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Abstract

We recently have witnessed two important trends in online retailing: The advent of new media (e.g., social media and search engines) makes advertising affordable for small sellers, and large online retailers (e.g., Amazon and JD.com) open their platforms to allow even direct competitors to sell on their platforms. We examine how new-media advertising affects retail platform openness. We develop a game-theoretic model in which a leading retailer, who has both valuation and awareness advantages, and a third-party seller, who sells an identical product, engage in price competition. We find that the availability of relatively low-cost advertising through new media plays a critical role in influencing the leading retailer to open its platform and to form a partnership with the third-party seller, which would be impossible when the cost of advertising is relatively high. Low-cost advertising can increase consumer surplus either directly via the third-party seller's advertising or indirectly via the partnership on the leading retailer's platform. We also find that the leading retailer has a greater incentive to open its platform and that the partnership is more likely to be formed when there are network effects, when the leading retailer can control the third-party seller's exposure on its platform, or when the leading retailer can offer a direct advertising service to the third-party seller. Meanwhile, the constraints on the third-party seller's advertising budget can reduce the leading retailer's incentive to open its platform, making the partnership less likely. Our analysis offers important insights into the underlying economic incentives that help explain the emerging open retail platform trend in the era of new-media advertising.

1 Introduction

With global e-commerce sales reaching more than $1 trillion and Amazon's mammoth growth in the retail industry during the past decade, thousands of small merchants now depend on Amazon to reach customers who otherwise would not know of their existence. Small sellers are attracted to the Amazon marketplace by the promise of tapping into the Internet retailer's roughly 208 million unique monthly visitors[1] as a means to expand their reach and sales. In turn, Amazon takes a commission for every marketplace sale (e.g., 6% for personal computers and 15% for books). As of the first quarter of 2020, third-party sales accounted for 52% of the paid units sold on Amazon.[2] Both Amazon and the third-party sellers seem to benefit from the partnership, especially when small sellers do not have the resources to effectively and efficiently pursue e-commerce. In light of Amazon's success, an increasing number of large online retailers have opened their platforms to third-party sellers. For example, JD.com, one of the largest e-commerce sites in China, has expanded its business from a pure online retailer to a marketplace operator that allows third-party sellers to sell products directly to consumers via the JD.com website and mobile channels.

When Amazon itself does not carry the same products as the third-party sellers that join its platform, Amazon acts solely as a platform owner to help the sellers reach potential buyers. Amazon also benefits from small sellers' joining because of the commission fee and the network effects resulting from the increased product varieties. Thus, the partnership incentives are well aligned. However, when Amazon sells the same products as the third-party sellers, Amazon acts as both a platform owner and a competing seller. Why Amazon would allow direct competitors to sell on its platform in this case is less obvious. One argument suggests that Amazon does so for the commission fee. However, excluding competing sellers makes Amazon a monopolist for the consumers who are aware only of its products, and the monopoly profit can plausibly outweigh the gain from a small share of the competing sellers' sales. Therefore, a simple commission-fee argument might not be sufficient to explain the leading retailer's willingness to open its platform. In addition, whether the third-party seller's additional profit from the increased sales brought by

[1]https://www.statista.com/statistics/271412
[2]https://www.statista.com/statistics/259782

additional exposure is enough to compensate for the commission paid to the platform is unclear. So the traditional commission-fee argument might also be insufficient to explain the third-party seller's willingness to join the leading retailer's platform.

Another important trend in e-retailing, in addition to the open retail platforms offered by giant online retailers, is the prevalence of low-cost advertising through new media, such as sponsored searches on search engines (e.g., Google and Baidu) and social media marketing (e.g., Facebook and Twitter). Television advertising traditionally incurs a high setup cost to generate the ad, and the cost of national commercials in 2016 averaged around \$123,000 per 30-second spot (Aland, 2017). The high cost creates a real barrier for small sellers with low advertising budgets. However, search engines and social media have dramatically changed the advertising industry to accommodate low-budget advertisers, which makes advertising affordable for small sellers. For example, advertising on social media platforms has an average cost of \$2.5 per thousand impressions (i.e., \$2.5 CPM), which is significantly lower than the advertising cost in newspapers and magazines (\$16 CPM), broadcast TV (\$28 CPM), and direct mail (\$57 CPM).[3] In particular, search engines provide organic listing services, and social media platforms, such as Facebook and YouTube, provide a free *company page* or *company channel.* Small sellers also can create commercials on YouTube and Hulu for only a fraction of the cost of advertising on TV. The low-cost advertising helps small sellers to gain market exposure and to increase their product awareness levels, leveling the playing field in the retail competition with leading retailers.

Motivated by these parallel trends and the fact that low-cost advertising reduces leading retailers' relative awareness advantage and thus might affect leading retailers' marketplace strategies, we aim to answer the following research questions: How does the low-cost new-media advertising affect a leading retailer's incentive to open its platform? What role does new-media advertising play in influencing whether a leading retailer and a third-party seller form a strategic partnership? How do low-cost advertising and a platform partnership affect consumer surplus? In addition, how do network effects, the third-party seller's advertising budget and other outside options, and the leading retailer's exposure control and direct advertising services affect the likelihood that a partnership between the two

[3] https://www.lyfemarketing.com/traditional-media-versus-social-media

sellers will be formed?

We develop a game-theoretic model to analyze price competition between a leading retailer and a relatively small third-party seller who sells an identical product. The leading retailer has both a valuation advantage and an awareness advantage over the third-party seller. The valuation advantage comes from the leading retailer's reputation and the quality of its customer service. The awareness advantage comes from the leading retailer's brand awareness. The leading retailer strategically decides whether to open its platform to allow the third-party seller to sell on its platform and access its customer base by charging a commission fee. The third-party seller then decides whether to join the platform or to advertise on its own. We analyze how the cost of advertising affects both the leading retailer's incentive to open its platform and the third-party seller's strategic choice of advertising. We further characterize the platform-openness conditions under which both the leading retailer's and the third-party seller's incentives are aligned to form the partnership.

Our results show that the availability of low-cost advertising through social media or search engines can be an important driving force for platform openness and retail partnership. Although the commission fee in itself might be a plausible explanation for this phenomenon, we show that when the cost of advertising is high, the leading retailer's and the third-party seller's incentives might not be aligned to form a partnership, regardless of the commission rate. Low-cost advertising increases the value of the third-party seller's outside option and decreases the leading retailer's awareness advantage; thus, it decreases the third-party seller's incentives to form a partnership but increases the leading retailer's incentives. Despite this asymmetric effect of low-cost advertising on the two sellers' incentives, we show that the partnership can emerge as an equilibrium outcome when the cost of advertising is low but not too low. When the cost of advertising is very low, the third-party seller prefers to pursue advertising on its own. Moreover, we find that low-cost advertising can increase consumer surplus either directly via the third-party seller's advertising with new media to increase its exposure, or indirectly via the partnership with the leading retailer on its otherwise closed platform.

We offer additional insights and demonstrate the robustness and generalization of our findings through various model extensions in the main paper and the online supplement. We show that the leading retailer has a greater incentive to open its platform and the partnership is more likely to be formed when there are network effects, when the leading retailer can control the level of its platform openness, or when the leading retailer offers a direct advertising service. In contrast, the leading retailer has less incentive to open its platform and the partnership is less likely to be formed when the third-party seller's advertising budget is constrained. Furthermore, our results on platform openness and partnership formation need not be limited to advertising. The same insights can be generalized to the third-party sellers' other valuable outside options, such as an alternative sales outlet (e.g., a C2C platform).

Prior studies on platform openness have focused on either mutual benefits (e.g., network effects) or strategic considerations from the leading retailers' perspectives (e.g., commission rate). We consider how IT can empower small sellers and change the competitive landscape. We make two important contributions to the literature. First, we show that small sellers' outside options in the digital ecosystem (e.g., new-media advertising and C2C trading platforms) can be an important driving force to induce leading retailers to open their otherwise closed platforms, which is a key addition to the literature on platform openness. Second, we identify conditions under which the partnership between the leading retailer and the third-party seller can emerge as equilibrium even in the absence of network effects and a commission fee. When other plausible explanations fail to explain the phenomenon, our results provide strong evidence that external pressures resulting from the third-party sellers' increasingly attractive outside options are an important strategic consideration for leading retailers' platform-openness decisions.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 introduces our baseline model. Section 4 derives the equilibrium outcome and examines the effects of low-cost advertising on the two sellers' incentives to partner and on consumer surplus. In Section 5, we extend the baseline model by considering the level of platform openness, network effects, and alternative sales outlets. Section 6 discusses managerial implications, limitations, and future research.

2 Related Literature

Our research is closely related to several streams of literature: dual-channel strategies in e-commerce, platform business models, and coopetition in the new-media era.

The advent of e-commerce has enabled manufacturers to sell directly to consumers, creating a dual-channel retail environment. A large body of research in supply chain management and marketing focuses on the competition between a manufacturer's electronic channel and a brick-and-mortar retailer's physical channel. Many studies find that cross-channel competition might not be harmful. For example, Chiang et al. (2003) and Cattani et al. (2006) show that the addition of the e-channel can increase the manufacturer's profit and supply chain efficiency by reducing the degree of double marginalization. Tsay and Agrawal (2004) study channel conflict and the manufacturer–reseller relationship. They propose several contract schemes to coordinate the dual-channel supply chain, including changes in wholesale pricing, paying a reseller a commission for diverting customers toward the manufacturer's direct channel, and conceding the demand-fulfillment function entirely to the reseller.

More recently, the proliferation of e-channels has fundamentally changed traditional retail market dynamics. As retailers become more powerful in their e-channels, a new form of contractual relationship and pricing model—called *agency selling*—has emerged (Abhishek et al., 2016; Hao et al., 2017). Different from the traditional wholesale model, in which the manufacturer sets wholesale prices and the retailer sets retail prices, the agency model has a manufacturer setting the retail price, selling directly to consumers on the retailer's platform, and sharing a fraction of the revenue with the platform owner for providing the access. These models have been analyzed in selling digital content, such as apps and e-books (Hao and Fan, 2014; Tan and Carrillo, 2016). Most of this previous research finds that the agency model achieves higher supply chain efficiency than the wholesale-price model. The commission-fee pricing structure in our model is the same as the revenue-sharing contract in the agency-selling framework. However, in contrast to this stream of literature, which focuses on the vertical supply chain relationship between a manufacturer and a retailer, we study horizontal retail competition in the e-channel, where one leading retailer has a significant competitive advantage over a third-party seller.

Our research also is related to studies on platform business models and, more specifically, on platform openness. Broadly speaking, a platform is more open if it imposes fewer restrictions on participation, development, or use, whether for developers or end users (Eisenmann et al., 2011). Platforms also can serve different functions, providing a technological foundation for constructing complementary products and services (West, 2003) or a sales channel for matching buyers and sellers (Hagiu, 2007). Empirical studies of technological platform innovation show an inverted U shape in the relationship between new product development and the level of platform openness (Boudreau, 2010), suggesting the existence of an optimal level of openness in the platform ecosystem. Parker and Alstyne (2018) develop a sequential innovation model to theoretically analyze the optimal levels of openness and of intellectual property protection duration in the platform economy. The second function of the platform—serving as a sales channel—is closely related to e-commerce and marketing, the focus of this study. Hagiu (2007) compares two strategies for market intermediation. The first is the merchant or reseller model, in which retailers act as intermediaries by reselling to buyers the products they purchase from suppliers. The second is the two-sided platform model, or the marketplace model, in which affiliated sellers sell directly to affiliated buyers via a platform. With the strong growth in online retailing in recent years, some large retailers (e.g., Amazon) have moved to the marketplace model.

In terms of the strategic operation of a marketplace platform, several recent studies have focused on analyzing the potential conflicts and incentives when an online retailer opens its platform to direct competitors (e.g., Jiang et al., 2011; Zhu and Liu, 2018; Song et al., 2020). Ryan et al. (2012) analyze the price competition and channel conflict between a marketplace seller and a third-party retailer. They focus on a revenue-sharing contract, in which a fixed fee for participation serves as a coordination mechanism, and they find that the third-party seller prefers to sell either through a private channel or through the marketplace platform, but not both. Prior research has also identified various plausible explanations for a leading online retailer's incentive to open its platform to competing third-party sellers. Jiang et al. (2011) consider a setting in which the retailer faces uncertain demand, and they show that the retailer can benefit from opening its platform because it learns about future demand from small sellers who sell on its platform. Meanwhile, empirical evidence shows that platform owners gradually enter complementors' successful product spaces and compete against them, discouraging affected third-party sellers from subsequently pursuing growth on the platform (Zhu and Liu, 2018). Mantin et al. (2014) provide a different insight into the marketplace model. They show that, by opening their platforms, retailers create an "outside option" that improves their bargaining position in negotiations with manufacturers. Adding to this stream of research, our work provides an alternative explanation for the prevalence of the marketplace model. We show that a third-party seller's ability to increase its exposure using low-cost new-media advertising externally pressures the leading retailer to open its otherwise closed platform.

Cooperation and competition (i.e., coopetition) are fundamental to firms' digital strategies in today's platform ecosystems (Adner et al., 2020). In the context of platforms and digital innovation, Parker et al. (2017) find that platform-to-platform competition strictly increases the level of platform openness, but developer-to-developer competition can either increase or decrease the optimal level of platform openness. Niculescu et al. (2018) show that open-platform coopetition outcomes may arise in a market characterized by intermediate network effects. Song et al. (2020) examine the spillover effect on the third-party seller's product offering on a retailer's platform and find that it does not always benefit both sellers in light of coopetition. In the new-media age, a prominent example of coopetition is strategic formation of hyperlinks in content networks. Dellarocas et al. (2013) develop a game-theoretic model to study content nodes' incentives to produce quality content versus their incentives to link to third-party content. They find that hyperlinks can both benefit and hurt content creators and consumers. Lambin (2019) shows that interplatform referencing may result in lower quality of content, which outweighs the positive effect of wider content accessibility and leads to lower consumer surplus. Different from these prior results, we demonstrate the strategic effect of new-media advertising on retail-platform openness, which benefits consumers. Our research enriches the understanding of the social implications of firms' coopetition strategies in the new-media age.

3 The Model

We consider a leading retailer (A), such as Amazon or JD.com, and a relatively small third-party seller (B) that both sell an identical product. The market consists of a continuum of consumers with unit mass. Each consumer has a unit demand for the product. Because of its reputation and popularity, the leading retailer has two advantages over the third-party seller: a *valuation advantage* and an *awareness advantage*. Valuation advantage means that everything else being equal, consumers prefer to buy from the retailer over the third-party seller because of the retailer's established reputation (e.g., for good customer service in product handling, shipping, and returns). The awareness advantage comes from brand awareness, in that some consumers are aware of the leading retailer but not the third-party seller. In particular, we assume that consumers derive value 1 from purchasing the product from A and derive a discounted value k from purchasing from B, where k is uniformly distributed over $[0, 1]$ across all consumers. All consumers are aware of A, and initially only a proportion α of consumers is aware of B.

Third-party seller B might advertise its product with new media, such as social media platforms (e.g., Facebook) and search engines (e.g., Google), and it can increase its awareness to ψ at cost $C(\psi)$. We assume that the cost of advertising is an increasing and convex function of the awareness level; that is, $C'(\psi) \geq 0$ and $C''(\psi) \geq 0$ for $\psi \in (\alpha, 1)$. We allow for a general cost function that might contain a fixed cost (e.g., a setup cost). For example, $C(\psi) = \mu(\psi - \alpha) + f$ is a linear cost function, with $\mu \geq 0$ as the marginal cost and $f \geq 0$ as the fixed cost. If B does not advertise, it incurs no cost, and its awareness level stays at level α. We define $C(\alpha) = 0$ for the nonadvertising case. Thus, $C(\psi)$ will be discontinuous at α in the presence of a nonzero fixed cost. If both the marginal and fixed advertising costs are low, such that increasing its awareness beyond α is profitable for B, then we call it *low-cost advertising*.

Retailer A might open its retail platform to B. If B joins A's platform, B pays a commission rate ρ for each unit sale. Meanwhile, B benefits from joining A's platform in two respects: First, all consumers become aware of B, so there is no need for B to advertise anymore. Second, consumers' valuation of B's product may be enhanced because of A's established reputation. We denote this valuation gain as δ, which may come, for example, from consumers' increased trust when transacting on A's platform. Therefore, consumers' valuation of B's product can be expressed as $\min\{k + \delta, 1\}$. The valuation is capped by 1 because we have normalized consumers' maximum valuation (i.e., the valuation of purchasing the product from A) to 1.

To exclude some trivial cases, we assume that $\alpha \leq \frac{2}{3}$; that is, B's initial awareness level is relatively low to ensure that A's awareness advantage over B is salient. Otherwise, B has no incentive to join A's platform, regardless of the commission rate, so partnership formation becomes moot. We also assume that δ is not too large; that is, the value enhancement for B from joining A's platform is limited, so that A's valuation advantage continues to be salient for the consumer population after A opens its platform. We normalize the marginal cost of selling the product to zero. Consumers purchase a product only when they are aware of the product and the product generates a net utility that is no less than a certain reservation value, which is normalized to zero. Consumers who derive positive net utility from both sellers' products purchase the product with the higher net utility.

The time sequence of the game is as follows. In Stage 1, the retailer decides whether to open its platform. If it does, it announces the commission rate ρ. In Stage 2, if the retailer's platform is open, the third-party seller decides whether to join the platform. If the third-party seller does not appear on the platform, it chooses its advertising level ψ. In Stage 3, both sellers decide their retail prices, p_{A} and p_{B}, and consumers make their purchase decisions.

4 Equilibrium Partnership and Effects of Advertising

We use backward induction to solve the game. We first analyze the price competition in Stage 3. We consider the price competition when the third-party seller does not join and when it does join the retailer's platform, respectively. We then examine the third-party seller's platform-joining decision if the retailer's platform is open and the third-party seller's advertising decision when it does not join the platform in Stage 2. Finally, we consider the retailer's platform-openness decision in Stage 1 and examine the conditions under which the two sellers can form a partnership.

4.1 Price Competition

We first consider the price competition in Stage 3. Based on consumer preference, we conjecture and can verify that, in equilibrium, $p_{\mathrm{A}} > p_{\mathrm{B}}$. For comparison, we use the regular notations (e.g., π_{A}^*) for the scenario in which B does not join A's platform and notations with hats (e.g., $\hat{\pi}_{\mathrm{A}}^*$) for the scenario in which B does join A's platform.

B does not join A's platform. When B does not join A's platform, a portion ψ of consumers is aware of both products, and a portion $(1-\psi)$ of consumers is aware of A's product only, where ψ is B's choice of awareness level from Stage 2. Therefore, $(1-\psi)$ is the exclusive demand for A, reflecting A's awareness advantage over B. The consumers who are aware of both sellers buy from A as long as $1 - p_{\mathrm{A}} \geq k - p_{\mathrm{B}}$. Therefore, among all consumers who are aware of both sellers, the ones with $k \leq 1 - (p_A - p_{\mathrm{B}})$ buy from A, and the rest buy from B. We can formulate the demand functions for both sellers as

$$\begin{aligned} D_{\mathrm{A}}\left(p_{\mathrm{A}}, p_{\mathrm{B}}\right) &= (1-\psi) + \psi\left[1 - \left(p_{\mathrm{A}} - p_{\mathrm{B}}\right)\right] \\ D_{\mathrm{B}}\left(p_{\mathrm{B}}, p_{\mathrm{A}}\right) &= \psi\left(p_{\mathrm{A}} - p_{\mathrm{B}}\right), \end{aligned} \tag{1}$$

where $p_{\mathrm{A}}, p_{\mathrm{B}} \in [0,1]$. The first term in $D_{\mathrm{A}}(p_{\mathrm{A}}, p_{\mathrm{B}})$ is A's exclusive demand, and the second term is the competing demand. B has only competing demand. The two sellers' profits can thus be written as

$$\pi_i\left(p_i, p_{\bar{i}}\right) = p_i D_i\left(p_i, p_{\bar{i}}\right), \; \{i, \bar{i}\} = \{\mathrm{A}, \mathrm{B}\}. \tag{2}$$

Both sellers maximize their profits by choosing optimal prices. Based on the best response functions, we can derive the equilibrium prices. Furthermore, by substituting the equilibrium prices into the profit functions in Equation (2), we can obtain the equilibrium profits. The following lemma summarizes the equilibrium outcome.

Lemma 1. *When the third-party seller does not join the retailer's platform, the equilibrium prices are*

$$p_{\mathrm{A}}^* = \min\left\{\frac{2}{3\psi}, 1\right\} \quad \text{and} \quad p_{\mathrm{B}}^* = \min\left\{\frac{1}{3\psi}, \frac{1}{2}\right\} \tag{3}$$

and the equilibrium profits are

$$\pi_{\mathrm{A}}^{*}=\begin{cases}\frac{4}{9\psi} & \text{if } \psi>\frac{2}{3}\\ \frac{2-\psi}{2} & \text{otherwise}\end{cases} \quad \text{and } \pi_{\mathrm{B}}^{*}=\begin{cases}\frac{1}{9\psi} & \text{if } \psi>\frac{2}{3}\\ \frac{\psi}{4} & \text{otherwise}\end{cases}. \tag{4}$$

Proof. All proofs are in the online supplement (available at https://osf.io/498de). □

Note that in equilibrium, as conjectured, $p_{\mathrm{A}}^{*}>p_{\mathrm{B}}^{*}$. When the retailer has a significant awareness advantage (i.e., $\psi\leq\frac{2}{3}$), $p_{\mathrm{A}}^{*}=1$, according to Equation (3). That is, when its awareness advantage is reasonably large, the retailer simply charges the optimal monopoly price to fully exploit its exclusive demand and to capture the demand left by the third-party seller. In contrast, when the retailer does not have a significant awareness advantage (i.e., $\psi>\frac{2}{3}$), it competes with the third-party seller aggressively and, in equilibrium, charges a price less than 1.

B joins A's platform. When B joins A's platform, B pays to A a commission rate ρ on each of its sales, which is the cost of joining for B. The direct benefit of joining A's platform is the increased awareness and the value enhancement: All consumers become aware of B, and consumers' valuation of B's product becomes $\min\{k+\delta,1\}$. The consumers buy from A as long as $1-p_{\mathrm{A}}\geq\min\{k+\delta,1\}-p_{\mathrm{B}}$. We conjecture and can verify that, in equilibrium, $p_{\mathrm{A}}>p_{\mathrm{B}}$, and thus for the marginal consumer who is indifferent between purchasing A's and B's products $k+\delta<1$. Therefore, the consumers with $k\leq1-\delta-(p_{\mathrm{A}}-p_{\mathrm{B}})$ buy from A, and the rest buy from B. The two sellers' profits can be formulated as

$$\begin{aligned}\pi_{\mathrm{A}}\left(p_{\mathrm{A}},p_{\mathrm{B}}\right) &= p_{\mathrm{A}}\left[1-\delta-\left(p_{\mathrm{A}}-p_{\mathrm{B}}\right)\right]+\rho p_{\mathrm{B}}\left(\delta+p_{\mathrm{A}}-p_{\mathrm{B}}\right)\\ \pi_{\mathrm{B}}\left(p_{\mathrm{B}},p_{\mathrm{A}}\right) &= (1-\rho)p_{\mathrm{B}}\left(\delta+p_{\mathrm{A}}-p_{\mathrm{B}}\right).\end{aligned} \tag{5}$$

Similar to the case where B does not join A's platform, both sellers optimize their profits by determining the optimal prices. Based on the best response functions, we can derive the equilibrium prices. Furthermore, we can obtain the equilibrium profits by substituting the equilibrium prices into the profit functions. The following lemma summarizes the equilibrium outcome.

Lemma 2. *When the third-party seller joins the retailer's platform, the equilibrium prices are*

$$\hat{p}_{\mathrm{A}}^{*}=\tfrac{2-(1-\rho)\delta}{3-\rho}\quad and\quad \hat{p}_{\mathrm{B}}^{*}=\tfrac{1+\delta}{3-\rho} \tag{6}$$

and the equilibrium profits are

$$\hat{\pi}_{\mathrm{A}}^{*}=\tfrac{4-\rho+\delta^{2}-(4-\rho)(1-\rho)\delta}{(3-\rho)^{2}}\quad and\quad \hat{\pi}_{\mathrm{B}}^{*}=\tfrac{(1-\rho)(1+\delta)^{2}}{(3-\rho)^{2}}\ . \tag{7}$$

Several important observations are worth highlighting. First, both A's and B's retail prices increase in the commission rate ρ. When A charges a higher commission rate, a larger proportion of B's sales also go to A's revenue; thus, the competition between A and B is softened, and both sellers are able to charge a higher product price. Consequently, the retailer's profit increases in the commission rate ρ. However, B's profit decreases in the commission rate because B's increased commission fee cannot be recouped through the benefit from softened price competition. In addition, A's price decreases and B's price increases in δ. Intuitively, the third-party seller gains valuation enhancement after joining the platform, enabling it to charge a higher price. Meanwhile, the third-party seller's valuation enhancement reduces the retailer's competitive advantage, inducing the retailer to lower its price.

4.2 Third-Party Seller's Advertising and Joining Decisions

Anticipating the price competition in Stage 3, we next consider the third-party seller's decision in Stage 2. In Stage 2, when B does not join A's platform, B chooses its optimal awareness level. Intuitively, when B's awareness level is low, A forgoes the competition and simply charges the optimal monopoly price. In contrast, when B's awareness level becomes comparable to A's level, a more intense competition is triggered, such that A has an incentive to lower its price and compete aggressively with B for the consumers who are aware of both products. Thus, an increase in B's awareness level can intensify the competition, and the benefit to B from its increased awareness cannot compensate for the loss caused by this increased competition. As a result, B would avoid increasing its awareness to the degree that it would trigger A's retaliation. The following lemma summarizes this finding.

Lemma 3. *When the third-party seller does not join the retailer's platform, it never advertises to achieve an awareness level beyond* $\bar{\psi} = \frac{2}{3}$*, even if advertising is free.*

When B advertises, it advertises to an optimal level by balancing the marginal benefit of an increase in the awareness level and the marginal advertising cost. If A's platform is open, B decides whether to join A's platform by weighing its optimal profit when advertising against its profit when joining. The following proposition presents the third-party seller's optimal choice when the leading retailer's platform is not open and when it is open.

Proposition 1. *(a) When the retailer's platform is not open, the third-party seller advertises to an optimal awareness level* ψ^**, and its optimal payoff is* $\Pi_{\mathrm{B}}^* = \frac{\psi^*}{4} - C(\psi^*)$*, where*

$$\psi^* = \begin{cases} \frac{2}{3} & \text{if } C'(\frac{2}{3}) < \frac{1}{4} \text{ and } \frac{1}{4}(\frac{2}{3} - \alpha) \geq C(\frac{2}{3}) \\ \tilde{\psi} & \text{if } C'(\alpha) \leq \frac{1}{4} \leq C'(\frac{2}{3}) \text{ and } \frac{1}{4}(\tilde{\psi} - \alpha) \geq C(\tilde{\psi}) \\ \alpha & \text{otherwise,} \end{cases} \tag{8}$$

and $\tilde{\psi}$ *is determined by* $C'(\tilde{\psi}) = \frac{1}{4}$.

(b) When the retailer's platform is *open, the third-party seller joins the platform only if* $\Pi_{\mathrm{B}}^* \leq \frac{(1+\delta)^2}{9}$ *and* $\rho \leq 3 - \frac{4}{1+\sqrt{1-8(1+\delta)^{-2}\Pi_{\mathrm{B}}^*}}$*; otherwise, the third-party seller does not join but advertises on its own to the optimal awareness level* ψ^*.

Intuitively, if B advertises, the marginal benefit of an increase in the awareness level is $\frac{1}{4}$, according to Equation (4) (for the case with $\psi \leq \frac{2}{3}$), and the marginal advertising cost is $C'(\psi)$. When the marginal advertising cost is low, such that $C'(\frac{2}{3}) < \frac{1}{4}$, B advertises to increase its awareness level to $\frac{2}{3}$. When the marginal advertising cost is high, such that $C'(\alpha) > \frac{1}{4}$, B has no incentive to advertise at all. When the marginal cost is intermediate, the optimal advertising level falls between the two. Given the optimal advertising level that can be chosen, B trades off the benefit of advertising (i.e., $\frac{1}{4}(\psi - \alpha)$) against the total advertising cost (i.e., $C(\psi)$, which might include a fixed cost) to decide whether it should advertise. If the benefit cannot outweigh the total cost, B chooses not to advertise and stays at the awareness level α.

When A's platform is open, B may join A's platform only when the commission rate is low because B's payoff when joining A's platform decreases in the commission rate (by Lemma 2). The condition $\Pi_{\mathrm{B}}^{*} \leq \frac{(1+\delta)^2}{9}$ requires that B's optimal payoff when not joining A's platform should be no more than its profit when it joins A's platform without a commission fee (i.e., letting $\rho = 0$ in $\hat{\pi}_{\mathrm{B}}^{*}$ from Lemma 2). In other words, B has no incentive to join A's platform when Π_{B}^{*} is high enough or, equivalently, when the advertising cost is low enough. Furthermore, to attract B to the platform, the highest commission rate that A can charge decreases in Π_{B}^{*}. Therefore, low-cost advertising would make the third-party seller more likely to advertise on its own and would give the retailer less room to charge a high commission.

4.3 Retailer's Openness Decision and Equilibrium Partnership

In Stage 1, A makes its platform openness decision, anticipating B's reaction in Stage 2. On the one hand, if A opens its platform, according to Lemma 2, A's payoff increases in the commission rate, and thus A has incentive to charge a high commission rate. On the other hand, if the commission rate is too high, B cannot be induced to join A's platform. Considering these factors, A chooses its optimal commission rate when opening the platform. Further, A decides whether to open its platform, weighing its payoff if it does not open the platform against its payoff if it opens the platform with the optimal commission rate.

To highlight the effect of low-cost advertising on the retailer's and the third-party seller's incentives to form the partnership, we first consider as a benchmark the case without the low-cost advertising option, such that B's awareness level remains at α (i.e., $\psi^* = \alpha$ in Equation (8)). In the absence of low-cost advertising, A has both awareness and valuation advantages over B. When A has a significant awareness advantage, it has no incentive to open its platform to B. The reason is that, although A could harvest the commission fee by having B on its platform, the more effective strategy for A is to exploit its exclusive demand by charging a high price. Meanwhile, when A's awareness advantage is small and consumers' awareness of B is high enough, B has no incentive to join A. The reason is that if B increases its awareness by joining A's platform, the competition between the two sellers also increases, which hurts B's profit. When a low-cost advertising option becomes available, the incentives of A and B are affected differently, as summarized in the following proposition.

Proposition 2. *(a) In the absence of a low-cost advertising option, the incentives of the retailer and the third-party seller cannot be aligned. In equilibrium, the third-party seller does not appear on the retailer's platform. (b) In the presence of a low-cost advertising option, the retailer has a greater incentive to have the third-party seller on its platform, but the third-party seller has less incentive to join the platform. That is, given any* ρ*,* $\hat{\pi}^*_{\mathrm{A}}(\rho) - \pi^*_{\mathrm{A}}(\alpha) \leq \hat{\pi}^*_{\mathrm{A}}(\rho) - \pi^*_{\mathrm{A}}(\psi^*)$*, and* $\hat{\pi}^*_{\mathrm{B}}(\rho) - \pi^*_{\mathrm{B}}(\alpha) \geq \hat{\pi}^*_{\mathrm{B}}(\rho) - [\pi^*_{\mathrm{B}}(\psi^*) - C(\psi^*)]$.

Conventional wisdom might suggest that A is willing to open its platform and B has an incentive to join the platform because A can enjoy the commission fee and B can benefit from the increased awareness and value enhancement. However, this explanation does not always hold, according to Proposition 2(a). The main reason is that when B is at a competitive disadvantage, the more profitable strategy for A is to exploit its advantage in the market itself; charging a low commission fee is less effective, and charging a high commission fee might discourage B from joining the platform. Thus, in our setting, the commission fee itself is not sufficient to explain why the retailer is willing to open its platform while the third-party seller has incentive to join the platform.

Proposition 2(b) shows that a low-cost advertising option has an asymmetric effect on A and B. When a low-cost advertising option is available, B might choose not to join A's platform and instead choose to advertise on its own to increase its awareness level from α to ψ^*. The low-cost advertising option essentially increases the value of B's outside option of not joining A's platform. Therefore, for a given commission rate ρ, the third-party seller has less incentive to join the retailer's platform with the low-cost advertising option than it has without this option. In contrast, when B can increase its awareness through low-cost advertising, A's awareness advantage over B is reduced if A excludes B from its platform. Therefore, the low-cost advertising option gives the retailer a greater incentive to open its platform and partner with the third-party seller.

Although a low-cost advertising option has the opposite effect on the two sellers' incentives, we show that the partnership between the retailer and the third-party seller can emerge as an equilibrium because of the low-cost advertising option. The following proposition prescribes the conditions to form the partnership.

Proposition 3. *If* $(\frac{2-\psi^*}{2} - \frac{3+\rho^*\delta^2-(6-\rho^*)(1-\rho^*)\delta}{(3-\rho^*)^2}) \leq \Pi_{\mathrm{B}}^* \leq \frac{(1+\delta)^2}{9}$*, then the retailer opens its platform and the third-party seller joins the platform; otherwise, the third-party seller does not join the retailer's platform and advertises on its own, where* $\rho^* = 3 - \frac{4}{1+\sqrt{1-8(1+\delta)^{-2}\Pi_{\mathrm{B}}^*}}$ *is the retailer's optimal commission rate and* ψ^* *and* Π_{B}^* *are defined as in Proposition 1.*

The condition on the upper bound in Proposition 3, as in Proposition 1, requires that B's optimal payoff in not joining A's platform should be no more than its profit from joining A's platform without a commission fee. This upper-bound condition ensures that B can be induced to join A's platform if the commission rate is not too high. Notice that when the advertising cost is sufficiently low, the value of B's outside option of using low-cost advertising can be so high that the condition cannot be satisfied. In this case, the third-party seller has no incentive to join the retailer's platform at all.

The condition on the lower bound in Proposition 3 requires that the value of B's outside option of using low-cost advertising is high enough that A is better off allowing B to sell on its platform and thus earning a commission because A's awareness advantage could be significantly reduced anyway. This lower-bound condition ensures that A has an incentive to open its platform. Notice that when the advertising cost is high enough, B cannot effectively increase its awareness level, such that A continues to have significant awareness advantage when selling separately and the condition cannot be satisfied. In this case, the retailer has no incentive to open its platform.

Together, the two conditions essentially require the advertising cost to be neither too low nor too high. In other words, only when the advertising cost is low but not too low can both sellers' incentives be aligned and the partnership between the two sellers emerge as an equilibrium.

We next use the class of the linear advertising cost function, $C(\phi) = \mu(\psi - \alpha) + f$, to illustrate the main idea. When B does not join A's platform, according to Proposition 1, if the marginal advertising cost (μ) or the fixed cost (f) is too high, B has no incentive to advertise. Otherwise, B advertises with new media to increase its awareness to the optimal

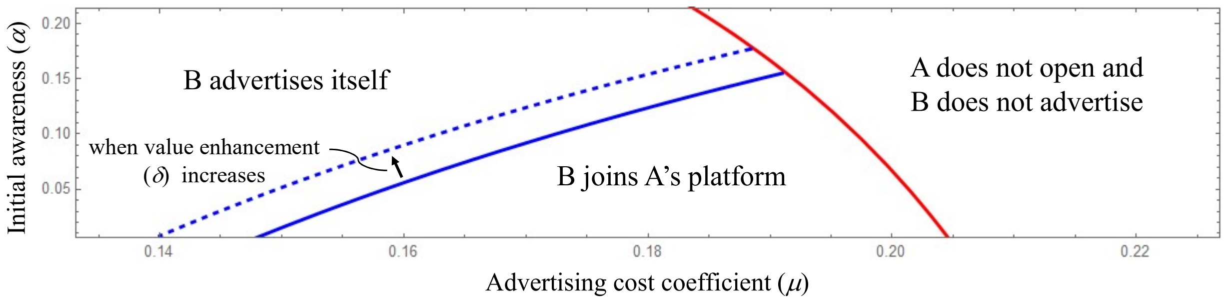

Figure 1: Equilibrium outcome under linear cost function $C(\psi) = \mu(\psi - \alpha) + f$

level, $\psi^* = \frac{2}{3}$. However, if the advertising cost is not too low, joining A's platform might be better for B than advertising on its own, as the following corollary shows.

Corollary 1. *When advertising incurs a linear cost $C(\psi) = \mu(\psi - \alpha) + f$, in equilibrium,*
(a) if $\frac{1}{4} < \mu + \frac{3f}{2-3\alpha}$, the third-party seller neither joins the retailer's platform nor advertises;
(b) if $\frac{18+3(11+5\delta)\delta}{(4-6\alpha)(1+\delta)} - \frac{(3+\delta)\sqrt{3(11+12\delta)}}{4-6\alpha} < \mu + \frac{3f}{2-3\alpha} \leq \frac{1}{4}$, the third-party seller joins the platform;
(c) otherwise, the third-party seller advertises on its own and does not join the platform.

Corollary 1 shows the effect of advertising cost on the equilibrium outcome, in which $\mu + \frac{3f}{2-3\alpha}$ measures the average advertising cost of increasing awareness from α to $\frac{2}{3}$. As Figure 1 also illustrates, on the one hand, if the advertising cost is high, the benefit for B from increased awareness cannot compensate for the cost, leaving B with no incentive to advertise. In this case, advertising does not increase the value of B's outside option when it does not join A's platform. As a result, the two sellers' incentives cannot be aligned to form a partnership, which explains Corollary 1(a). On the other hand, if the advertising cost is very low, as in Corollary 1(c), B can increase its awareness to an appropriate level by advertising and can compete with A from a stronger position. In contrast, if B does join A's platform, B has to pay a commission fee. The increased sales from joining cannot compensate for the lost revenue from the commission fee. As a result, when the advertising cost is very low, the third-party seller has no incentive to join the retailer's platform and instead is better off advertising on its own, even if the retailer is willing to open its platform.

Finally, Corollary 1(b) indicates that, when the cost of advertising is low but not too low (in the middle low region in Figure 1), A is willing to open its platform, and B is induced to join it. In this case, B can advertise to increase its awareness level without joining A's platform, which in turn reduces A's awareness advantage and decreases A's incentive to keep its platform closed. As a result, the retailer is willing to open its platform. Meanwhile, although B can increase its awareness level, it has to take into account the nonnegligible advertising cost. Comparing the benefit of advertising with that of joining the retailer's platform, the third-party seller joins the platform.

Corollary 1 and Figure 1 also illustrate that the initial awareness level α moderates the threshold of the advertising cost beyond which B chooses to join A's platform instead of advertising on its own. In the presence of an intermediate advertising cost, B is more likely to join A's platform when B's initial awareness is low. In this case, its awareness disadvantage is significant, and increasing its awareness to a desired level through advertising would not be cost effective. In addition, the dashed line in Figure 1 illustrates that the value-enhancement factor (δ) makes the partnership more likely to occur, compared with the solid blue line, which represents the case with no value enhancement (i.e., $\delta = 0$). Intuitively, the value enhancement makes the partnership more attractive because consumers generally value the third-party seller's product more when it is listed on the retailer's platform.

Figure 2 demonstrates the same insights when the advertising cost is nonlinear. The blue curves with kinks (indicated by the black dots) manifest the two conditions in Proposition 3. The curves before the kinks represent B's joining condition, and the curves after the kinks represent A's opening condition. In addition, Figure 2 illustrates the effect of a fixed cost, in which the solid and dashed lines represent relatively high and low fixed costs, respectively. When the fixed cost decreases, the third-party seller is more likely to advertise (i.e., the vertical line moves toward the right) because of the reduction in the average advertising cost. However, the partnership is less likely to be formed (i.e., the region of "B joins A's platform" shrinks) because the third-party seller is more attracted to the low-cost advertising option.

In sum, if the advertising cost is neither too high nor too low, the retailer has an incentive to open its platform and the third-party seller has an incentive to join the platform. When the advertising cost is very high, the retailer might prefer to keep its

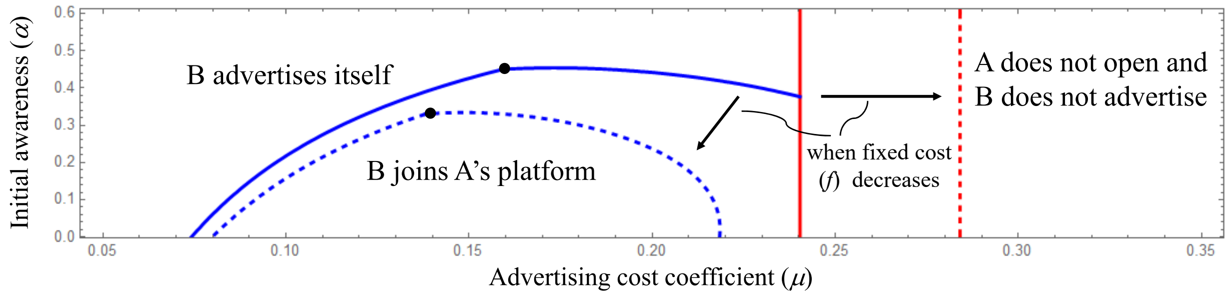

Figure 2: Equilibrium outcome under quadratic cost function $C(\psi) = \mu(\psi - \alpha)^2 + f$

platform closed and exclude the third-party seller. For instance, high-cost advertising using traditional media cannot induce the retailer to open its platform. However, if the third-party seller can effectively take advantage of very low-cost new-media advertising or free organic listings on search engines, it has no incentive to pay a commission fee to join the retailer's platform, even if the platform is open.

Finally, we examine the effects of low-cost advertising on consumer surplus. Consumer surplus is the difference between the total amount that consumers are willing to pay and the total amount that they actually pay. We denote $CS(\alpha)$, $CS(\psi^*)$, and $CS(1)$ as consumer surplus for the benchmark case without the low-cost advertising option, the case when B advertises on its own, and the case when B joins A's platform, respectively. For example, $CS(1)$ can be computed as

$$CS(1) = \int_0^{1-\delta-\left(\hat{p}_{\mathrm{A}}^* - \hat{p}_{\mathrm{B}}^*\right)} (1 - \hat{p}_{\mathrm{A}}^*)\,\mathrm{d}x + \int_{1-\delta-\left(\hat{p}_{\mathrm{A}}^* - \hat{p}_{\mathrm{B}}^*\right)}^{1} (\min\{k+\delta, 1\} - \hat{p}_{\mathrm{B}}^*)\,\mathrm{d}k. \qquad (9)$$

Recall that, in equilibrium, consumers with low k purchase from A and consumers with high k purchase from B, and $1 - \delta - (\hat{p}_{\mathrm{A}}^* - \hat{p}_{\mathrm{B}}^*)$ is the threshold between the two groups. The first integral in the equation is the surplus of the consumers who purchase from A, and the second integral is the surplus of those who purchase from B. We can derive the consumer surpluses $CS(\alpha)$ and $CS(\psi^*)$ similarly. Comparing the consumer surpluses under these three cases, we can draw the following conclusion.

Proposition 4. *The presence of the low-cost advertising option increases consumer surplus; that is, $CS(\psi^*) \geq CS(\alpha)$ and $CS(1) > CS(\alpha)$. Moreover, consumer surplus under* *the platform partnership is higher than consumer surplus under the third-party seller's own advertising; that is,* $CS(1) > CS(\psi^*)$.

We find that the low-cost advertising option increases consumer surplus either directly through the third-party seller's own advertising (i.e., $CS(\psi^*) \geq CS(\alpha)$) or indirectly by inducing the platform partnership (i.e., $CS(1) > CS(\alpha)$). In the former case, the third-party seller may take advantage of the relatively low cost of sponsored advertising on search engines or social media marketing to increase its exposure, offering consumers more purchasing options. The increased exposure directly increases consumer surplus because some consumers who would otherwise be aware only of the leading retailer's product can now choose from the cheaper third-party seller for purchases. In the latter case, viewing the third-party seller's outside advertising option as a credible threat, the leading retailer is willing to open its otherwise closed platform. Platform partnership increases both the third-party seller's awareness and its product valuation. Increased awareness offers consumers more purchasing options, and enhanced valuation increases consumers' utility of purchasing from the third-party seller. Furthermore, both factors intensify competition between the leading retailer and the third-party seller. All these factors benefit consumers and increase consumer surplus.

Our results further show that the indirect effect of advertising on consumer surplus is more significant than its direct effect (i.e., $CS(1) > CS(\psi^*)$). Under the direct effect, to avoid head-to-head competition, the third-party seller never advertises to achieve an awareness level beyond $\frac{2}{3}$, even if advertising is free (Lemma 3), which is not as beneficial for consumers as the retailer and third-party partnership. In addition, under the indirect effect, the partnership can potentially enhance consumer valuation, which also benefits consumers.

5 Model Extensions

In the previous sections, we develop a stylized model to study the leading retailer's incentive to open its platform and the third-party seller's incentive to join the platform. In this section, we extend our model by considering the leading retailer's control of its platform openness and the network effects on the equilibrium partnership. In the online supplement (available at https://osf.io/498de), we further extend our model in several directions by considering product differentiation, correlations between consumers' awareness and valuation, the third-party seller's advertising budget constraint, the third-party seller's alternative sales outlets, and the leading retailer's offer of a direct advertising service to the third-party seller. We demonstrate that the main qualitative insights gained from our baseline model are robust under these various model extensions.

5.1 Level of Platform Openness

In our baseline model, we assume that A completely opens its platform to B after they form the partnership. B gains full exposure on A's platform and has access to its entire customer base. In this extension, we consider a situation where A has control over its platform and to some extent can determine the level of platform openness, so that only a fraction ψ of its customers become aware of B's product. In practice, the leading retailer can influence the third-party seller's exposure on its platform by controlling how it presents the third-party seller on the product page. For example, A can choose whether to place B in a prominent spot on a webpage or whether to display B at a particular time, but not at other times. To make the extension more interesting and realistic, we assume that $\psi \geq \underline{\psi}$, to ensure that the exposure on the platform cannot be arbitrarily low; otherwise, the partnership might not be perceived as a viable option. Furthermore, for ease of exposition, we assume $\underline{\psi} \leq \frac{2}{3+\delta}$, to ensure that the retailer has adequate flexibility in choosing the exposure level. The other case can be similarly analyzed. Everything else remains the same as the baseline model.

In stage 2, when B does not join A's platform, the equilibrium outcome remains the same as in the baseline model. When B joins A's platform, the competing demand is ψ, and the exclusive demand for A is $1-\psi$. The two sellers' profit functions can thus be formulated as

$$\begin{aligned} \pi_{\mathrm{A}}\left(p_{\mathrm{A}}, p_{\mathrm{B}}\right) &= p_{\mathrm{A}}\left[(1-\psi)+\psi\left[1-\delta-\left(p_{\mathrm{A}}-p_{\mathrm{B}}\right)\right]\right]+\rho \psi p_{\mathrm{B}}\left(\delta+p_{\mathrm{A}}-p_{\mathrm{B}}\right) \\ \pi_{\mathrm{B}}\left(p_{\mathrm{B}}, p_{\mathrm{A}}\right) &= (1-\rho) \psi p_{\mathrm{B}}\left(\delta+p_{\mathrm{A}}-p_{\mathrm{B}}\right). \end{aligned} \tag{10}$$

Following the same approach as in the baseline model, we can derive the equilibrium prices as follows:

$$p_{\mathrm{A}}^{*}(\psi, \rho)=\min \left\{\frac{2-(1-\rho) \delta \psi}{(3-\rho) \psi}, 1\right\} \text{ and } p_{\mathrm{B}}^{*}(\psi, \rho)=\frac{p_{\mathrm{A}}^{*}+\delta}{2}\ . \tag{11}$$

Similar to Lemma 1, a high exposure level beyond some threshold can hurt the third-party seller because a high exposure level can change the nature of the competition between the two sellers. Different from Lemma 1, the threshold in this general case is moderated by the commission rate and the value enhancement because both factors adjust the intensity of the competition.

The following proposition summarizes the retailer's optimal choice of exposure level in stage 1 and the conditions under which the two sellers have incentive to form the partnership.

Proposition 5. *In the presence of* $\underline{\psi}$ *with* $\underline{\psi} \leq \frac{2}{3+\delta}$, *if* $(\frac{(1+\delta)(3+\delta-2\rho_o^*-2\delta\rho_o^*)\psi_o^*}{4} - \frac{\psi^*}{2}) \leq \Pi_{\mathrm{B}}^*$, *the retailer opens its platform and the third-party seller joins the platform; otherwise, the third-party seller does not join the platform and advertises on its own, where* ψ^* *and* Π_{B}^* *are defined as in Proposition 1, and*

$$(\psi_o^*, \rho_o^*) = \begin{cases} (4(1+\delta)^{-2}\Pi_{\mathrm{B}}^*, 0) & \text{if } \underline{\psi} \leq 4(1+\delta)^{-2}\Pi_{\mathrm{B}}^* \\ (\underline{\psi}, 1 - \frac{4}{\underline{\psi}}(1+\delta)^{-2}\Pi_{\mathrm{B}}^*) & \text{otherwise.} \end{cases} \tag{12}$$

are the retailer's optimal exposure level and optimal commission rate. Moreover, ψ_o^* *(weakly) increases in* Π_{B}^* *and is less than 1.*

The first case in Equation (12) is worth highlighting: When B's outside option value is high (i.e., $4(1+\delta)^{-2}\Pi_{\mathrm{B}}^* \geq \underline{\psi}$) and A has a certain flexibility in choosing the exposure level (i.e., $\underline{\psi} \leq \frac{2}{3+\delta}$), the optimal commission rate is 0; that is, the retailer is better off when tightly controlling the third-party seller's exposure and forgoing the opportunity to charge the third-party seller a commission fee. This result is counterintuitive; one might expect that charging a commission fee could be more effective because the retailer not only acquires a direct revenue contribution but also can soften the competition. Although the commission fee is a more direct approach to generating profit on the retailer's platform, we find that the indirect approach—controlling exposure—can more effectively maximize the retailer's profit. The reason is that, in our setting, the retailer has a valuation advantage and can maximally exploit its valuation advantage in serving consumers by charging a higher price than B. In contrast, increasing B's exposure means that more consumers purchase from B, and the additional commission would not be sufficient to compensate for A's own revenue loss. Our result demonstrates that the demand-shifting effect resulting from the third-party seller's increased exposure can dominate the revenue-sharing effect from the commission fee, such that the leading retailer might have an incentive to offer the minimum level of exposure at which either the third-party seller is just induced to join the platform or the exposure constraint binds.

Note that the optimal exposure level is generally less than 1, implying that the leading retailer would have no incentive to open its platform completely. The reason is that the high exposure level can hurt both sellers: A high exposure level leaves the retailer with little awareness advantage and intensifies its competition with the third-party seller. Consequently, the retailer optimally sets a low exposure level for the third-party seller and benefits from this option of controlling exposure. Because controlling exposure provides the retailer an additional device to improve its profit while ensuring the third-party seller's incentive to partner, the two sellers are more likely to form the partnership compared to the baseline case.

5.2 Network Effects

In the baseline model, we assume that the total number of consumers on the retailer's platform stays the same, regardless of whether the third-party seller joins the retailer's platform, and that the product sold by the two sellers is identical. In line with the positive indirect network effects on consumers resulting from the increased variety of products, as discussed in the existing literature (e.g., Chen et al., 2016), we also can argue that the increased variety of sellers on the retailer's platform attracts more consumers, helping the retailer build a larger customer base. In this subsection, we consider indirect network effects. In particular, we assume that when the third-party seller joins the retailer's platform, the number of consumers on the retailer's platform increases from 1 to $(1 + N)$, where $N \geq 0$. Everything else remains the same as in the baseline model. The parameter N represents the indirect network effects, and when $N = 0$, this extension reduces to the baseline model.

In the subgame where B does not join A's platform, the equilibrium outcome of price competition and B's optimal choice of advertising remain the same as in Lemma 1 and

Proposition 1. In the subgame where B joins A's platform, the market segmentation is similar to that in the baseline model. What is different is that the market expands from 1 to $(1+N)$. Following the same approach, we can derive the equilibrium prices for this subgame, which remain the same as in Lemma 2, and we can further derive the equilibrium profits as follows:

$$\hat{\pi}_{\mathrm{A}}^{*} = \frac{(1+N)[4-\rho+\delta^2-(4-\rho)(1-\rho)\delta]}{(3-\rho)^2} \quad \text{and} \quad \hat{\pi}_{\mathrm{B}}^{*} = \frac{(1+N)(1-\rho)(1+\delta)^2}{(3-\rho)^2} \ . \tag{13}$$

By comparing the equilibrium outcome when B joins A's platform and when it does not join A's platform, similar to Proposition 3, we can derive the conditions under which the partnership arises in equilibrium: If $(\frac{2-\psi^*}{2} - \frac{(1+N)[3+\rho^*\delta^2-(6-\rho^*)(1-\rho^*)\delta]}{(3-\rho^*)^2}) \leq \Pi_{\mathrm{B}}^{*} \leq \frac{(1+N)(1+\delta)^2}{9}$, then A opens its platform and B joins A's platform; otherwise, B does not join A's platform and advertises on its own, where ρ^* is A's optimal commission rate, and ψ^* and Π_{B}^{*} are as defined in Proposition 1.

Notice that the partnership conditions depend on the magnitude of the network effects. As in the baseline model, in the presence of weak network effects, when the advertising cost is low and the value of the third-party seller's outside option of using low-cost advertising is high, the third-party seller might have no incentive to join the retailer's platform. When the advertising cost is high and the value of B's outside option is low, the retailer might have no incentive to open its platform. Only when the advertising cost is low but not too low can the incentives of both parties align and give rise to the partnership in equilibrium. Therefore, the qualitative insights delivered under the baseline model carry over to the cases with network effects.

Intuitively, the presence of network effects enlarges the consumer base when the partnership is formed, which might provide the retailer and the third-party seller extra incentives to cooperate. As shown in the following proposition, stronger network effects make the two sellers more likely to partner. In contrast to Proposition 2, when network effects are strong enough—even in the absence of the advertising option—the retailer's and the third-party seller's incentives can be aligned and, in equilibrium, the third-party seller joins the retailer's platform.

Proposition 6. *(a) When network effects increase (i.e., when N increases), the retailer and the third-party seller are more likely to form a partnership in equilibrium. (b) If network effects are strong enough, the retailer and the third-party seller have an incentive to partner even in the absence of the low-cost advertising option.*

It is worth highlighting that although both network effects and low-cost advertising can serve as the driving force for the retailer's platform openness and equilibrium partnership, these two mechanisms are fundamentally different. Because of an enlarged customer base, network effects can benefit both sellers, as shown in Equation (13), thus giving both sellers more incentive to partner. In contrast, as shown in Proposition 2, the effect of advertising is asymmetric—it reduces B's incentive to partner and increases A's incentive to do so.

6 Conclusion

We analyze the strategic partnership formation between a leading retailer and a third-party seller in the era of new-media advertising. We find that when the advertising is expensive, the leading retailer prefers to keep its retail platform closed. When the cost of advertising is very low, the third-party seller prefers to increase its awareness through its own advertising effort. In both cases, the leading retailer's incentive cannot be aligned with the third-party seller's to form a partnership. Only when the advertising cost is not too high and not extremely low can the partnership be formed: The leading retailer has an incentive to open its platform, and the third-party seller can be induced to join the leading retailer's platform. Our results indicate that the decreasing cost of new-media advertising plays an important role in inducing the leading retailer to open its platform. Furthermore, we show that low-cost advertising increases consumer surplus; it does so through a direct effect, in that the third-party seller can advertise to increase its awareness, as well as through an indirect effect, in which the viable advertising option creates a credible threat for the leading retailer, inducing it to open its platform. We also find that the leading retailer has a greater incentive to open its platform and that the partnership is more likely to be formed when there are network effects, when the leading retailer can control the level of its platform openness, and when the leading retailer offers a direct advertising service. However, the leading retailer has less incentive to open its platform and the partnership is less likely to be formed when the third-party seller has advertising budget constraints. These insights are not limited only to advertising; they are robust to the third-party seller's other viable outside options (e.g., an alternative sales outlet on a C2C platform). Findings in this research not only enrich theoretical platform-openness research but also provide practical guideline on effective platform governance.

Our results have important implications for platform owners and market participants. First, market leaders should recognize the advancement in advertising technologies and should adjust their perspectives to consider the paradigm shift when defending their market leadership. In the past, firms have sought to establish their competitive advantage and to protect and extract value from their position as market leaders. The Web 2.0 era has witnessed the coexistence of competition and cooperation in an open environment. Our study demonstrates that simply keeping their platforms closed can no longer protect leading retailers' competitive advantage; in fact, it can actually hurt them because competitors can improve their market position through various new-media advertising tools and platforms enabled by Web 2.0 technologies. Instead, by opening their platforms and empowering weak competitors to sell on their platforms, leading retailers can benefit from the partnerships.

Our analysis also suggests that, in addition to the paradigm shift toward open platforms, leading retailers should pay close attention to their implementation tactics. If they can influence the exposure of third-party sellers when these sellers join their platforms, the leading retailers have two devices to enhance profit: charging a commission or advertising fee and controlling the exposure. We demonstrate that manipulating the third-party sellers' exposure can be more effective for the leading retailer than charging a commission or advertising fee. Leading retailers might even be better off by completely forgoing the opportunity to charge any commission fee (i.e., opening their platforms for free) in exchange for tight control over third-party sellers' exposure when inducing these sellers to join their platforms. As a result, leading retailers may have no incentive to fully open their platforms to maximize profit.

Second, third-party sellers should embrace new media and take advantage of low-cost advertising opportunities to improve their market position when competing with leading retailers. Google has made serious efforts to adapt its AdWords platform for small business advertising.[4] Facebook marketing has shown that digital advertising on its platform offers an enormous boost of sales for many small businesses.[5] Although small businesses are recognizing the importance of digital advertising, a recent Small Business Trend report shows that half of the respondents did all their marketing in-house and that many did not know how to optimize for mobile presence.[6] The presence of the low-cost advertising option creates a credible threat to leading retailers' market positions, which could induce them to open their otherwise closed platforms. We illustrate that partnerships can emerge as an equilibrium outcome, but only when the outside advertising is not too expensive for third-party sellers. Therefore, our study calls for small, third-party sellers to act in light of new media, which can help them to improve their competitive advantage either directly via advertising or indirectly via partnership with leading retailers.

Third, our study also suggests that advances in Web technologies increase consumer surplus either directly or indirectly. Small sellers and consumers benefit directly from new media because use of the new media allows small sellers to increase their awareness level. In addition, advertising with new media might indirectly incentivize leading retailers to open their platforms and to partner with small sellers, resulting in a win–win–win outcome for leading retailers, small sellers, and consumers. Social planners and policymakers should encourage, support, and facilitate the development of new media in e-commerce applications, foster collaboration between industry players, and help orchestrate partnership formation. Our findings also shed light on the ongoing debate about platform openness and strategic partnership in various other contexts. For example, Kickstarter opened its platform and lowered the barriers to entry in 2014, which allowed laypersons and amateurs to enter the market to raise capital for their projects. Tripadvisor allows users to access competitor content and to compare their search results with those of competitors, and many news websites routinely refer readers to their own competitors through hyperlinks. Our research has important social and policy implications that opening platforms to increase

[4]https://www.wordstream.com/blog/ws/2014/03/24/small-business-advertising
[5]https://www.facebook.com/business/success/categories/small-business
[6]https://smallbiztrends.com/2019/04/small-business-advertising-statistics.html

participation or accommodate competition would benefit consumers and result in higher consumer surplus.

This paper has several limitations that suggest directions for future research. First, prior studies have identified several driving forces to explain retail platform openness from the perspective of leading retailers' various strategic considerations. We complement this stream of literature by focusing on new-media advertising as a viable outside option for third-party sellers and as an important alternative driving force for leading retailers' platform-openness decisions. However, determining which force is the primary driver for platform openness remains as an empirical question.

Second, in this study, we assume that the leading retailer has a salient valuation advantage over the third-party seller. This assumption is necessary in our context of identical products; otherwise, Bertrand-type price competition would hurt both sellers and lead to the trivial no-partnership equilibrium. This assumption can be relaxed in models studying differentiated or complementary products. In addition, a third-party seller might have its own specialty that consumers value more than they value the leading retailer's advantages in some niche markets. Future research might consider the case where the third-party seller has a valuation advantage and examine the equilibrium outcome under other product-competition frameworks.

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Online Supplement to "New-Media Advertising and Retail Platform Openness"

A Model Extensions

A.1 Product Differentiation

In the baseline model, we consider the products offered by the retailer and by the third-party seller to be identical. In this extension, we allow the products to be horizontally differentiated. In particular, on top of the baseline model, we introduce a Hotelling line to model consumers' possibly different preferences between the two products that arise because of different degrees of misfit between a product and a consumer's need.

Following a typical horizontal product-differentiation model (Hotelling, 1929), we assume that products offered by the retailer and the third-party seller are located at positions 0 and 1 on a line of length 1 (i.e., at the two ends of the line), respectively, and that consumers are uniformly distributed along the line. The distance between a consumer and a product measures the degree of misfit of that product for the consumer. The misfit cost is the degree of misfit times a unit misfit cost t. A consumer's net utility from a product is the maximum value that the product offers, net of the misfit cost and the price. When B does not join A's platform, a consumer located at $x \in [0,1]$ derives net utilities $v - xt - p_{\mathrm{A}}$ and $kv - (1-x)t - p_{\mathrm{B}}$ from products offered by the retailer and the third-party seller, respectively. When B joins A's platform, kv is enhanced to $kv + \delta$. As in the baseline model, we normalize v to 1, and assume that the unit misfit cost is not too large (so that the market is fully covered). When $t = 0$, this framework reduces to the baseline model.

When B does not join A's platform, as in the baseline model, a portion ψ of consumers is aware of both products, and a portion $(1-\psi)$ of consumers is aware of A's product only. A consumer who is located at x and is aware of both sellers buys from A if $1 - xt - p_{\mathrm{A}} \geq k - (1-x)t - p_{\mathrm{B}}$. Therefore, among the consumers who are aware of both sellers, those with $k \leq k^*(x)$ buy from A, and the rest buy from B, where

$$k^*(x) = 1 + t - 2tx - (p_{\mathrm{A}} - p_{\mathrm{B}}).$$

is the indifference curve. Based on the indifference curve, we can formulate the demand functions for both sellers and can derive the equilibrium prices and profits as summarized in the following lemma.

Lemma 4. *When the third-party seller does not join the retailer's platform, the equilibrium prices are*

$$p_{\mathrm{A}}^* = \min\left\{\frac{2}{3\psi}, 1-t\right\} \text{ and } p_{\mathrm{B}}^* = \min\left\{\frac{1}{3\psi}, \frac{1-t}{2}\right\}, \tag{14}$$

and the equilibrium profits are

$$(\pi_{\mathrm{A}}^*, \pi_{\mathrm{B}}^*) = \begin{cases} (\frac{4}{9\psi}, \frac{1}{9\psi}) & \text{if } \psi > \frac{2}{3(1-t)} \\ (\frac{2-(1-t)\psi}{2}(1-t), \frac{(1-t)^2}{4}\psi) & \text{otherwise} \end{cases}. \tag{15}$$

As in the baseline model, the equilibrium prices may take two forms, depending on A's awareness advantage. In the presence of a relatively large awareness advantage (i.e., $\psi < \frac{2}{3(1-t)}$), A optimally charges $(1-t)$, which is the optimal monopoly price under this setting, to fully exploit its exclusive demand; otherwise, A charges a lower price $\frac{2}{3\psi}$ to compete effectively with B. As in Proposition 1, we can derive the third-party seller's optimal advertising level as follows.

Proposition 7. *When the third-party seller does not join the retailer's platform, (a) the third-party seller never advertises to achieve an awareness level beyond $\bar{\psi} = \frac{2}{3(1-t)}$, even if* *advertising is free; (b) the optimal awareness level is*

$$\psi^* = \begin{cases} \frac{2}{3(1-t)} & \text{if } C'\left(\frac{2}{3(1-t)}\right) < \frac{(1-t)^2}{4} \text{ and } \frac{(1-t)^2}{4}\left(\frac{2}{3(1-t)} - \alpha\right) \geq C\left(\frac{2}{3(1-t)}\right) \\ \tilde{\psi} & \text{if } C'(\alpha) \leq \frac{(1-t)^2}{4} \leq C'\left(\frac{2}{3(1-t)}\right) \text{ and } \frac{(1-t)^2}{4}(\tilde{\psi} - \alpha) \geq C\left(\tilde{\psi}\right) \\ \alpha & \text{otherwise,} \end{cases} \tag{16}$$

where $\tilde{\psi}$ is characterized by $C'(\tilde{\psi}) = \frac{(1-t)^2}{4}$. The third-party seller's optimal payoff is $\Pi_B^* = \frac{(1-t)^2\psi^*}{4} - C(\psi^*)$.

When B joins A's platform, as in the baseline model, we can derive the equilibrium outcome similar to that in Lemma 2. In the baseline model, A's equilibrium price, $\frac{2-(1-\rho)\delta}{3-\rho}$, can be close to 1 (the optimal monopoly price under the baseline setting) when the commission rate ρ is high. In this extension, the highest price A might charge is the optimal monopoly price $(1-t)$. We thus define $\bar{\rho}$ such that $\frac{2-(1-\bar{\rho})\delta}{3-\bar{\rho}} = 1-t$, or $\bar{\rho} = \frac{1+\delta-3t}{1+\delta-t}$, which is the highest commission rate below which the equilibrium price in this extension takes the same form as in Lemma 2. When $\rho > \bar{\rho}$, A charges $1-t$. In line with the expressions in the baseline model, we can write the equilibrium prices in a uniform format as $\hat{p}_A^* = \frac{2-(1-\min\{\rho,\bar{\rho}\})\delta}{3-\min\{\rho,\bar{\rho}\}}$ and $\hat{p}_B^* = \frac{\hat{p}_A^*+\delta}{2}$. Substituting these optimal prices into Equation (5), we can derive the equilibrium profits.

Comparing the equilibrium outcomes where B joins and does not join A's platform, similar to Proposition 3, we can derive the conditions under which the partnership arises in equilibrium.

Proposition 8. *If* $\left(\frac{2-(1-t)\psi^*}{2}(1-t) - \frac{(2-\delta+\min\{\rho^*,\bar{\rho}\}\delta)(2-\delta-\min\{\rho^*,\bar{\rho}\})+(2\rho^*-1)(1+\delta)^2}{(3-\min\{\rho^*,\bar{\rho}\})^2}\right) \leq \Pi_B^* \leq \frac{(1+\delta)^2}{9}$*, then the retailer opens its platform and the third-party seller joins the platform; otherwise, the third-party seller does not join the retailer's platform and advertises on its own, where*

$$\rho^* = \begin{cases} 3 - \frac{4}{1+\sqrt{1-8(1+\delta)^{-2}\Pi_B^*}} & \text{if } 3 - \frac{4}{1+\sqrt{1-8(1+\delta)^{-2}\Pi_B^*}} \leq \bar{\rho} \\ 1-(3-\bar{\rho})^2(1+\delta)^{-2}\Pi_B^* & \text{otherwise,} \end{cases} \tag{17}$$

is the retailer's optimal commission rate and ψ^* *and* Π_{B}^* *are defined as in Proposition 7.*

As we can see from this proposition, similar to the baseline model, only when the advertising cost is low but not too low can the incentives of both parties align and the partnership arise as an equilibrium. When the advertising cost is too low or high, the third-party seller or the retailer has no incentive to partner. Therefore, the qualitative insights delivered under the baseline model carry over to the cases where the products sold by the retailer and the third-party seller are horizontally differentiated.

A.2 Correlation between Consumers' Awareness and Valuation

In the baseline model, we assume that the consumer valuation is independent of the awareness level. That is, among the ψ proportion of consumers who are aware of the third-party seller, their preferences for the retailer over the third-party seller are still uniformly distributed over [0,1]. In this extension, we differentiate consumers in terms of their probabilities of becoming aware of the third-party seller's product. For instance, consumers who have lower brand preferences are more likely to be aware of the small third-party seller. We assume that consumers with higher k have greater probabilities to be aware of B's product than consumers with lower k.

In particular, in the subgame where B does not join A's platform, when B's overall awareness level is ψ (which can be the awareness level before or after advertising), we consider that among the consumers with $k \in \left[\frac{1}{2}, 1\right]$, the awareness level is $\psi + \epsilon$, and among those with $k \in \left[0, \frac{1}{2}\right]$ the awareness level is $\psi - \epsilon$. For ease of exposition, we assume that $0 \leq \psi - \epsilon$ and $\psi + \epsilon \leq 1$. Under this setup, the awareness level is positively correlated with k, which is captured by ϵ. Everything else stays the same as in the baseline model. When $\epsilon = 0$, this extended model reduces to the baseline model.

Notice that in the subgame where B joins A's platform, the analysis and equilibrium result remain the same as in the baseline model because we assume all consumers become aware of both sellers. We next focus on the subgame where B does not join A's platform. In this subgame, similar to the baseline analysis, the consumers who are aware of both sellers buy from A as long as $1 - p_{\mathrm{A}} \geq k - p_{\mathrm{B}}$. Therefore, among all consumers who are aware of both sellers, the ones with $k \leq 1 - (p_{\mathrm{A}} - p_{\mathrm{B}})$ buy from A, and the rest buy from B. Under

B's awareness level ψ, we can formulate B's demand function as

$$D_{\mathrm{B}}(p_{\mathrm{B}},p_{\mathrm{A}})=\begin{cases}(\psi+\epsilon)(p_{\mathrm{A}}-p_{\mathrm{B}}) & \text{if } p_{\mathrm{A}}-p_{\mathrm{B}}\le\frac{1}{2}\\ \epsilon+(\psi-\epsilon)(p_{\mathrm{A}}-p_{\mathrm{B}}) & \text{if } p_{\mathrm{A}}-p_{\mathrm{B}}>\frac{1}{2}.\end{cases}$$

Because the consumers with a relatively high valuation of the third-party seller's product are more likely aware of the product, B's demand is higher than it is in the baseline analysis, provided the prices are the same.

We conjecture and can verify that, in equilibrium, $p_{\mathrm{A}}^*-p_{\mathrm{B}}^*\le\frac{1}{2}$. We can formulate the sellers' profit functions as

$$\begin{aligned}\pi_{\mathrm{A}}\left(p_{\mathrm{A}},p_{\mathrm{B}}\right) &= \left[1-(\psi+\epsilon)+(\psi+\epsilon)\left(1-(p_{\mathrm{A}}-p_{\mathrm{B}})\right)\right]p_{\mathrm{A}}\\ \pi_{\mathrm{B}}\left(p_{\mathrm{B}},p_{\mathrm{A}}\right) &= (\psi+\epsilon)\left(p_{\mathrm{A}}-p_{\mathrm{B}}\right)p_{\mathrm{B}}.\end{aligned}\tag{18}$$

Based on the best-response functions, we can derive the equilibrium prices as follows:

$$p_{\mathrm{A}}^*=\min\left\{\tfrac{2}{3(\psi+\epsilon)},1\right\}\quad\text{and}\quad p_{\mathrm{B}}^*=\min\left\{\tfrac{1}{3(\psi+\epsilon)},\tfrac{1}{2}\right\}.\tag{19}$$

By substituting the equilibrium prices into the profit functions in Equation (18), we can obtain the equilibrium profits as follows:

$$(\pi_{\mathrm{A}}^*,\pi_{\mathrm{B}}^*)=\begin{cases}\left(\frac{4}{9(\psi+\epsilon)},\frac{1}{9(\psi+\epsilon)}\right) & \text{if } \psi>\frac{2}{3}-\epsilon\\ \left(\frac{2-\psi-\epsilon}{2},\frac{\psi+\epsilon}{4}\right) & \text{otherwise.}\end{cases}\tag{20}$$

As in Lemma 1, when B's awareness level is low, A simply charges a monopoly price, whereas when B's awareness level is high, A competes aggressively with B and charges a lower price. The effect of the correlation on B's profit (captured by ϵ) is opposite in these two scenarios. Compared to the baseline case, when B's awareness level is low, B benefits but A is hurt by the correlation ϵ because A does not compete aggressively with B and B's demand is enhanced by ϵ. In contrast, when B's awareness level is high, both sellers are hurt by the correlation ϵ. Notice that in this scenario, A competes aggressively with B. Because consumers aware of both sellers are more clustered on the turf that the two sellers compete for, the competition is more intense than in the baseline model. As a result, both sellers are hurt by the correlation.

Similar to Lemma 3 and Proposition 1 in the paper, we can derive the third-party seller's optimal advertising decision.

Proposition 9. *When the third-party seller does not join the retailer's platform, (a) the third-party seller never advertises to achieve an awareness level beyond $\bar{\psi} = \frac{2}{3} - \epsilon$, even if advertising is free; (b) the optimal awareness level is*

$$\psi^* = \begin{cases} \frac{2}{3} - \epsilon & \text{if } C'\left(\frac{2}{3} - \epsilon\right) < \frac{1}{4} \text{ and } \frac{1}{4}\left(\frac{2}{3} - \epsilon - \alpha\right) \geq C\left(\frac{2}{3} - \epsilon\right) \\ \tilde{\psi} & \text{if } C'(\alpha) \leq \frac{1}{4} \leq C'\left(\frac{2}{3} - \epsilon\right) \text{ and } \frac{1}{4}\left(\tilde{\psi} - \alpha\right) \geq C\left(\tilde{\psi}\right) \\ \alpha & \text{otherwise,} \end{cases} \tag{21}$$

where $\tilde{\psi}$ is characterized by $C'(\tilde{\psi}) = \frac{1}{4}$. The third-party seller's optimal payoff is $\Pi_{\mathrm{B}}^* = \frac{\psi^* + \epsilon}{4} - C(\psi^*)$.

As in the baseline analysis, the optimal advertising level is the result of balancing the marginal benefit of an increase in the awareness level and the marginal cost of advertising.

Similar to Proposition 3 in the paper, we can derive the conditions under which both the retailer and the third-party seller have an incentive to partner.

Proposition 10. *If $\left(\frac{2-\psi^*-\epsilon}{2} - \frac{3+\rho^*\delta^2-(6-\rho^*)(1-\rho^*)\delta}{(3-\rho^*)^2}\right) \leq \Pi_{\mathrm{B}}^* \leq \frac{(1+\delta)^2}{9}$, then the retailer opens its platform and the third-party seller joins the platform; otherwise, the third-party seller does not join the platform and advertises on its own, where $\rho^* = 3 - \frac{4}{1+\sqrt{1-8(1+\delta)^{-2}\Pi_{\mathrm{B}}^*}}$ is the retailer's optimal commission rate and ψ^* and Π_{B}^* are defined in Proposition 9.*

As in Proposition 3 in the paper, the condition on the upper bound in Proposition 10 requires that B's optimal payoff if it does not join A's platform should be no more than its profit from joining A's platform without a commission fee. This condition ensures that B can be induced to join A's platform with a feasible commission rate. The condition on the lower bound in Proposition 10 requires that the value of B's outside option of using low-cost advertising is high enough that A is better off allowing B to sell on its platform and earning commission because A's awareness advantage could be significantly reduced anyway. This condition ensures that A has an incentive to open its platform.

As in the baseline model analysis, the two conditions essentially require that the advertising cost be not too low and not too high. The conditions imply that only when the advertising cost is low but not too low can the two sellers' incentives align and the partnership between them emerge as an equilibrium. Therefore, the insights remain qualitatively the same as in the baseline model.

The only difference lies in the role that the correlation, ϵ, plays in these two conditions. Compared to the baseline model, because B's demand is enhanced by the correlation when not joining A's platform (i.e., the consumers with a relatively high valuation of B's product are more likely aware of the product), B has less incentive to join A's platform, and the retailer has more incentive to open its platform. The increase in the retailer's incentive can be more significant than the decrease in the third-party seller's incentive. As a result, the partnership could still be more likely to occur.

A.3 Advertising Budget Constraints

In this extension, we consider that the third-party seller has an advertising budget constraint M ($M > 0$), which is the maximum amount of money that can be used for advertising. For ease of exposition, we consider a linear advertising cost function, $C(\psi) = \mu(\psi - \alpha) + f$. Everything else remains the same as in the baseline model.

In the subgame where B does not join A's platform, given B's awareness level ψ, the equilibrium outcome of price competition remains the same as in Lemma 1. However, unlike the baseline model, when B chooses its optimal awareness level, it faces a budget constraint. Because of the budget constraint, B may have to choose a suboptimal awareness level (lower than without the budget constraint), even when the marginal benefit of advertising is relatively high (compared to the marginal cost). Similar to Proposition 1, we characterize the third-party seller's optimal choice of advertising and the resulting payoff as follows.

Corollary 2. *In the presence of a budget constraint and a linear advertising cost* $C(\psi) = \mu(\psi - \alpha) + f$*, when the third-party seller does not join the retailer's platform, the* *third-party seller's optimal awareness level is*

$$\psi^* = \begin{cases} \alpha & \textit{if } \mu + \frac{3f}{2-3\alpha} > \frac{1}{4} \textit{ or } M < \frac{f}{1-4\mu} \\ \min\left\{\frac{2}{3}, \frac{M-f}{\mu} + \alpha\right\} & \textit{otherwise,} \end{cases} \tag{22}$$

and its optimal payoff is

$$\Pi_{\mathrm{B}}^* = \frac{\psi^*}{4} - \mu(\psi^* - \alpha) - f. \tag{23}$$

In the subgame where B joins A's platform, the equilibrium outcome of price competition remains the same as in Lemma 2. Comparing the equilibrium outcome when B joins A's platform and when B does not join, similar to Corollary 1, we can derive the conditions under which the partnership arises in equilibrium.

Corollary 3. *In the presence of a budget constraint and a linear advertising cost $C(\psi) = \mu(\psi - \alpha) + f$, in equilibrium, (a) if $\frac{1}{4} < \mu + \frac{3f}{2-3\alpha}$ or $M < \frac{f}{1-4\mu}$, the third-party seller does not join the retailer's platform and does not advertise; (b) if $M \geq \mu(\frac{1}{2} - \alpha - \frac{\delta^2}{2}) + f$ and $\underline{\mu} < \mu \leq \frac{1}{4} - \frac{3f}{2-3\alpha}$, the third-party seller joins the platform; (c) otherwise, the third-party seller simply advertises on its own and does not join the platform, where $\underline{\mu}$ is the solution to*

$$\tfrac{1}{2}\left[-7 - 5\delta + 2\psi^* + (3+\delta)\sqrt{5 + 4\delta - 2\psi^*}\right] = \tfrac{\psi^*}{4} - \mu(\psi^* - \alpha) - f \ ,$$

and $\psi^* = \min\left\{\frac{2}{3}, \frac{M-f}{\mu} + \alpha\right\}$.

When the budget is high enough (i.e., $M \geq \mu\left(\frac{2}{3} - \alpha\right) + f$, as shown in Corollary 2), the case with a budget constraint is equivalent to the baseline case, and thus the above Corollary 3 reduces to Corollary 1. The main difference between this extension and the baseline setting lies in the scenarios where the third-party seller has a low budget. In particular, when the advertising budget is very limited (e.g., $M < \mu(\frac{1}{2} - \alpha - \frac{\delta^2}{2}) + f$), even in the presence of low-cost advertising, the awareness level that the third-party seller can afford is significantly lower than the optimal level that would have been chosen under an unconstrained budget. Consequently, the low awareness level resulting from a low budget cannot create enough competitive pressure to incentivize the retailer to open its platform.

In general, a low advertising budget prevents the third-party seller from effectively increasing its awareness level to compete with the retailer. As a result, compared to the cases without a budget constraint or with a high budget, a low budget gives the retailer less incentive to open its platform but gives the third-party seller more incentive to join the retailer's platform.

As illustrated in Corollary 3, the insights from the baseline model continue to hold. When the advertising cost is high, the third-party seller has no incentive to advertise; and when the advertising cost is low, the third-party seller is better off advertising on its own. In these two cases, the retailer's and the third-party seller's incentives for partnership cannot be aligned. Only when the advertising cost is low but not too low can the incentives align and the partnership arise in equilibrium. In the presence of an advertising budget constraint, the budget moderates the effect of the advertising option: The budget constraint limits the third-party seller's value of advertising and reduces the threat of the advertising option to the retailer, giving the former more incentive but the latter less incentive to form a partnership.

A.4 Alternative Sales Outlet

Both new-media advertising and online trading platforms (e.g., eBay.com) are new means to empower small sellers to reach large numbers of potential consumers. In this subsection, we consider that the third-party seller might choose an alternative platform as the sales outlet, instead of using new-media advertising to increase awareness of its product. We assume that the alternative platform can increase the third-party seller's awareness to ψ_o and that it charges a commission rate ρ_o for each unit sale. For ease of exposition, we assume that $\alpha \leq \psi_o \leq \frac{2}{3}$. The case of $\psi_o > \frac{2}{3}$ can be similarly analyzed, and the insights remain the same.

In the subgames where B joins A's platform and where B does not join A's or the alternative platform, the equilibrium outcome remains the same as in the baseline model (in Lemmas 2 and 1). In the subgame where B joins the alternative platform, B pays commission rate ρ_o to the platform for each unit sale. The competing demand for A and B becomes ψ_o, and the exclusive demand for A becomes $1-\psi_o$. The two sellers' profit functions can thus be formulated as

$$\pi_{\mathrm{A}}\left(p_{\mathrm{A}}, p_{\mathrm{B}}\right)=\left(1-\psi_o\right) p_{\mathrm{A}}+\psi_o p_{\mathrm{A}}\left[1-\left(p_{\mathrm{A}}-p_B\right)\right] \tag{24}$$

$$\pi_{\mathrm{B}}\left(p_{\mathrm{B}}, p_{\mathrm{A}}\right)=\psi_o(1-\rho_o) p_{\mathrm{B}}\left(p_{\mathrm{A}}-p_{\mathrm{B}}\right). \tag{25}$$

Following the same approach as in the baseline model, we can derive the equilibrium. The equilibrium prices and A's profit take the same forms as in Lemma 1 by substituting ψ with ψ_o. B's equilibrium profit becomes $(1-\rho_o)\frac{\psi_o}{4}$.

In Stage 2, if B does not join A's platform, B chooses whether to participate in the alternative platform by trading off the cost of its commission fee against the benefit from an awareness increase. Intuitively, when the commission rate is very high, B is better off not joining the alternative platform. Only when the commission rate is low enough (i.e., $\rho_o \leq 1-\frac{\alpha}{\psi_o}$) does B have an incentive to join. Accordingly, B's equilibrium profit is as follows:

$$\Pi_{\mathrm{B}}^{*}=\begin{cases}(1-\rho_o)\frac{\psi_o}{4} & \text{if } \rho_o \leq 1-\frac{\alpha}{\psi_o} \\ \frac{\alpha}{4} & \text{otherwise.}\end{cases} \tag{26}$$

In Stage 1, the retailer makes its platform-openness decision, anticipating B's choice with the alternative platform. Similar to Proposition 3 in the baseline model, we can derive the conditions under which A and B have an incentive to partner, which take the same form, except that Π_{B}^{*} is replaced with the expression in Equation (26). As in the baseline model, when the alternative platform is highly attractive (e.g., the commission rate is low enough or the awareness level is relatively high), the third-party seller might have no incentive to join the retailer's platform. When the alternative platform does not create a credible threat, the retailer might have no incentive to open its platform. Only when the alternative platform is moderately valuable to the third-party seller can both parties' incentives align and the partnership emerge in equilibrium. When these partnership conditions are not satisfied, the third-party seller joins the alternative platform or sells on its own.

Although we focus on the effect of advertising on partnership formation in this research, the qualitative insights delivered can carry over to other contexts as well, as illustrated.

Essentially, if and only if the value of the third-party seller's outside option is high, but not too high, the third-party seller's and the retailer's incentives can be aligned, and the equilibrium partnership emerges. When the outside option offers little value for the third-party seller, it does not create a credible threat to the retailer; the retailer thus keeps its platform closed. When the outside option is highly valuable, the third-party seller can simply take advantage of the outside option without partnering with the leading retailer.

A.5 Direct Advertising

In our baseline model, we assume that the third-party seller can gain exposure by either advertising through new media or joining the leading retailer's platform. We recently have witnessed a new trend: Platforms such as Amazon have started to offer advertising services to third-party sellers, including the sellers that sell the same products as the platforms. This type of direct advertising is often conducted by displaying links on the leading retailers' platforms that can redirect consumers to the third-party sellers' own websites. In this extension, we consider the scenario in which the leading retailer offers the third-party seller the chance to advertise on its platform.

The time sequence of the game in this case progresses as follows. In Stage 1, A announces the advertising fee structure $S(\psi)$ on its platform. In Stage 2, B decides where to advertise (i.e., on A's platform or with outside new media) and chooses its exposure level. In Stage 3, both sellers decide their retail prices p_{A} and p_{B}, and consumers make their purchase decisions. Following the same approach as in the baseline model, we can derive the equilibrium outcome. The following proposition highlights the main result in equilibrium.

Proposition 11. *In the presence of a low-cost advertising option, the retailer is always willing to offer direct advertising on its platform in equilibrium, and the partnership can be formed. The optimal exposure level for the third-party seller in this partnership is* $4(1+\delta)^{-2}\Pi_{\mathrm{B}}^{*}$.

Intuitively, when the new-media advertising cost is low, the third-party seller would actually advertise on new media to gain exposure, as prescribed in Proposition 1. The increased exposure could intensify the competition between the two sellers, which hurts A. Anticipating that this increased competition is coming anyway, A is better off when it opens its platform and offers direct advertising to B. For instance, A can offer the same advertising fee menu (with a slight price discount) that new media would and thus induce B both to join A's platform and to choose the same exposure level B would have targeted through new media. Doing so does not alter the competition because the chosen exposure level is the same, but the retailer makes additional profit from the advertising service. Therefore, the partnership can always be formed in this case.

Furthermore, the retailer can even optimize its advertising fee structure. After all, what induces B to join A's platform is the expected payoff—not the exposure level. For example, A can set the advertising cost to be high for a high exposure level, but it also can set the cost to be low (or even free in the extreme case) for a low exposure level. A properly designed fee structure can induce B to advertise less and pay less than it would otherwise choose with outside new media. Because controlling exposure can be an effective means to gain competitive advantage, A has room to further improve its profitability when it offers direct-advertising services to B. In equilibrium, the retailer might even induce the third-party seller to advertise on its platform to a certain exposure level and can offer that level of exposure for free to the third-party seller.

In sum, this extension and the extension on "Level of Platform Openness" demonstrate the following two important insights. First, if the third-party seller's exposure can be influenced by the leading retailer (through either direct control or proper design of the advertising cost menu) when it joins the leading retailer's platform, the partnership between the two sellers is more likely to be formed. Second, whether the outside advertising option creates a credible threat plays a critical role in determining whether the leading retailer is willing to open its platform. When the outside option is too expensive and is not a viable option for the third-party seller, the leading retailer does not open its platform, even if it can influence the exposure level on the platform. Our study underscores the importance of low-cost new-media advertising in determining both the retail platform openness and the competitive retail outcome.

References

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B Proofs

B.1 Proof of Lemma 1

Proof. B's optimal price is characterized by the first-order condition of Equation (2), where the demand function D_i is from Equation (1):

$$\frac{\mathrm{d}\pi_{\mathrm{B}}}{\mathrm{d}p_{\mathrm{B}}} = \psi\left(p_{\mathrm{A}} - p_{\mathrm{B}}\right) - \psi p_r = 0.$$

Therefore, we conclude that $p_{\mathrm{B}}^*(p_{\mathrm{A}}) = \frac{p_{\mathrm{A}}}{2}$.

A's optimal price is characterized by the first-order derivative of Equation (2):

$$\frac{\mathrm{d}\pi_{\mathrm{A}}}{\mathrm{d}p_{\mathrm{A}}} = (1-\psi) + \psi\left[1 - (p_{\mathrm{A}} - p_{\mathrm{B}})\right] - \psi p_{\mathrm{A}} = 1 - \frac{3\psi}{2}p_r,$$

where the second equality is established by substituting $p_{\mathrm{B}}^*(p_{\mathrm{A}})$. Notice that when $\psi < \frac{2}{3}$, $\frac{\mathrm{d}\pi_{\mathrm{A}}}{\mathrm{d}p_{\mathrm{A}}} > 0$ for any $p_{\mathrm{A}} \in [0,1]$, and thus $p_{\mathrm{A}}^* = 1$. When $\psi \geq \frac{2}{3}$, $p_{\mathrm{A}}^* = \frac{2}{3\psi}$ by solving $\frac{\mathrm{d}\pi_{\mathrm{A}}}{\mathrm{d}p_{\mathrm{A}}} = 0$. Together, the optimal prices p_{A}^* and p_{B}^* can be written as in Equation (3).

Therefore, if $\psi > \frac{2}{3}$, then $p_{\mathrm{A}}^* = \frac{2}{3\psi}$ and $p_{\mathrm{B}}^* = \frac{1}{3\psi}$; otherwise, $p_{\mathrm{A}}^* = 1$ and $p_{\mathrm{B}}^* = \frac{1}{2}$. Substituting these optimal prices into Equation (2), we derive the equilibrium profits as in Equation (4). □

B.2 Proof of Lemma 2

Proof. The optimal prices of A and B are characterized by the first-order conditions of π_{A} and π_{B} in Equation(5), respectively:

$$\begin{aligned} \tfrac{\mathrm{d}\pi_{\mathrm{A}}}{\mathrm{d}p_{\mathrm{A}}} &= \left[1 - \delta - (p_{\mathrm{A}} - p_{\mathrm{B}})\right] - p_{\mathrm{A}} + \rho p_{\mathrm{B}} = 0 \\ \tfrac{\mathrm{d}\pi_{\mathrm{B}}}{\mathrm{d}p_{\mathrm{B}}} &= (1-\rho)\left(\delta + p_{\mathrm{A}} - p_{\mathrm{B}}\right) - (1-\rho)p_{\mathrm{B}} = 0. \end{aligned}$$

Solving this system of equations, we can derive the equilibrium prices as in Equation (6). Substituting these optimal prices into Equation (5), we derive the equilibrium profits as in Equation (7).

Notice that A might deviate to charge a price no higher than B's. When $\hat{p}_{\mathrm{B}}^* \times 1 \leq \hat{\pi}_{\mathrm{A}}^*$, or, equivalently, when

$$\delta < \tfrac{1}{2}\left(7 - 6\rho + \rho^2 - (3-\rho)\sqrt{(5-\rho)(1-\rho)}\right), \tag{27}$$

such deviation is unprofitable, and the pricing strategy in the lemma is an equilibrium. □

B.3 Proof of Lemma 3

Proof. If $\psi \geq \frac{2}{3}$, $\pi_{\mathrm{B}}^* = \frac{1}{9\psi}$, which decreases in ψ. Therefore, even if advertising is cost-free, B never advertises to an awareness level beyond $\frac{2}{3}$. □

B.4 Proof of Proposition 1

Proof. (a) Among all $\psi \in [\alpha, \frac{2}{3}]$, the payoff function $\pi_{\mathrm{B}}^*(\psi) - C(\psi) = \frac{\psi}{4} - C(\psi)$. If B advertises, the optimal advertising level is characterized by its first-order derivative: $\frac{1}{4} - C'(\psi)$. Because $C''(\psi) \geq 0$, if $C'(\frac{2}{3}) < \frac{1}{4}$, then $C'(\psi) < \frac{1}{4}$ for all $\psi \in \left[\alpha, \frac{2}{3}\right]$, and the optimal awareness choice is $\frac{2}{3}$. If $C'(\alpha) \leq \frac{1}{4} \leq C'(\frac{2}{3})$, the optimal awareness choice is determined by $\frac{1}{4} - C'(\tilde{\psi}) = 0$. When $\frac{\psi^{\mathrm{opt}}}{4} - C(\psi^{\mathrm{opt}}) \geq \frac{\alpha}{4}$, where $\psi^{\mathrm{opt}} = \frac{2}{3}$ in the former and $\psi^{\mathrm{opt}} = \tilde{\psi}$ in the latter, B advertises; otherwise, it does not. When $C'(\alpha) > \frac{1}{4}$, the first-order derivative is negative and B does not advertise.

(b) Because $\hat{\pi}_{\mathrm{B}}^*(\rho)$ decreases in ρ, B can be induced to join A's platform only if $\Pi_{\mathrm{B}}^* \leq \hat{\pi}_{\mathrm{B}}^*(0) = \frac{(1+\delta)^2}{9}$; otherwise, B has no incentive to join under any $\rho \in [0,1]$. If $\Pi_{\mathrm{B}}^* \leq \hat{\pi}_{\mathrm{B}}^*(0)$, then because $\Pi_{\mathrm{B}}^* > \hat{\pi}_{\mathrm{B}}^*(1) = 0$, there exists a unique $\rho \in [0,1]$ that satisfies $\Pi_{\mathrm{B}}^* = \hat{\pi}_{\mathrm{B}}^*(\rho) = \frac{(1-\rho)(1+\delta)^2}{(3-\rho)^2}$. Solving this equation leads to the upper bound of the commission rate below which B has incentive to join A's platform. □

B.5 Proof of Proposition 2

Proof. (a) A's and B's incentives can be aligned only if $\hat{\pi}_{\mathrm{A}}^*(\rho) \geq \pi_{\mathrm{A}}^*(\alpha)$ and $\hat{\pi}_{\mathrm{B}}^*(\rho) \geq \pi_{\mathrm{B}}^*(\alpha)$. If these two conditions are satisfied, we should have $[\hat{\pi}_{\mathrm{A}}^*(\rho) - \pi_{\mathrm{A}}^*(\alpha)] + 2\,[\hat{\pi}_{\mathrm{B}}^*(\rho) - \pi_{\mathrm{B}}^*(\alpha)] \geq 0$. However, by substituting the equilibrium profits from Equations (4) and (7), we have

$$[\hat{\pi}_{\mathrm{A}}^*(\rho) - \pi_{\mathrm{A}}^*(\alpha)] + 2\,[\hat{\pi}_{\mathrm{B}}^*(\rho) - \pi_{\mathrm{B}}^*(\alpha)] = \frac{(\delta+1)\,[-3 + (3-\rho)\rho + \delta(3-2\rho)]}{(3-\rho)^2}. \tag{28}$$

Under Assumption (27), Equation (28) can be verified to be negative. Therefore, the two firms' incentives cannot be aligned.

(b) Showing that $\hat{\pi}^*_{\mathrm{A}}(\rho) - \pi^*_{\mathrm{A}}(\alpha) \leq \hat{\pi}^*_{\mathrm{A}}(\rho) - \pi^*_{\mathrm{A}}(\psi^*)$ is equivalent to showing that $\pi^*_{\mathrm{A}}(\alpha) \geq \pi^*_{\mathrm{A}}(\psi^*)$. By Equation (4), we notice that $\pi^*_{\mathrm{A}}(\psi)$ decreases in ψ. Because $\psi^* \geq \alpha$, $\pi^*_{\mathrm{A}}(\alpha) \geq \pi^*_{\mathrm{A}}(\psi^*)$. Showing that $\hat{\pi}^*_{\mathrm{B}}(\rho) - \pi^*_{\mathrm{B}}(\alpha) \geq \hat{\pi}^*_{\mathrm{B}}(\rho) - [\pi^*_{\mathrm{B}}(\psi^*) - C(\psi^*)]$ is equivalent to showing that $\pi^*_{\mathrm{B}}(\alpha) \leq \pi^*_{\mathrm{B}}(\psi^*) - C(\psi^*)$, which is true because ψ^* is B's optimal awareness level after balancing the benefits and costs of advertising. $\square$

B.6 Proof of Proposition 3

Proof. Based on Proposition 1, B can be induced to join A's platform only if $\Pi^*_{\mathrm{B}} \leq \frac{(1+\delta)^2}{9}$. Because $\hat{\pi}^*_{\mathrm{A}}(\rho)$ increases and $\hat{\pi}^*_{\mathrm{B}}(\rho)$ decreases in ρ, under this condition, if A is opening, it chooses ρ^* such that $\Pi^*_{\mathrm{B}} = \hat{\pi}^*_{\mathrm{B}}(\rho^*)$, and this choice leads to ρ^* in the proposition. Under ρ^*, A opens its platform when $\pi^*_{\mathrm{A}}(\psi^*) \leq \hat{\pi}^*_{\mathrm{A}}(\rho^*)$ or, equivalently, when $\pi^*_{\mathrm{A}}(\psi^*) - [\hat{\pi}^*_{\mathrm{A}}(\rho^*) - \hat{\pi}^*_{\mathrm{B}}(\rho^*)] \leq \Pi^*_{\mathrm{B}}$, leading to the condition on the lower bound in the proposition. $\square$

B.7 Proof of Corollary 1

Proof. (a) According to Proposition 1, when B does not join A's platform, if $C'(\psi) = \mu > \frac{1}{4}$, then $\psi^* = \alpha$; if $C'(\psi) = \mu \leq \frac{1}{4}$, the optimal awareness would be $\frac{2}{3}$, and B advertises if and only if $\frac{1}{4}(\frac{2}{3} - \alpha) \geq \mu(\frac{2}{3} - \alpha) + f$. Therefore, when $\frac{1}{4} < \mu + \frac{3f}{2-3\alpha}$, B does not advertise, which is equivalent to the case without the low-cost advertising option. In this case, according to Proposition 2, A's and B's incentives cannot be aligned, and B does not appear on A's platform.

(b) and (c) If $\mu + \frac{3f}{2-3\alpha} \leq \frac{1}{4}$, when B does not join A's platform, $\psi^* = \frac{2}{3}$. A is willing to open its platform if $\hat{\pi}^*_{\mathrm{A}}(\rho) \geq \pi^*_{\mathrm{A}}\left(\frac{2}{3}\right)$. Because $\hat{\pi}^*_{\mathrm{A}}(\rho)$ increases in ρ, the lowest commission rate that A might charge, ρ_1, satisfies $\hat{\pi}^*_{\mathrm{A}}(\rho) = \pi^*_{\mathrm{A}}(\frac{2}{3})$. By Lemmas 1 and 2, we can derive $\rho_1 = \frac{9+15\delta-\sqrt{3(11+12\delta)(1+\delta)^2}}{4+6\delta}$. Because $\hat{\pi}^*_{\mathrm{B}}(\rho)$ decreases in ρ, when $\hat{\pi}^*_{\mathrm{B}}(\rho) \geq \pi^*_{\mathrm{B}}\left(\frac{2}{3}\right) - C\left(\frac{2}{3}\right)$ or, equivalently, when $\frac{(1-\rho)(1+\delta)^2}{(3-\rho)^2} \geq \frac{1}{6} - \mu(\frac{2}{3} - \alpha) - f$, then B has an incentive to join A's platform. By substituting ρ_1 into this inequality, we can derive that when the advertising cost is as specified in Corollary 1(b), B has an incentive to join A's platform; otherwise, B has no incentive to join. $\square$

B.8 Proof of Proposition 4

Proof. In the case that B advertises on its own, when $\psi \le \frac{2}{3}$, we have $p_{\mathrm{A}}^{*} = 1$ by Lemma 1. Thus, the consumer surplus of the consumers who purchase from A is zero, and the consumer surplus of those who purchase from B is the total consumer surplus; that is,

$$CS\left(\psi\right) = \psi \int_{1-\left(p_{\mathrm{A}}^{*}-p_{\mathrm{B}}^{*}\right)}^{1} \left(k - p_{\mathrm{B}}^{*}\right) \mathrm{d}k = \psi \int_{\frac{1}{2}}^{1} \left(k - \tfrac{1}{2}\right) \mathrm{d}k = \tfrac{\psi}{8}, \tag{29}$$

where $1 - (p_{\mathrm{A}}^{*} - p_{\mathrm{B}}^{*})$ is the threshold above which the consumers aware of both offerings purchase from B rather than from A, and the second equality is because $p_{\mathrm{B}}^{*} = \frac{1}{2}$ (by Lemma 1). $CS\left(\alpha\right) \le CS\left(\psi^{*}\right)$ because $\alpha \le \psi^{*}$ and $\psi^{*} \le \frac{2}{3}$ (by Proposition 1).

In the case of partnership, we notice that

$$\begin{aligned} CS(1) &= \int_{0}^{\frac{2-\rho-\delta}{3-\rho}} \left(1 - \tfrac{2-\delta+\rho\delta}{3-\rho}\right) \mathrm{d}x + \int_{\frac{2-\rho-\delta}{3-\rho}}^{1} \left(\min\{k+\delta, 1\} - \tfrac{1+\delta}{3-\rho}\right) \mathrm{d}k \\ &= \tfrac{(2-\rho-\delta)(1-\rho+\delta-\rho\delta)}{(3-\rho)^2} + \tfrac{\delta(2-\delta-\rho)}{3-\rho} + \tfrac{(1-2\delta+\rho\delta))(3-2\rho-\rho\delta)}{2(3-\rho)^2} = \tfrac{7-8\rho+2\rho^2+2\delta(2-\rho)^2-(4-\rho)(2-\rho)\delta^2}{2(3-\rho)^2} \end{aligned}$$

where the first equality comes from substituting $\hat{p}_{\mathrm{A}}^{*}$ and $\hat{p}_{\mathrm{B}}^{*}$ derived in Lemma 2 into Equation (9). Because $CS(1)$ increases in δ when δ is small (i.e., $\delta < \frac{2-\rho}{4-\rho}$), $CS(\psi)$ increases in ψ (by Equation (29)), and $\psi^{*} \le \frac{2}{3}$ (by Proposition 1), to establish $CS\left(\psi^{*}\right) \le CS\left(1\right)$, it is sufficient to show that

$$CS(\tfrac{2}{3}) = \tfrac{1}{12} \le \tfrac{7-8\rho+2\rho^2}{2(3-\rho)^2} = CS(1)|_{\delta=0}$$

or, equivalently, that $(3-\rho)^2 \le 6(7-8\rho+2\rho^2)$, which is true for any $\rho \in [0,1]$. $\square$

B.9 Proof of Proposition 5

Proof. Following the same approach as for Lemma 1, we can derive p_{A}^{*} and p_{B}^{*} as in Equation (11). Substituting them into Equation (10), we derive the equilibrium profits as follows:

$$(\pi_{\mathrm{A}}^{*}(\psi,\rho), \pi_{\mathrm{B}}^{*}(\psi,\rho)) = \begin{cases} \left(\frac{[2-(1-\rho)\delta\psi](2-\rho-\delta\psi)+\rho(1+\delta\psi)^2}{(3-\rho)^2\psi}, \frac{(1-\rho)(1+\delta\psi)^2}{(3-\rho)^2\psi}\right) & \text{if } \psi > \tilde{\psi}(\rho) \\ \left(\frac{4-(1+\delta)(2-\rho-\rho\delta)\psi}{4}, \frac{(1-\rho)(1+\delta)^2\psi}{4}\right) & \text{otherwise,} \end{cases} \tag{30}$$

where $\tilde{\psi}(\rho) \equiv \frac{2}{(3-\rho)+(1-\rho)\delta}$. Similar to that for Lemma 2, we can verify that $\pi_{\rm A}^*(\psi,\rho)$ increases and $\pi_{\rm B}^*(\psi,\rho)$ decreases in ρ. Similar to that for Lemma 1, both $\pi_{\rm A}^*(\psi,\rho)$ and $\pi_{\rm B}^*(\psi,\rho)$ decrease in ψ if $\psi > \tilde{\psi}(\rho)$; otherwise, $\pi_{\rm A}^*(\psi,\rho)$ decreases and $\pi_{\rm B}^*(\psi,\rho)$ increases in ψ.

Under the assumption that $\underline{\psi} \leq \frac{2}{3+\delta}$, because $\pi_{\rm B}^*(\frac{2}{3+\delta},0) \geq \Pi_{\rm B}^*$, B can be induced to join A's platform. Because $\pi_{\rm A}^*(\psi,\rho)$ increases and $\pi_{\rm B}^*(\psi,\rho)$ decreases in ρ, if A opens its platform, then under A's optimal choice, $\pi_{\rm B}^*(\psi,\rho) = \Pi_{\rm B}^*$. In region $\psi \leq \tilde{\psi}(\rho)$, by Equation (30), A's objective function can be formulated as

$$\begin{aligned} \max_{\{\psi,\rho\}} \tfrac{4-(1+\delta)(2-\rho-\rho\delta)\psi}{4} \quad &= \quad \max_{\{\psi,\rho\}} \tfrac{4-(1-\delta^2)\psi}{4} - \Pi_{\rm B}^* \\ &\text{s.t.} \quad \tfrac{(1-\rho)(1+\delta)^2\psi}{4} = \Pi_{\rm B}^* \text{ and } \psi \geq \underline{\psi} \end{aligned}.$$

Because $\frac{4-(1-\delta^2)\psi}{4}$ decreases in ψ, the optimal ψ is the lowest one within the two constraints. When $\underline{\psi} \leq 4(1+\delta)^{-2}\Pi_B^*$, $\psi_o^* = 4(1+\delta)^{-2}\Pi_{\rm B}^*$ and $\rho_o^* = 0$; otherwise, $\psi_o^* = \underline{\psi}$ and $\rho_o^* = 1 - \frac{4}{\underline{\psi}}(1+\delta)^{-2}\Pi_{\rm B}^*$. In region $\psi \geq \tilde{\psi}(\rho)$, because both $\pi_{\rm A}^*(\psi,\rho)$ and $\pi_{\rm B}^*(\psi,\rho)$ decrease in ψ, the optimal solution lies at the intersection of the curves $\psi = \tilde{\psi}(\rho)$ and $\pi_{\rm B}^*(\psi,\rho) = \Pi_{\rm B}^*$. Because this optimal solution lies on the curve $\psi = \tilde{\psi}(\rho)$, it is dominated by the optimal solution in region $\psi \leq \tilde{\psi}(\rho)$.

Under (ψ_o^*, ρ_o^*), A opens its platform if $\pi_{\rm A}^*(\psi^*) \leq \pi_{\rm A}^*(\psi_o^*,\rho_o^*)$ or, equivalently, if $\pi_{\rm A}^*(\psi^*) - [\pi_{\rm A}^*(\psi_o^*,\rho_o^*) - \pi_{\rm B}^*(\psi_o^*,\rho_o^*)] \leq \Pi_{\rm B}^*$, leading to the condition in the proposition. Note that ψ_o^* is either $\underline{\psi}$ or $4(1+\delta)^{-2}\Pi_{\rm B}^*$, and thus it (weakly) increases in $\Pi_{\rm B}^*$. Because $4\Pi_{\rm B}^* \leq \frac{2}{3}$ by Proposition 1, $\psi_o^* < 1$. □

B.10 Proof of Proposition 6

Proof. (a) First, we notice that the upper bound in the partnership conditions, $\frac{(1+N)(1+\delta)^2}{9}$, increases in N. Second, the lower bound, $(\frac{2-\psi^*}{2} - \frac{(1+N)[3+\rho^*\delta^2-(6-\rho^*)(1-\rho^*)\delta]}{(3-\rho^*)^2})$, decreases in N, because $\frac{3+\rho\delta^2-(6-\rho)(1-\rho)\delta}{(3-\rho)^2}$ increases in ρ and ρ^* increases in N (by noting that ρ^* is determined by $\Pi_{\rm B}^* = \hat{\pi}_{\rm B}^*(\rho) = \frac{(1-\rho)(1+N)(1+\delta)^2}{(3-\rho)^2}$ and $\frac{(1-\rho)}{(3-\rho)^2}$ decreases in ρ). Therefore, when N increases, both the upper bound and lower bound conditions are relatively easy to satisfy, and the partnership is more likely to be formed.

(b) In the absence of the low-cost advertising option, $\psi^* = \alpha$. Because the upper bound increases and the lower bound decreases in N, both conditions can be satisfied when N is large enough. □

B.11 Proof of Lemma 4

Proof. First, we derive A's optimal monopoly price. Under any $p \leq 1-t$, all consumers purchase, and the optimal price is $1-t$. Under any $p \geq 1-t$, the consumers with $1-xt-p \geq 0$ purchase, and thus the demand is $\frac{1-p}{t}$. In this case, because the profit function, $\frac{(1-p)p}{t}$, decreases in p for $p > \frac{1}{2}$, when t is small (e.g., $t \leq \frac{1}{3}$), the optimal price is $1-t$ among all $p \geq 1-t$. The optimal monopoly price thus is $1-t$. We can verify that in the presence of competition, A has no incentive to charge a price higher than its optimal monopoly price. We next consider $p_A \leq 1-t$.

Under $p_{\mathrm{A}} \in [0, 1-t]$, when $k^*(0) \leq 1$ and $k^*(1) \geq 0$, we can derive B's demand as

$$D_{\mathrm{B}}(p_{\mathrm{B}}, p_{\mathrm{A}}) = \psi \int_0^1 (1 - k^*(x))\mathrm{d}x = \psi(p_{\mathrm{A}} - p_{\mathrm{B}}),$$

which takes the same form as B's demand in the baseline model. Therefore, the demand and profit functions for both sellers remain the same as in Equations (1) and (2), respectively. As in the proof of Lemma 1, we have $p_{\mathrm{B}}^*(p_{\mathrm{A}}) = \frac{p_{\mathrm{A}}}{2}$ and $\frac{\mathrm{d}\pi_{\mathrm{A}}}{\mathrm{d}p_{\mathrm{A}}} = 1 - \frac{3\psi}{2}p_{\mathrm{A}}$. When $\psi < \frac{2}{3(1-t)}$, $\frac{\mathrm{d}\pi_{\mathrm{A}}}{\mathrm{d}p_{\mathrm{A}}} > 0$ for any $p_{\mathrm{A}} \in [0, 1-t]$, and thus $p_{\mathrm{A}}^* = 1-t$. When $\psi \geq \frac{2}{3(1-t)}$, $p_{\mathrm{A}}^* = \frac{2}{3\psi}$ by solving $\frac{\mathrm{d}\pi_{\mathrm{A}}}{\mathrm{d}p_{\mathrm{A}}} = 0$. Together, the optimal prices p_{A}^* and p_{B}^* can be written as in Equation (14). Substituting these optimal prices into Equation (2), we derive the equilibrium profits as in Equation (15).

When t is small (e.g., $t \leq \frac{1}{3}$), we can verify that $k^*(0) = (1+t) - \frac{p_{\mathrm{A}}^*}{2} \leq 1$ and $k^*(1) = (1-t) - \frac{p_{\mathrm{A}}^*}{2} > 0$ under the equilibrium prices. We can also verify that neither firm has an incentive to deviate from the equilibrium prices. □

B.12 Proof of Proposition 7

Proof. The proof is similar to that of Proposition 1 and thus is omitted. □

B.13 Proof of Proposition 8

Proof. First, we derive the equilibrium outcome for the subgame where B joins A's platform. As in the proof of Lemma 2, $\hat{p}_{\mathrm{B}}^* = \frac{p_{\mathrm{A}}^* + \delta}{2}$, and A optimally charges $\frac{2-(1-\rho)\delta}{3-\rho}$ when ρ

is low. Different from the baseline model, when ρ is high, such that $\frac{2-(1-\rho)\delta}{3-\rho} \geq 1-t$, A optimally charges $(1-t)$, its optimal monopoly price. Altogether, $\hat{p}_{\mathrm{A}}^{*} = \frac{2-(1-\min\{\rho,\bar{\rho}\})\delta}{3-\min\{\rho,\bar{\rho}\}}$. Substituting these optimal prices into Equation (5), we derive the equilibrium profits as

$$\begin{aligned} \hat{\pi}_{\mathrm{A}}^{*} &= \tfrac{(2-\delta+\min\{\rho,\bar{\rho}\}\delta)(2-\delta-\min\{\rho,\bar{\rho}\})+(1+\delta)^2\rho}{(3-\min\{\rho,\bar{\rho}\})^2} \\ \hat{\pi}_{\mathrm{B}}^{*} &= \tfrac{(1-\rho)(1+\delta)^2}{(3-\min\{\rho,\bar{\rho}\})^2}. \end{aligned} \tag{31}$$

When t is small (e.g., $t \leq \frac{1}{3}$), we can verify that $k^*(0) = (1+t) - \frac{p_{\mathrm{A}}^*}{2} \leq 1$ and $k^*(1) = (1-t) - \frac{p_{\mathrm{A}}^*}{2} > 0$ under the equilibrium prices. We can also verify that neither firm has an incentive to deviate from the equilibrium prices.

Because $\hat{\pi}_{\mathrm{B}}^{*}(\rho)$ decreases in ρ, A can induce B to join its platform only if $\Pi_{\mathrm{B}}^{*} \leq \hat{\pi}_{\mathrm{B}}^{*}(0) = \frac{(1+\delta)^2}{9}$; otherwise, B has no incentive to join under any $\rho \in [0,1]$. If $\Pi_{\mathrm{B}}^{*} \leq \hat{\pi}_{\mathrm{B}}^{*}(0)$, then because $\Pi_{\mathrm{B}}^{*} > \hat{\pi}_{\mathrm{B}}^{*}(1) = 0$, a unique $\rho \in [0,1]$ exists that satisfies $\Pi_{\mathrm{B}}^{*} = \hat{\pi}_{\mathrm{B}}^{*}(\rho) = \frac{(1-\rho)(1+\delta)^2}{(3-\min\{\rho,\bar{\rho}\})^2}$. Solving this equation leads to ρ^* as in Equation (17). Because ρ^* is the highest commission rate under which B can be induced to join A's platform and because $\hat{\pi}_{\mathrm{A}}^{*}(\rho)$ increases in ρ, ρ^* is the optimal commission rate. Under ρ^*, A opens its platform if $\pi_{\mathrm{A}}^{*}(\psi^*) \leq \hat{\pi}_{\mathrm{A}}^{*}(\rho^*)$ or, equivalently, if $\pi_{\mathrm{A}}^{*}(\psi^*) - [\hat{\pi}_{\mathrm{A}}^{*}(\rho^*) - \hat{\pi}_{\mathrm{B}}^{*}(\rho^*)] \leq \Pi_{\mathrm{B}}^{*}$, leading to the condition on the lower bound in the proposition. □

B.14 Proof of Proposition 9

Proof. The proof is similar to that of Proposition 1 and thus is omitted. □

B.15 Proof of Proposition 10

Proof. The proof is similar to that of Proposition 3 and thus is omitted. □

B.16 Proof of Corollary 2

Proof. By Proposition 1, B never advertises to achieve an awareness level beyond $\frac{2}{3}$. Among all $\psi \in \left[\alpha, \frac{2}{3}\right]$, by Corollary 1, if $\frac{1}{4} < \mu + \frac{3f}{2-3\alpha}$, B does not advertise and $\psi^* = \alpha$. Otherwise, when B does advertise, it would choose the awareness level either at the upper bound of the interval (i.e., $\frac{2}{3}$) if the budget is not binding or at the level that uses up the budget (i.e., $\frac{M-f}{\mu} + \alpha$), because, by $\pi_{\mathrm{B}}^{*}(\psi) - C(\psi) = \frac{\psi}{4} - \mu(\psi - \alpha) - f$, B's payoff increases in ψ. The former is the high-budget case, which is the same as the case without budget constraints and with B's advertising. The latter is the low-budget case, such that $\frac{M-f}{\mu}+\alpha<\frac{2}{3}$, and B chooses to advertise if and only if

$$\frac{1}{4}\left(\frac{M-f}{\mu}+\alpha\right)-M\geq\frac{\alpha}{4}$$

or, equivalently, if and only if $M\geq\frac{f}{1-4\mu}$. Altogether, we can write the optimal awareness level as in Equation (22) and the optimal payoff as in Equation (23). □

B.17 Proof of Corollary 3

Proof. (a) The proof is the same as for Corollary 2.

(b) and (c) When B does not join A's platform and advertises, $\psi^*=\min\left\{\frac{2}{3},\frac{M-f}{\mu}+\alpha\right\}$ by Corollary 2. A is willing to open its platform if

$$\hat{\pi}_{\mathrm{A}}^*(\rho)=\frac{4-\rho+\delta^2-(4-\rho)(1-\rho)\delta}{(3-\rho)^2}\geq\pi_{\mathrm{A}}^*(\psi^*)=\frac{2-\min\left\{\frac{2}{3},\frac{M-f}{\mu}+\alpha\right\}}{2},\tag{32}$$

where the equality is by Lemmas 1 and 2. Because $\hat{\pi}_{\mathrm{A}}^*(\rho)$ increases in ρ, Inequality (32) is possible only if $\hat{\pi}_{\mathrm{A}}^*(1)\geq\pi_{\mathrm{A}}^*(\psi^*)$, or, equivalently, only if $M\geq f+\mu(\frac{1}{2}-\alpha-\frac{\delta^2}{2})$.

We next consider $M\geq f+\mu(\frac{1}{2}-\alpha-\frac{\delta^2}{2})$. Because $\hat{\pi}_{A}^*(\rho)$ increases in ρ, the lowest commission rate that A might charge, ρ_1, satisfies $\frac{4-\rho+\delta^2-(4-\rho)(1-\rho)\delta}{(3-\rho)^2}=\pi_{\mathrm{A}}^*$, which leads to $\rho_1=\frac{(6\pi_{\mathrm{A}}^*-1+5\delta)-(1+\delta)\sqrt{4\pi_{\mathrm{A}}^*+4\delta+1}}{2(\pi_{\mathrm{A}}^*+\delta)}$. Because $\hat{\pi}_{\mathrm{B}}^*(\rho)$ decreases in ρ, when $\hat{\pi}_{\mathrm{B}}^*(\rho)=\frac{(1-\rho)(1+\delta)^2}{(3-\rho)^2}\geq\frac{\psi^*}{4}-\mu(\psi^*-\alpha)-f$, B has an incentive to join A's platform. By substituting ρ_1 into this inequality, we can derive that when μ is as small as is specified in Corollary 3(b), B has an incentive to join A's platform; otherwise, B has no incentive to join. □

B.18 Proof of Proposition 11

Proof. In Stage 2 of the game, when B advertises with new media, the optimal payoff is Π_{B}^*, defined in Proposition 1. Similarly, provided that $S'(\psi)\geq 0$ and $S''(\psi)\geq 0$, when B advertises on A's platform, B's profit function is prescribed as in Equation (30) by letting

$\rho = 0$, and the optimal payoff is $\frac{(1+\delta)^2\psi_{\mathrm{d}}^*}{4} - S(\psi_{\mathrm{d}}^*)$, where

$$\psi_{\mathrm{d}}^* = \begin{cases} \frac{2}{3+\delta} & \text{if } S'\left(\frac{2}{3+\delta}\right) < \frac{(1+\delta)^2}{4} \text{ and } \frac{(1+\delta)^2}{4}\frac{2}{3+\delta} - \frac{\alpha}{4} \geq S\left(\frac{2}{3+\delta}\right) \\ \tilde{\psi} & \text{if } S'(\alpha) \leq \frac{(1+\delta)^2}{4} \leq S'\left(\frac{2}{3}\right) \text{ and } \frac{(1+\delta)^2}{4}\tilde{\psi} - \frac{\alpha}{4} \geq S(\tilde{\psi}) \\ \alpha & \text{otherwise} \end{cases}$$

and $\tilde{\psi}_{\mathrm{d}}$ characterized by $S'(\tilde{\psi}_{\mathrm{d}}) = \frac{(1+\delta)^2}{4}$. In Stage 1, A's objective function can be formulated as

$$\begin{aligned} \max_{S(\psi)} \pi_{\mathrm{A}}^*(S(\psi)) \quad &= \quad \max_{S(\psi)} \frac{2-(1+\delta)\psi_{\mathrm{d}}^*}{2} + S(\psi_{\mathrm{d}}^*) \\ &\quad\quad \text{s.t.} \quad \frac{(1+\delta)^2\psi_{\mathrm{d}}^*}{4} - S(\psi_{\mathrm{d}}^*) \geq \Pi_{\mathrm{B}}^*. \end{aligned}$$

Given that A's payoff increases in $S(\psi_{\mathrm{d}}^*)$, in equilibrium, the constraint always binds, and thus A's optimization problem becomes $\max_{S(\psi)} \frac{4-(1-\delta^2)\psi_{\mathrm{d}}^*}{4} - \Pi_{\mathrm{B}}^*$, subject to $\frac{(1+\delta)^2\psi_{\mathrm{d}}^*}{4} - S(\psi_{\mathrm{d}}^*) = \Pi_{\mathrm{B}}^*$. Therefore, the optimal ψ_{d}^* to be induced should satisfy $S(\psi_{\mathrm{d}}^*) = 0$ and $\psi_{\mathrm{d}}^* = 4(1+\delta)^{-2}\Pi_{\mathrm{B}}^*$.

Furthermore, the partnership can always be formed in the presence of the outside low-cost advertising option because A can induce B to join its platform simply by letting $S(\psi) = C(\psi)$. A is thus better off opening the platform to B than letting B advertise with new media. When A optimally chooses $S(\psi)$, its payoff can be further improved. $\square$