2S}^*, and the equilibrium profits π_1^*, π_2^* for both the original and new businesses (specific results omitted).

(Proof in Appendix 1)

4. Equilibrium Analysis

4.1. Pricing Strategy Analysis

The platform's pricing strategy (charging or subsidizing) for both sides of the original business and its relationship with cross-market network effects are as follows:

Table 1. Platform Pricing Strategies for Charging or Subsidizing Users on Both Sides of the Original Business

α	h	p_{ij}^*	$\frac{\partial p_{ij}^*}{\partial X}$	$\frac{\partial p_{ij}^*}{\partial h}$
$0 < \alpha_S < \overline{\alpha_S}$ $(\overline{\alpha_B} < \alpha_B < 1)$	$0 < h < h_1$	$p_{1B}^* > 0$	$\frac{\partial p_{1B}^*}{\partial X} > 0$	$\frac{\partial p_{1B}^*}{\partial h} < 0$
	$h_1 < h < 1$	$p_{1B}^* < 0$	$\frac{\partial p_{1B}^*}{\partial X} < 0$	
$\overline{\alpha_S} < \alpha_S < 1$ $(0 < \alpha_B < \overline{\alpha_B})$	-	$p_{1B}^* < 0$	$\frac{\partial p_{1B}^*}{\partial X} < 0$	
$0 < \alpha_B < \overline{\overline{\alpha_B}}$ $(\overline{\overline{\alpha_S}} < \alpha_S < 1)$	$0 < h < h_2$	$p_{1S}^* > 0$	$\frac{\partial p_{1S}^*}{\partial X} > 0$	$\frac{\partial p_{1S}^*}{\partial h} < 0$
	$h_2 < h < 1$	$p_{1S}^* < 0$	$\frac{\partial p_{1S}^*}{\partial X} < 0$	
$\overline{\alpha_B} < \alpha_B < 1$ $(0 < \alpha_S < \overline{\overline{\alpha_S}})$	-	$p_{1S}^* < 0$	$\frac{\partial p_{1S}^*}{\partial X} < 0$	

Note: $h_1 = \frac{\sqrt{2}\sqrt{((\alpha_S+\alpha_B)^2-4)(-\alpha_B^2+\alpha_B\alpha_S+\alpha_B+3\alpha_S+4)(\alpha_B^2\alpha_S+(\alpha_S^2-\alpha_S-2)\alpha_B+\alpha_S^2)}}{-2\alpha_B^2+(2\alpha_S+2)\alpha_B+6\alpha_S+8}$, $\overline{\alpha_B} = \frac{-\alpha_S^2+\alpha_S+2-\sqrt{\alpha_S^4-6\alpha_S^3-3\alpha_S^2+4\alpha_S+4}}{2\alpha_S}$,
$h_2 = \frac{\sqrt{2}\sqrt{((\alpha_S+\alpha_B)^2-4)(-\alpha_S^2+(\alpha_B+1)\alpha_S+3\alpha_B+4)(\alpha_B\alpha_S^2+(\alpha_B^2-\alpha_B-2)\alpha_S+\alpha_B^2)}}{-2\alpha_S^2+(2\alpha_B+2)\alpha_S+6\alpha_B+8}$, $\overline{\alpha_S} = \frac{-\alpha_B^2+\alpha_B+\sqrt{\alpha_B^4-2\alpha_B^3+9\alpha_B^2+8\alpha_B}}{2(\alpha_B+1)}$

Inference 1: When cross-network effects are strong on the original business's seller (buyer) side, the platform should subsidize the original business's buyer (seller) side, with subsidy amounts increasing as the user base grows. When cross-network effects are weak on the original business's seller (buyer) side and cross-market network effects are also weak, the platform should charge the original business's buyer (seller) side, with fees increasing as the user base grows. When cross-market network effects are strong, the platform should subsidize the original business buyers (sellers), with subsidy amounts increasing as the user base grows.

When cross-network effects on the original business seller side are strong, the buyer side provides greater utility to the seller side. To maximize attracting and retaining these high-value buyers, the platform adopts a subsidy strategy to reduce buyers' entry costs. A larger buyer base enhances attractiveness to sellers. Therefore, as the user base grows, the platform is willing to invest more subsidies to further attract additional buyers (increasing marginal utility), embodying the principle that "greater user bases warrant higher subsidies."

When cross-market network effects on the original business's seller side are weak, the utility derived by sellers from the buyer side is limited. Sellers exhibit low sensitivity to buyer numbers, meaning increased buyer quantities hold little appeal for sellers to join the platform. Simultaneously, cross-market network effects are also weak, meaning the mutual reinforcement between the original business and the new business is not pronounced. An increase in the number of buyers in the original business has limited value enhancement for the new business. At this stage, the platform should charge fees on the buyer side of the original business to generate profits, and "the larger the user base, the higher the fees."

When cross-market network effects are strong, growth in buyers/sellers for the original business drives expansion of the new business. The platform attracts more buyers/sellers from the original business by offering subsidies. Here, a larger user base amplifies the pull of cross-market network effects on the new business, prompting the platform to invest more subsidies to sustain and accelerate this positive cycle—meaning "the larger the user base, the greater the subsidies."

Inference 2: The platform's pricing strategy (charging or subsidizing) for new business two-sided transactions and its influence from cross-market network effects and user base are analyzed as follows: (1) $p_{2S}^* > 0$, $\frac{\partial p_{2S}^*}{\partial h} > 0$, $\frac{\partial p_{2S}^*}{\partial X} > 0$. (2) When $\alpha_B < \alpha_S$, $p_{2B}^* < 0$, $\frac{\partial p_{2B}^*}{\partial X} < 0$, $\frac{\partial p_{2B}^*}{\partial h} < 0$; when $\alpha_B > \alpha_S$, $p_{2B}^* > 0$, $\frac{\partial p_{2B}^*}{\partial X} > 0$, $\frac{\partial p_{2B}^*}{\partial h} > 0$. (Proof omitted)

Inference 2 indicates that the platform consistently charges new business sellers, with the fee amount positively correlated with cross-market network effects and user base. When buyer cross-market network effects are weaker than seller cross-market network effects, the platform subsidizes new business buyers, with subsidy levels increasing alongside cross-market network effects and user base size. Conversely, when buyer cross-market network effects are stronger than seller cross-market network effects, the platform charges new business buyers, with fee levels rising with cross-market network effects and user base size.

This occurs because the platform's pricing strategy for new business buyers is significantly influenced by the strength of two-sided cross-market network effects. Specifically, when cross-market network effects on the buyer side of a new business are relatively weaker than those on the seller side, sellers become more dependent on buyer numbers. Consequently, the platform must subsidize buyers in the new business to lower their entry barriers, using this as leverage to attract sellers to pay for access. In this scenario, both cross-market network effects and the existing user base of the original business act as amplifiers for the pricing strategy of the new business platform. Conversely, when cross-network effects on the buyer side of the new business significantly outweigh those on the seller side, the marginal utility gain for sellers from increased buyer numbers becomes relatively small. Here, platforms opt to charge buyers for the new business. This mechanism aims to screen out high-value buyer users, thereby establishing a virtuous cycle where "buyers attract sellers, and sellers attract buyers."

On the other end of pricing, sellers in the new business—as suppliers—have role characteristics that dictate the platform's charging logic. Bearing higher marginal costs for production, verification, and other activities, while being highly dependent on the platform's traffic and user base, sellers typically possess stronger payment capacity. Therefore, as cross-market network effects strengthen and the original

user base expands, leading to increased seller scale and intensified competition, the platform gains both justification and room to raise fees (e.g., by increasing commission rates). This not only helps the platform filter out high-quality supply and cover rising operational costs but also further solidifies its market dominance.

4.2. Analysis of User Quantity and Equilibrium Profit

Inference 3. $\frac{\partial N_{1B}^*}{\partial h} > 0$, $\frac{\partial N_{1S}^*}{\partial h} > 0$, $\frac{\partial N_{2B}^*}{\partial h} > 0$, $\frac{\partial N_{2S}^*}{\partial h} > 0$. (Proof omitted)

Inference 3 indicates that as cross-market network effects strengthen, both the original business and new business segments of the platform experience growth in two-sided user numbers. On one hand, enhanced cross-market effects prompt the platform to reduce membership fees for its original business, thereby attracting more users from the original market. On the other hand, as cross-market network effects intensify and the user base of the original business expands, the proportion of existing and new users within the original business segment who develop demand for the new business increases accordingly, leading to growth in two-sided users for the new business as well.

Inference 4: (1) When $0 < h < h_3$, $\frac{\partial \pi_1^*}{\partial X} > 0$; When $h_3 < h < 1$, $\frac{\partial \pi_1^*}{\partial X} < 0$. (2) $\frac{\partial \pi_2^*}{\partial X} > 0$, $\frac{\partial \pi^*}{\partial X} > 0$.

(Note: $h_3 = \frac{\sqrt{2}\sqrt{((\alpha_S+\alpha_B)^2-4)((\alpha_B-\alpha_S)^2-8(\alpha_B+\alpha_S+2))}\left(\sqrt{(\alpha_B+\alpha_S+2)\left((\alpha_S+1)\alpha_B^2+\alpha_B\alpha_S^2+\alpha_S^2\right)(\alpha_B+\alpha_S-4)^2}+(-2\alpha_S-2)\alpha_B^2-2\alpha_B\alpha_S^2-2\alpha_S^2\right)}{2(8(\alpha_B+\alpha_S+2)-(\alpha_B-\alpha_S)^2)}$)

As shown in Inference 4, both the platform's total profit and new business profit are positively correlated with the user base, while the relationship between the platform's original business profit and the user base depends on the strength of cross-market network effects. When cross-market network effects are weak, the platform implements a charging strategy for newly added users on both sides of the original business to generate profits. As the user base expands, the continuous influx of new users into the original business drives its profit growth, creating a positive feedback loop. Conversely, when cross-market network effects are strong, both existing users and new users on the platform's original business generate significant demand for the platform's new business. At this stage, the platform adopts a subsidy strategy for original business two-sided users to lower participation barriers and expand the original business user base. During this subsidy period, the platform's original business profits turn negative. Furthermore, as the user base grows, the number of users joining the original business increases continuously, requiring correspondingly higher subsidy amounts. Consequently, the expansion of the user base paradoxically leads to a continuous decline in profits for the original business.

Inference 5: The relationship between the magnitude of platform new business profits, total business profits, and original profits, and their cross-market effects and network effects is as follows: (1) $\pi_2^* > 0$, $\pi^* > 0$; (2) When $0 < h < h_3$, $\pi_1^* > 0$; When $h_3 < h < 1$, $\pi_1^* < 0$; (3) $\frac{\partial \pi_1^*}{\partial h} < 0$, $\frac{\partial \pi_2^*}{\partial h} > 0$, $\frac{\partial \pi^*}{\partial h} > 0$. (Proof omitted)

As shown in Inference 5, the platform's new business and total business profits consistently remain above zero and exhibit a positive correlation with cross-market network effects, while the original business profits show a negative correlation with cross-market network effects. When cross-market network effects are small, original business profits exceed zero; when cross-market network effects are large, original business profits fall below zero.

This occurs because when cross-market network effects are weak, only a small proportion of the platform's existing users demand the new business. The platform primarily relies on charging fees to users on both sides of the original business to generate profits. However, when cross-market network effects are strong, demand for the new business surges significantly among both existing users of the original business and newly acquired users. To capture as many users as possible, the platform adopts free or subsidized strategies for the original business, leading to declining profits or even losses. Consequently, the profit of the platform's original business decreases as cross-market network effects increase.

However, strong cross-market network effects enhance cross-business traffic generation, driving user growth for the new business. In this scenario, the platform can adopt a subsidy strategy on the original business side to expand its user base, thereby achieving overall profitability through the new business. Therefore, the profit of the new business and the platform's total profit increase as network effects grow.

5. Numerical Analysis

This chapter employs numerical simulation to analyze pricing strategies and optimal profits for two-sided platforms during business expansion. By assigning values to various parameters and generating intuitive graphical representations, the validity of the conclusions is verified.

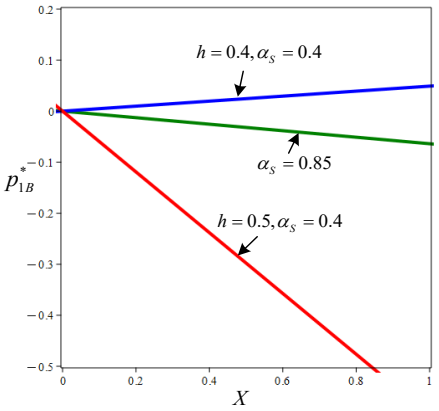


Figure 2. Effect of X on p_{1B}^*

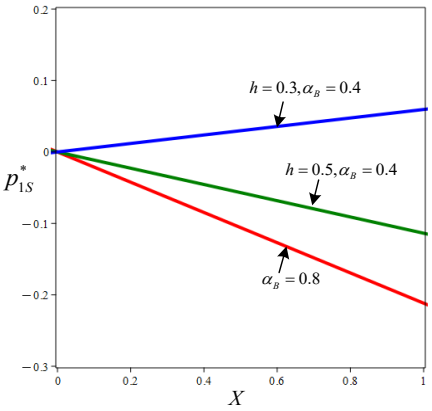


Figure 3. Effect of X on p_{1S}^*

As shown in Figure 2, let the parameter $\alpha_B = 0.4$, at this time $\overline{\alpha_S} = 0.67$. The relationship between the original business's pricing size and user base is shown in Figure 2: It can be seen that when $\alpha_S = 0.4\ (< \overline{\alpha_S})$, $h_1 = 0.45$; if$h = 0.4\ (< h_1)$, the platform charges the original business's buyer, and as user

Increases with an increase in x; if h-0.5 (h1), the platform subsidizes the original business buyer, and increases the subsidy as x increases; when $\alpha_S = 0.85\ (> \overline{\alpha_S})$, the platform subsidizes the original business buyer, and increases the subsidy as X increases.

As shown in Figure 3, let the parameter in the model $\alpha_S = 0.3$, then $\overline{\alpha_B} = 0.76$ and $h_2 = 0.39$. First, let $\alpha_B = 0.4\ (< \overline{\alpha_B})$, and when $h = 0.3\ (< h_2)$, the platform charges the seller of the original business, and increases with the increase of X; When $h = 0.5\ (> h_2)$, the platform subsidizes the seller of the original business, and the subsidy increases with the increase of X. Secondly, let $\alpha_B = 0.8\ (> \overline{\alpha_B})$, at which point the platform subsidizes the seller of the original business, and the subsidy increases with the increase of X. This confirms inference 1.

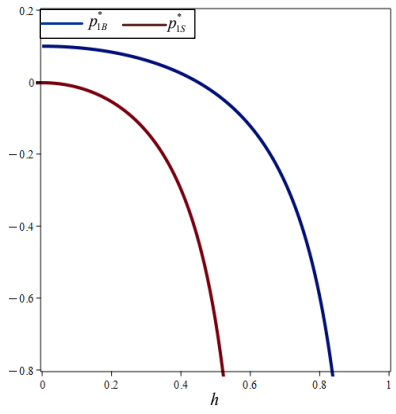


Figure 4. Effect of h on p_{1B}^*, p_{1S}^*

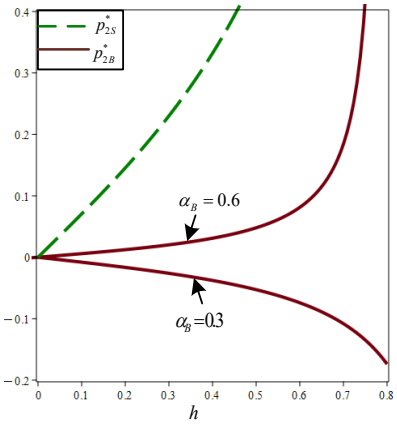


Figure 5. Effect of h on p_{2B}^*, p_{2S}^*

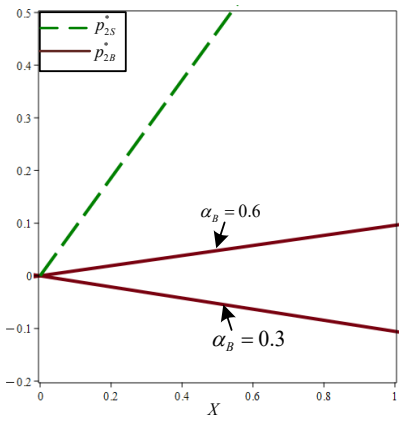


Figure 6. Effect of X on p_{2B}^*, p_{2S}^*

As shown in Figure 4, setting $X = 0.5$, the impact of cross-market network effect h on the magnitude of two-sided pricing for the original business is illustrated. It can be observed that as h increases, the two-sided pricing for the original business decreases.

As shown in Figure 5, setting $X = 0.5$ and $\alpha_S = 0.5$. When $\alpha_B = 0.6\ (\alpha_B > \alpha_S)$, the platform charges buyers in the new business segment, with fees increasing as h rises. When $\alpha_B = 0.3\ (\alpha_B < \alpha_S)$, the platform subsidizes buyers in the new business segment, with subsidies growing as h increases. Pricing for sellers in the new business segment remains above zero and increases with h. This confirms Inference 2.

As shown in Figure 6, with $h = 0.5$ and $\alpha_S = 0.5$: When $\alpha_B = 0.6\ (\alpha_B > \alpha_S)$, the platform's pricing for new business buyers increases with h. When $\alpha_B = 0.3\ (\alpha_B < \alpha_S)$, the platform's pricing for new business buyers decreases with h. New business seller pricing increases with X. This confirms Inference 2.

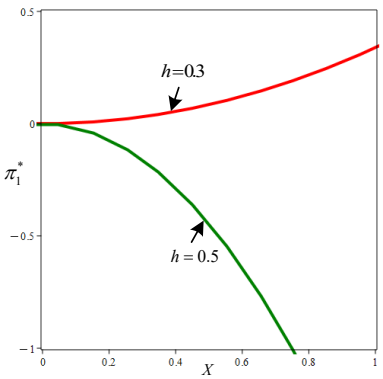


Figure 7. Effect of X on π_1^*

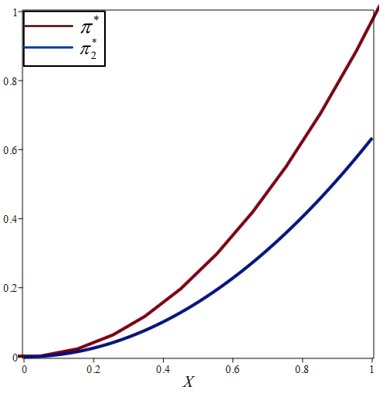


Figure 8. Effect of X on π^*, π_2^*

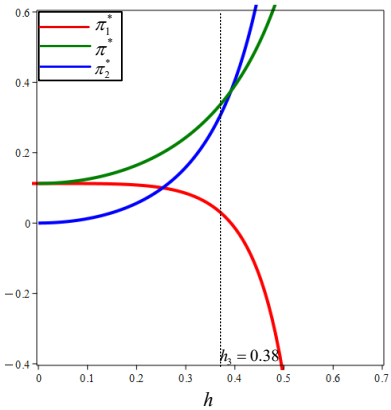


Figure 9. Effect of h on π_1^*, π_2^*, π^*

As shown in Figures 7 and 8, let $\alpha_B = 0.6$ and $\alpha_S = 0.6$, resulting in $h_4 = 0.38$. It is evident from Figures 7-8 that: when $h = 0.3$ $(h < h_3)$, the original business profit increases with the growth of the user base X; when $h = 0.5$ $(h > h_3)$, the original business profit decreases with the growth of X. New business profit and total business profit consistently increase with X. This confirms Inference 4.

As shown in Figure 9, assuming $X = 0.5$, $\alpha_B = 0.6$, $\alpha_S = 0.6$, resulting in $h_3 = 0.38$. It is readily apparent from Figure 9 that: Original business profit decreases as cross-market network effect h increases. When $h < h_3$, original business profit remains positive; when $h > h_3$, original business profit becomes negative. Both new business profit and total business profit remain positive and increase with h. This confirms Inference 5.

6. Summary

This paper constructs a Steinberg game model to explore two-sided pricing strategies for new and existing businesses when a platform with an established user base expands its operations. It analyzes the impact of cross-market network effects and two-sided cross-network effects on the game equilibrium, including equilibrium prices and profits for both new and existing platform businesses.

The main conclusions are as follows: (1) When cross-network effects are strong on the seller (buyer) side of the original business, the platform subsidizes the buyer (seller) of the original business; When cross-network effects on the seller (buyer) side of the original business are small and cross-market network effects are also small, the platform charges the original business buyers (sellers). (2) The platform always charges sellers in the new business. When cross-network effects on the buyer side of the new business are smaller than (larger than) those on the seller side, the platform subsidizes (charges) the new business buyers. (3) New business profits and total platform profits are always positive and positively correlated with cross-market network effects, while original business profits are negatively correlated with cross-market network effects.

This research has room for expansion. First, it assumes a monopolistic platform without considering inter-platform competition. Future work should examine two-sided pricing strategies in competitive platforms (e.g., oligopolistic markets) during cross-market competition. Second, while assuming asymmetric cross-network effects between two-sided users, the study does not further explore differences in cross-network effects between the original and new business markets. It is therefore necessary to examine pricing strategies when platform business expansion involves markets with divergent cross-network effects. Finally, the model employs relatively simple pricing strategies, whereas bundling and other pricing mechanisms are also used in platform business expansion. Research on the application of such coordinated pricing mechanisms in platform cross-market expansion is warranted.

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