Pricing Strategy of Competing Media Platforms

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Abstract

Media platforms generate revenue by bringing consumers and advertisers together. Though advertisers like to promote their services and products to consumers, consumers dislike advertisements to varying levels. Given heterogeneity in consumers' dislike for ads, platforms could adopt either a uniform pricing strategy or a tiered pricing strategy for consumers. In this paper, we examine competing media platforms' equilibrium pricing strategies in the presence of cross-side externalities between consumers and advertisers and their endogenous homing decisions. We find that symmetric platforms may adopt asymmetric pricing strategies in an attempt to focus on different sides of the market and soften inter-platform competition if the incremental value that consumers derive from multi-homing is large. However, they pursue only symmetric pricing strategies if this value is small. Counter to the intuition based on one-sided markets, our analysis shows that tiered pricing strategies need not improve the profits of platforms competing in a media market. In fact, when the incremental value that consumers derive from multi-homing is large, competing platforms may earn lower profits from tiered pricing and yet pursue it (Prisoner's dilemma). In contrast to standard results on tiered prices, we find that high-type consumers may not pay as much as their full willingness-to-pay for ad avoidance, implying that the incentive-compatibility constraint of high-type consumers may not be binding. Finally, we extend the model to allow for heterogeneous advertisers, vary the decision sequence, permit platforms to compete on ad capacity (rather than ad price), entertain an alternative formulation of transportation cost, and consider correlated advertising reach.

Keywords: Two-sided Platforms, Media Markets, Pricing Strategy, Tiered Pricing, Cross-side Externalities, Multi-homing, Single-homing

1 Introduction

Media platforms bring consumers and advertisers together and often generate revenue from both sides of the market. Examples of media markets include streaming music platforms (e.g., Spotify, Pandora), newspapers (e.g., The Wall Street Journal, The New York Times), streaming videos (e.g., Hulu, Youtube), and mobile apps (e.g., Flappy Bird, Jump). The global streaming music market is estimated to expand to $76.9 billion by 2027, and the streaming video market is projected to grow to $149.34 billion by 2026.[1] Thus media markets have not only grown rapidly in the past decade, they are also expected to grow even further in the near future because of the penetration of smart devices.

Advertisers strive to reach consumers through media platforms, but consumers dislike advertisements to varying levels (e.g., Wilbur 2008, Amaldoss, Du, and Shin 2021). Recognizing that there is heterogeneity in consumers' dislike for advertisements, some media platforms offer tiered prices to consumers. Kindle users, for example, pay $89.99 for a base e-reader with advertisements and $109.99 for an ad-free e-reader. Spotify's consumers pay nothing to listen to music streamed along with advertising or pay $9.99 per month to enjoy music devoid of advertisements. Likewise, consumers can watch streaming videos on Hulu without the nuisance of advertisements by paying $11.99 or with advertisements by paying $5.99 per month. However, not all media platforms offer tiered prices. The New York Times does not provide its subscribers an ad-free version of the newspaper. Until recently, even Hulu charged a uniform price of $7.99 for all its viewers, and it did not give them the option of avoiding advertisements. These diverging observations raise an important theoretical question: When should a media platform adopt a tiered pricing strategy and when should it pursue a uniform pricing strategy?

In practice, a media platform needs to carefully evaluate an important trade-off when deciding whether to use a tiered pricing strategy or a uniform pricing strategy: even though tiered prices help a platform earn more profits on the consumer side of the market, the profits from the advertiser side of the market could decrease. The profits from advertisers could reduce because a portion of consumers avoid advertisements by paying more and advertisers might want to pay less for reaching fewer consumers. In making the trade-off, a media

[1]source: Valuates Reports 2020

platform recognizes that it is competing with other platforms to attract consumers and advertisers to its platform. This competition could temper the potential profits it could earn from either side of the market and its choice of pricing strategy. In this paper, we seek to investigate how a platform's pricing strategy is shaped by inter-platform competition and the two-sided nature of a media market. Furthermore, we explore how market forces influence the specific prices a platform charges under a tiered pricing strategy in its pursuit to extract greater surplus from consumers and how its resulting equilibrium profits compare with those under a uniform pricing strategy.

To theoretically examine these issues, we consider a model of competing platforms that is faithful to the two-sided structure of media markets. Our model captures the two types of cross-side externalities observed in media markets: consumers' dislike for advertisements and advertisers' desire for consumers. Furthermore, we permit heterogeneity in consumers' dislike for ads. Specifically, we consider two types of consumers: H-type consumers with a high dislike for ads and L-type consumers with a low dislike for ads. In our formulation, the homing decisions of both consumers and advertisers are endogenous to the model. Our analysis of this model offers several useful insights on a media platforms' pricing strategies and on the implementation of tiered prices for consumers.

In principle, the equilibrium pricing strategies of the competing platforms could be one of the following three types: a symmetric uniform pricing strategy, a symmetric tiered pricing strategy, or an asymmetric pricing strategy. However, our analysis shows that only a symmetric pricing strategy can be observed in equilibrium when the incremental value that consumers derive from joining two platforms is low. This is because when the incremental value is low, consumers single-home. Consequently, each platform is providing advertisers access to a different set of consumers, and this motivates advertisers to multi-home on both platforms. In this context, by switching from a uniform pricing strategy to a tiered pricing strategy, a platform can win H-type consumers from the competing platform but not lose its advertisers to the competitor because advertisers multi-home. Therefore, a platform's choice between the two pricing strategies hinges on the benefit and cost of acquiring additional H-type consumers. The benefit is the higher price H-type consumers are willing to pay to join the platform, whereas the cost is the lower ad revenue due to fewer ad impressions when H-type consumers are insulated from advertising. Thus, a platform's choice of pricing strategy depends only on the relative sizes of the two cross-side externalities irrespective of the competing platform's pricing strategy. Therefore, symmetric platforms choose the same pricing strategy: a uniform pricing strategy when advertisers' desire for consumers is stronger than consumers' dislike for advertisements, but a tiered pricing strategy otherwise.

Given the preceding analyses, one may wonder whether symmetric platforms will always adopt only symmetric pricing strategies. On the contrary, our analysis shows that symmetric platforms may choose asymmetric pricing strategies if the incremental value that consumers derive from multi-homing on both platforms is high. To see this, note that consumers multi-home in this case. Thus, it is not cost efficient for an advertiser to reach an individual consumer through both platforms, and the utility an advertiser derives from joining a platform depends on whether the advertiser has also joined the other platform. This induces inter-platform competition for advertisers. We find that when platforms are competing on both sides of the market, they could differentiate themselves by adopting asymmetric pricing strategies. In particular, the platform adopting a tiered pricing strategy mainly profits from the consumer side of the market and charges a higher price for H-type consumers, whereas the platform adopting a uniform pricing strategy mainly focuses on the advertiser side of the market and charges advertisers a higher ad price. By avoiding head-on competition on both sides of the market, platforms earn more profits.

Next we turn our attention to media platforms' equilibrium profits. One could naively intuit that a tiered pricing strategy will yield higher profits than a uniform pricing strategy because a platform can strategically use two pricing levers to set the tiered prices (instead of using one lever to set the uniform price). Our analysis shows that this intuition is not valid when platforms compete. First, when the incremental value of multi-homing on both platforms is low, we find that the two pricing strategies are equally profitable. This is because, in their competition for consumers, the two platforms discount the consumer price by an amount equal to the value advertisers place on consumers' eyeballs. But the platforms can precisely make up this loss in consumer revenue by charging a higher ad price since they are not competing for multi-homing advertisers. Hence, platforms' profits do not depend on the cross-side externalities and remain the same irrespective of the pricing strategy. Second, if the incremental value that consumers derive from multi-homing on both platforms is high, there exists a case where uniform pricing is indeed more profitable for both of the competing platforms. In this case, however, each platform is individually better off by unilaterally choosing a tiered pricing strategy irrespective of the competing platform's pricing strategy and thus, in equilibrium, both platforms adopt a symmetric tiered pricing strategy. A unilateral defection from uniform pricing to tiered pricing is more profitable because the defecting platform can shield H-type consumers from advertising and earn more consumer revenue from them. The resulting gain in consumer revenue more than offsets the loss in advertising revenue from losing H-type consumers' eyeballs. However, if both platforms adopt a symmetric tiered pricing strategy, the increase in consumer revenue from H-type consumers is not enough to make up for the loss in advertising revenue because neither platforms gains additional demand from H-type consumers when both platforms insulate them from advertising.

Finally, we shift focus to the implementation of tiered prices, especially the optimal price for L-type consumers compared to the price for H-type consumers. Prior literature on the monopolistisic screening model suggests that the incentive-compatibility constraint of H-type consumers would be binding (Mussa and Rosen 1978). Yet we find that even when platforms act as local monopolists on the consumer side of the market, H-type consumers' IC constraint is not binding. To understand this result, note that the price premium paid by H-type consumers solely depends on the advertisers' willingness to pay for reaching L-type consumers when platforms pursue a symmetric tiered pricing strategy. This is because platforms discount the price for L-type consumers as much as the advertising revenue that can be generated from their impressions, but they do not discount the price for H-type consumers. Moreover, when platforms adopt an asymmetric pricing strategy, the platform adopting a tiered pricing strategy charges H-type consumers even more because their outside option is to join the other platform (offering a uniform price) and tolerate ads. In this case, the price premium depends on both advertisers' valuation for consumer eyeballs and H-type consumers' dislike for ads. In both cases, since a tiered pricing strategy is observed only when advertisers' desire for consumers is sufficiently strong compared to H-type consumers' dislike for advertisements, the equilibrium price premium is more than H-type consumers' dislike for ads. Thus, H-type consumers' IC constraint is not binding.

The rest of the paper is organized as follows. Section 2 discusses related literature and highlights the contribution of our work. Section 3 lays out the structure of a two-sided media market. Section 4 first analyzes a duopoly model of a two-sided media market where consumers derive a small incremental value from multi-homing on both platforms, and then examines the case when this incremental value is large. Section 5 concludes the paper outlining directions for further research. The proofs for all the claims made in the paper can be seen in the appendices.

2 Related Literature

Our work builds on prior literature on two-sided markets. The seminal work of Cailland and Jullien (2003) and Rochet and Tirole (2003) provides a theoretical foundation for investigating two-sided markets (see also Rochet and Tirole 2006, Armstrong 2006, Ambrus and Argenziano 2009, Weyl 2010, Liu and Serfes 2013). We add to this literature by jointly examining price discrimination and platform competition in two-sided markets. Armstrong (2006) finds a "competitive bottleneck" equilibrium, where platforms compete on the single-homing side of the market but earning profits from the other (multi-homing) side of the market. We obtain results that resonates with the competitive bottleneck equilibrium when incremental value of multi-homing is small for consumers. In addition, we show that when the incremental value of multi-homing is large for consumers, platforms may compete on both sides even though advertisers are multi-homing.

Our research is closely related to the literature on media markets. Gal-Or and Dukes (2003) investigate the competition between two broadcasters using a two-sided model. Contrary to conventional wisdom, they show that competing broadcasters may offer minimally differentiated programs. This is because when programs are minimally differentiated, advertisers choose lower levels of advertising. The lower levels of advertising soften the competition in the product market, help advertisers earn higher profits, and enable broadcasters to earn higher payments for advertising space. Dukes and Gal-Or (2003) show that broadcasters can benefit from offering exclusive advertising contracts. Note that exclusive advertising reduces the levels of advertising. This leaves consumers less informed about competing products and helps advertisers earn higher margins on their products; recognizing this, broadcasters charge a higher price for advertising. Anderson and Coate (2005) show that the advertising level in a two-sided media market can be lower than the socially optimal level. This is because each platform does not fully internalize the nuisance costs of advertising and sets a high price for advertisers due to its local monopoly power. In addition, as in Gal-Or and Dukes (2003) and Dukes and Gal-Or (2003), each platform may strategically hold down the advertising level in their competition for consumers (see also Peitz and Valletti 2008). One might assume that platforms would set a low price for content in an attempt to draw more consumers and leverage the larger consumer base to charge a higher price for advertisers. However, Godes et al. (2009) show that in a duopoly, competing platforms charge a higher price for content (compared to a monopolist) because of increased competition for advertisers and the resulting lower price per impression.

In contrast to these early papers, Ambrus et al. (2014) allow for the possibility that consumers could multi-home. They find that in the presence of multi-homing consumers, platforms have an incentive to strategically increase the level of advertising. As multi-homing consumers are exposed to ads on both platforms, advertisers find them less valuable compared to single-homing consumers. Thus, a platform does not generate as high an advertising revenue from multi-homing consumers as it does from exclusive consumers. Given this reality, by increasing the level of advertising, both platforms can reduce the body of multi-homing consumers and earn higher profits. In a recent paper, Athey et al. (2018) investigate how consumer multi-homing affects advertising prices and media competition. Consumer multi-homing makes advertising less efficient and encourages more advertisers to single-home. Furthermore, it increases competition among publishers on the advertiser side of the market and lowers advertising prices. This motivates publishers to increase the proportion of unique users and invest in content quality. Our goal and model structure are different. As in Athey et al. (2018), multi-homing consumers are less valuable to advertisers because of the potential for duplication in advertising. However, in our model, the proportion of multi-homing consumers is endogenously decided based on a) the incremental value consumers derive from joining an additional platform, b) consumer prices, and c) the advertising intensity. Moreover, the focus of our analysis is on consumer prices. Specifically, we examine the relative profitability of tiered pricing and uniform pricing, and the implementation of tiered pricing.

Using a model of vertical differentiation, Lin (2020) examines price discrimination by a monopoly platform and shows that price discrimination on the consumer-side of the market will increase the incentive for the monopoly platform to discriminate on the advertiser-side of the market. Furthermore, high-type consumers may get a lower-quality product, whereas low-type consumers may get a higher-quality product (than the corresponding socially efficient quality levels), implying that in a two-sided market the standard downward quality distortion result could be reversed. In contrast to Lin (2020), we consider a duopoly model of horizontal differentiation and examine how the incremental value that consumers derive from joining an additional platform market moderates the pricing strategies of competing platforms. In particular, we identify the conditions when competing platforms adopt a symmetric uniform pricing strategy, a symmetric tiered pricing strategy, and an asymmetric pricing strategy. With the aid of a one-sided model where consumers single-home and competing platforms directly choose the intensity of advertising, Despotakis et al. (2020) highlight the beneficial effect of ad blockers. They show that ad blockers can help competing platforms focus on the segment of consumers that is less sensitive to advertising, offer more advertising, and earn higher profits. In contrast to Despotakis et al. (2020), in our formulation the advertising intensity is not purely a choice of the platform but a consequence of the homing decision of consumers, the strategic interaction between the two sides of the market, and the platform's prices. Furthermore, we focus on the implementation of tiered prices in a two-sided market. Amaldoss, Du, and Shin (2021) examine media platforms' content provision strategy and its implications for the profits of content suppliers. They show that consumers' greater willingness to pay does not increase media platforms' profits because offering more content not only increases the content provision cost but also decreases ad space and ad revenue. Our current work, however, considers a two-sided media market with cross-side effects from both sides of the market and examines how the equilibrium pricing strategies are affected by the incremental value that consumers derive from joining both platforms, the disutility induced by advertising, and the heterogeneity of consumers and advertisers.

Our work also builds on the empirical literature on two-sided media markets. Kaiser and Wright (2006) examine German magazine data in light of Armstrong (2006). In keeping with Armstrong (2006), readers are subsidized. Wilbur (2008) estimates demand on both the advertiser side and the consumer side of the television industry, and finds that a 10% decrease in advertising increases audience size by 25%. Our formulation reflects this distaste for advertising and explores its implications for the pricing strategy and profits of a platform.

3 Model

In this section, we present a duopoly model of a two-sided media market. The two competing platforms offer consumers media content and host the promotional material of advertisers. The platforms earn profits from consumers and advertisers. On the consumer side of the market, a platform can either charge a uniform price to all consumers or offer tiered prices that consumers self-select to pay. In the case of tiered prices, consumers can either pay the high price and avoid advertisements or pay the low price and be exposed to advertisements. On the advertiser side of the market, each platform sets a uniform advertising fee for all advertisers. Below we describe consumers, advertisers, and platforms in order.

3.1 Consumers

Consumers join a platform for content. Because consumers have limited time, they allocate their attention between the two platforms. We assume that each consumer has one unit of attention. If consumers are single-homing, they allocate all their attention to one platform. However, if consumers are multi-homing, they allocate half of their attention to each platform.

Let u denote the base value that consumers derive on allocating all their attention to the content on a platform. Consumers are heterogeneous in their preference for the two platforms, and we assume that consumers are uniformly distributed on a Hotelling line of unit length, with platform 1 at the left end of the line and platform 2 at the right end of the line. The intrinsic utility that a consumer located at θ on the Hotelling line derives from joining platform 1 is $u - t\theta$, where t is the consumer's sensitivity to platform characteristics, such as content and delivery process. However, if the consumer were to join platform 2, the corresponding intrinsic utility will be $u - t(1 - \theta)$.

Consumers are also heterogeneous in their dislike for advertising (e.g., Wilbur 2008). We consider two types of consumers: H-type consumers have a high sensitivity to advertising (i.e., γ_H), whereas L-type consumers have a low sensitivity to advertising (i.e., γ_L with $\gamma_H > \gamma_L$). For expositional reasons, we assume that the mass of each type of consumer is half though this assumption is not crucial for the qualitative results presented in the paper. Furthermore, without loss of generality, we normalize $\gamma_L = 0$, implying that L-type consumers do not mind receiving advertisements. This also ensures that the two-sided market does not degenerate to a one-sided market. The indirect utility that a consumer of type $\lambda \in \{H, L\}$, who is located at θ on the Hotelling line, derives from joining only platform 1 is given by:

$$U_{1\lambda}(\theta) = u - t\theta - \kappa\gamma_\lambda\alpha_1 - p_{1\lambda} \tag{1}$$

where α_k is the number of advertisements shown to a consumer paying a unit of attention to platform $k \in \{1, 2\}$, $p_{k\lambda}$ is the price set by platform k for a consumer of type λ, and

$$\kappa = \begin{cases} 1 & \text{if the consumer is exposed to advertisements} \\ 0 & \text{otherwise.} \end{cases} \tag{2}$$

Likewise, the utility a single-homing consumer located at θ derives from joining Platform 2 is:

$$U_{2\lambda}(\theta) = u - t(1-\theta) - \kappa\gamma_\lambda\alpha_2 - p_{2\lambda}, \tag{3}$$

This set-up is in keeping with the empirical evidence that consumers are averse to ads (e.g., Wilbur 2008). Even if consumers derive some benefit from ads (Lin 2020), the overall ad externality would remain negative as long as ad annoyance outweighs the benefit.

Consumers may also join both platforms (i.e., multi-home). If they do, consumers derive $u + \delta$ utility, where δ is the benefit that accrues from multi-homing. To appreciate the benefit of multi-homing (δ), consider a consumer who already subscribes to the The Wall Street Journal. The upside of subscribing to the The New York Times as well is that the consumer could benefit from the complementary news and analysis covered in The New York Times, which could broaden her perspective or deepen her understanding. Moreover, a consumer may benefit from the greater variety of music when subscribing to both Spotify and Pandora rather than just one of them. These additional benefits from multi-homing arise even if the consumer spends the same amount of time as she would spend in one platform. δ captures such an additional utility. Since a multi-homing consumer divides her attention between the two platforms, she is exposed only to half the advertisements in each platform (Athey et al. 2018). Thus, the indirect utility derived from joining both platforms is given by:

$$U_{M\lambda}(\theta) = u + \delta - t - \gamma_\lambda\Big(\frac{\kappa_1\alpha_1}{2} + \frac{\kappa_2\alpha_2}{2}\Big) - p_{1\lambda} - p_{2\lambda}, \tag{4}$$

where $\kappa_k \in \{0, 1\}$ indicates whether or not consumers are exposed to ads hosted on platform k ($k = 1, 2$). Note that regardless of her location, a multi-homing consumer travels to both ends of the Hotelling line to reach the two platforms: $\theta + (1 - \theta) = 1$. Thus, the utility derived by a multi-homing consumer does not depend on her location (θ).

3.2 Advertisers

A unit mass of homogeneous advertisers is interested in promoting their products and services to consumers. Advertiser valuation of each consumers' eyeballs is v.[2] For providing advertisers access to its consumers, a platform charges advertisers a fee f_k for each ad impression. The number of impressions each advertiser receives depends on the number of consumers reached on the platform, which in turn depends on the platform's pricing strategy (uniform vs. tiered) as well as the advertiser's homing decision (single-homing vs. multi-homing). Let $D_{k\lambda}$ and $D_{M\lambda}$ denote the number of λ-type consumers who are single-homing and multi-homing, respectively, where $k \in \{1,2\}$ and $\lambda \in \{H, L\}$ and define $D_k \equiv D_{kH} + D_{kL}$ ($k \in \{1,2\}$) and $D_M \equiv D_{MH} + D_{ML}$. Note that following Athey et al. (2018), we assume advertisers value the first impression on each consumer but not subsequent impressions. This assumption captures the idea of diminishing marginal return of impressions for a single consumer. We discuss below the indirect utilities an advertiser derives from single-homing on a platform and multi-homing on both platforms.

A single-homing advertiser reaches a multi-homing consumer with probability $\frac{1}{2}$ since the consumer's attention is divided between two platforms. Moreover, when a platform offers tiered prices, H-type consumers self-select to pay the high price and avoid advertisements, implying that advertisers have access to only L-type consumers. Hence, the indirect utility a single-homing advertiser derives from joining platform k is:

$$V_k = \begin{cases} v \cdot \left(D_k + \frac{D_M}{2}\right) - f_k \cdot \left(D_k + \frac{D_M}{2}\right) & \text{under uniform pricing} \\ v \cdot \left(D_{kL} + \frac{D_{ML}}{2}\right) - f_k \cdot \left(D_{kL} + \frac{D_{ML}}{2}\right) & \text{under tiered pricing,} \end{cases} \quad , \quad (k = 1, 2) \qquad (5)$$

However, a multi-homing advertiser reaches a multi-homing consumer (to whom an advertiser has access on both platforms) with probability $\frac{3}{4}$. This is because a multi-homing advertiser may reach some of these consumers twice and the probability of unduplicated reach reduces to $\frac{3}{4}(= 1-\frac{1}{2}\cdot\frac{1}{2})$. Furthermore, multi-homing advertisers pay for these (doubly-reached) multi-homing consumers twice (once to each platform). Hence, multi-homing advertisers find advertising to single-homing consumers more cost efficient than advertising to multi-homing

[2] To facilitate exposition, we let advertisers be homogeneous in the main model. All our results are robust if we let advertisers be heterogeneous (See Section 4.3.1 and Section B4.1 of the Online Appendix for this robustness check).

consumers.[3] The utility a multi-homing advertiser derives on joining both platforms when both platforms use the same pricing strategy is as follows:

$$V_M = \begin{cases} v\cdot\left(D_1+D_2+\frac{3}{4}D_M\right)-f_1\cdot\left(D_1+\frac{D_M}{2}\right)-f_2\cdot\left(D_2+\frac{D_M}{2}\right) & \text{under symmetric uniform pricing} \\ v\cdot\left(D_{1L}+D_{2L}+\frac{3}{4}D_{ML}\right)-f_1\cdot\left(D_{1L}+\frac{D_{ML}}{2}\right)-f_2\cdot\left(D_{2L}+\frac{D_{ML}}{2}\right) & \text{under symmetric tiered pricing,} \end{cases} \tag{6}$$

Note that when only one platforms adopts tiered pricing (while the other adopts uniform pricing), a multi-homing advertiser does not have access to H-type consumers on the platform adopting uniform pricing. Thus, the probability of reaching H-type multi-homing consumers is $\frac{1}{2}$. In this case, the utility a multi-homing advertiser derives on joining both platforms is as follows:

$$V_M = v\cdot\left(D_1+D_{2L}+\frac{1}{2}D_{MH}+\frac{3}{4}D_{ML}\right)-f_1\cdot\left(D_1+\frac{1}{2}D_M\right)-f_2\cdot\left(D_{2L}+\frac{1}{2}D_{ML}\right) \tag{7}$$

3.3 Platforms

As noted earlier, the platforms earn profits from both consumers and advertisers by setting either a uniform price or tiered prices for the consumer side of the market and a single advertising fee for the advertiser side of the market. We normalize each platform's marginal cost to zero so that a platform's profit maximization problem reduces to one of maximizing its revenue. Then, the total profits that Platform k earns from consumers and advertisers are as follows:

$$\Pi_k = \begin{cases} (D_k+D_M)\cdot p_k+\alpha_k\cdot f_k\cdot\left(D_k+\frac{D_M}{2}\right) & \text{under uniform pricing} \\ (D_{kL}+D_{ML})\cdot p_{kL}+(D_{kH}+D_{MH})\cdot p_{kH}+\alpha_k\cdot f_k\cdot\left(D_{kL}+\frac{D_{ML}}{2}\right) & \text{under tiered pricing,} \end{cases} \tag{8}$$

Recall that α_k is the number of ads presented to each consumer in platform k. In our setting, because advertisers value only the first impression on a consumer, the platform will provide only one impression of each advertiser's ad per consumer. Thus, in our formulation, α_k is identical to the number of advertisers.

3.4 Decision sequence

The game unfolds in five stages as shown in Figure 1. In the first stage, each platform decides whether to adopt a uniform pricing strategy or a tiered pricing strategy for the

[3]The specific probability of unduplicated reach is derived from the assumption of equal split of multi-homing consumers' attention. However, this assumption is not critical and our results are robust to alternative behavioral assumptions as long as advertisers' multi-homing leads to double exposure to some consumers. See the extension in Section 4.3.5 for an example.

two segments of consumers. In the second stage, each platform sets prices for consumers (p_k or $\{p_{kH}, p_{kL}\}$). Letting platforms set the prices after choosing the pricing strategy is consistent with the reality that media platforms often change their prices without changing their broad pricing strategy. In the third stage, consumers decide to join one or both platforms. Consumers make this decision based on observed prices and the (correctly) anticipated level of advertisements on each platform. In the fourth stage, each platform sets the fee for each impression of advertising (f_k) based on the realized consumer demand. Finally, in the fifth stage, advertisers choose to join one or both platforms. Note that if advertisers are indifferent about single-homing on either platform, they will choose either platform with equal probability. This decision sequence reflects the fact that advertisers' decisions are based on the realized consumer demand (Athey et al. 2018). The two sides of the market are fully covered in that consumers and advertisers join at least one platform. We examine the subgame perfect equilibrium to understand the strategic behavior of consumers, advertisers, and platforms. Note that in the first stage of the game where platforms choose their pricing strategy, if both strategies yield the same profits, we assume platforms choose a uniform pricing strategy over a tiered pricing strategy.[4]

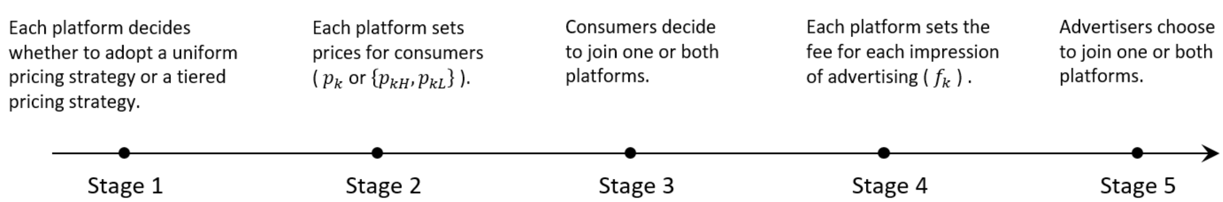

Figure 1: The Decision Sequence

4 Analysis

In this section, we analyze the game based on the size of the incremental value that consumers derive from multi-homing on both platforms instead of single-homing on one platform. In Section 4.1, we consider the situation where the incremental value (δ) is small. Then in Section 4.2, we study the situation where the incremental value is large. In each of these sections, we discuss the homing decisions of the two sides of the market, analyze each possible

[4]This assumption reflects the reality that at the margin implementing a tiered pricing strategy can be more costly to the platform due to menu costs. However, we do not explicitly model this difference in cost.

configuration of pricing strategies, and derive the equilibrium pricing strategy of the platforms. Later in Section 4.3, we show the robustness of our results by considering model extensions.

4.1 Small Incremental Value for Consumers

In this section, we consider the case where the incremental value that consumers derive from multi-homing on both platforms is small.

4.1.1 Homing Decisions

Suppose $\delta < \delta^*$, where δ^* is as defined in Lemma 5 of the online appendix. As established in the appendix, when δ is small, no consumer joins both platforms, implying $D_M = 0$.[5] In the absence of multi-homing consumers in the market, advertisers make their homing decisions based on the following tradeoff. On the one hand, advertisers would like to reach as many consumers as possible, and multi-homing on both platforms can help achieve this goal. On the other hand, the downside of advertisers multi-homing on both platforms is that some of their investment in advertising will be wasted if the same consumers are exposed to their ads on both platforms. But if there are no multi-homing consumers in the market, advertisers will not run the risk of reaching the same consumers on both platforms. Therefore, when the incremental value that consumers derive from multi-homing on both platforms is sufficiently small, all consumers single-home and this encourages all advertisers to multi-home.[6]

Next, given the likely behavior of consumers and advertisers, the two competing platforms can adopt three possible configurations of pricing strategies. Specifically, we consider Subgame 1 where both platforms use a uniform pricing strategy, Subgame 2 where both platforms follow a tiered pricing strategy, and Subgame 3 where one platform adopts a uniform pricing strategy and the other pursues a tiered pricing strategy. Based on the equilibrium outcomes

[5] See Lemmas 2, 3, and 4 of the online appendix.

[6] In our model, we assume that advertisers are not budget-constrained. However, if advertisers' budgets cannot cover the expenses for the impressions on both platforms, advertisers may consider either single-homing (if they cannot even cover the impressions on one platform) or multi-homing after exhausting the impressions on one platform (if they can cover impressions of one platform but not both) in an attempt to reduce the possibility that some consumers may be exposed to their ads on both platforms. In either case, the two platforms will compete for advertisers by reducing f_k until both platforms' impressions can be covered by advertisers' budgets. Thus, in equilibrium, advertisers will multi-home. Since this analysis requires additional assumptions on the budgets, we focus on the pricing decisions in the two-sided market by assuming that advertisers have sufficient funds for advertising (that is, advertisers are not budget-constrained).

of these three subgames, the platforms simultaneously choose the pricing strategy that yields the highest profits.

4.1.2 Subgame 1: A Symmetric Uniform Pricing Strategy

Since all the advertisers multi-home, the two platforms are not competing on the advertiser side of the market.[7] Hence, platforms charge an advertising fee as high as advertisers' valuation: $f_k = v$.[8] At this advertising fee, all advertisers still choose to advertise on both platforms, leading to $\alpha_1 = \alpha_2 = 1$.

Turning attention to the consumer side of the market, recall that $\lambda \in \{L, H\}$ denotes the type of consumer. If both platforms set a uniform price for consumers, the location of the λ-type consumer who is indifferent between joining platforms 1 and 2 is given by:

$$\begin{aligned} \theta_\lambda &= \tfrac{1}{2t}(p_2 - p_1 + \gamma_\lambda(\alpha_2 - \alpha_1)) + \tfrac{1}{2} \\ &= \tfrac{1}{2t}(p_2 - p_1) + \tfrac{1}{2}, \end{aligned} \tag{9}$$

because $\alpha_1 = \alpha_2 = 1$.

Since H-type and L-type consumers pay the same price under a uniform pricing strategy, we can view the two segments as a composite market with the "average" marginal consumer being $\theta = \frac{\theta_L + \theta_H}{2} = \theta_L = \theta_H$. Moreover, the mass of consumers joining each platform is given by $D_1 = \theta$ and $D_2 = 1 - \theta$. Then, each platform's profits are as follows:

$$\Pi_1 = D_1 \cdot p_1 + \alpha_1 \cdot f_1 \cdot D_1 \tag{10}$$

$$\Pi_2 = D_2 \cdot p_2 + \alpha_2 \cdot f_2 \cdot D_2 \tag{11}$$

On solving for the equilibrium prices, we obtain:

$$p_1^* = p_2^* = t - v \tag{12}$$

$$f_1^* = f_2^* = v \tag{13}$$

[7] As noted earlier, platforms may compete for multi-homing advertisers if advertisers' budgets are not sufficient. However, for the purpose of analyzing the pricing strategies, we assume that advertisers are not budget-constrained. When advertisers are not budget-constrained, platforms do not compete for multi-homing advertisers. We thank an anonymous reviewer for raising this possibility.

[8] According to Lemma 1 of the online appendix, this is also true for the other two subgames.

It follows that the mass of consumers joining each platform is given by $D_1^* = D_2^* = \frac{1}{2}$. The corresponding profits of each platform are:

$$\Pi_1^* = \Pi_2^* = \tfrac{t}{2} \tag{14}$$

Detailed derivation of the equilibrium solution and the proofs for the claims made in the paper are presented in the appendix.[9]

4.1.3 Subgame 2: A Symmetric Tiered Pricing Strategy

Here we consider the case where competing platforms customize the prices for each segment of consumers. Consumers can either pay a higher price and avoid advertisements or pay a lower price and tolerate advertisements. Therefore, when both platforms adopt a tiered pricing strategy, advertisers reach only consumers who pay the lower price. The platforms charge advertisers a uniform price.

Recall that $p_{k\lambda}$ and $D_{k\lambda}$ denote the price that platform k charges λ-type consumers and the corresponding demand, respectively. As before, all advertisers multi-home because every consumer single-homes, and hence we have $\alpha_1 = \alpha_2 = 1$. Then, given each platform's price for λ-type consumers, the marginal consumer who is indifferent between the two platforms is given by:

$$\theta_\lambda \;=\; \tfrac{1}{2t}(p_{2\lambda} - p_{1\lambda}) + \tfrac{1}{2}. \tag{15}$$

The mass of consumers of each type joining each platform is given by: $D_{1L} = \frac{\theta_L}{2}$, $D_{2L} = \frac{1-\theta_L}{2}$, $D_{1H} = \frac{\theta_H}{2}$, $D_{2H} = \frac{1-\theta_H}{2}$. Because only L-type consumers are exposed to advertisements, each advertiser reaches D_{kL} consumers on Platform k, where $k \in \{1, 2\}$. Hence, each platform's profits are given by:

$$\Pi_1 = D_{1L} \cdot p_{1L} + D_{1H} \cdot p_{1H} + \alpha_1 \cdot f_1 \cdot D_{1L} \tag{16}$$

$$\Pi_2 = D_{2L} \cdot p_{2L} + D_{2H} \cdot p_{2H} + \alpha_2 \cdot f_2 \cdot D_{2L}. \tag{17}$$

Noting that platforms set prices such that H-type consumers self-select to pay the high price but L-type consumers self-select to pay the low price, we solve for the equilibrium prices.

[9] In the online appendix, we establish the equilibrium solution through a series of lemmas. In the main appendix, we prove the propositions in the paper using the lemmas.

The L-type consumers joining platform k would prefer to pay p_{kL} and tolerate ads instead of paying p_{kH} for an ad-free content, implying $p_{kL} + \gamma_L \alpha_k \leq p_{kH}$, or equivalently $p_{kL} \leq p_{kH}$ (since $\gamma_L = 0$). However, H-type consumers would prefer to access the platform without the nuisance of ads, suggesting $p_{kH} \leq p_{kL} + \gamma_H \alpha_k$. Together, the IC constraints are given by:[10]

$$p_{kL} \leq p_{kH} \leq p_{kL} + \gamma_H \alpha_k, \ (k = 1, 2). \tag{18}$$

Under these IC constraints, we derive the equilibrium prices for advertisers and the two types of consumers. As the equilibrium prices are contingent on the relative size of cross-side externalities, we present below two sets of prices and relegate the details of the derivation to the online appendix. First, when $\gamma_H > v$, we have:

$$p^*_{1H} = p^*_{2H} = t \tag{19}$$

$$p^*_{1L} = p^*_{2L} = t - v \tag{20}$$

$$f^*_1 = f^*_2 = v. \tag{21}$$

In this case, H-type consumers' IC constraint is not binding: $p^*_{kH} < p^*_{kL} + \gamma_H \alpha^*_k$. Second, when $\gamma_H \leq v$, we have:

$$p^*_{1H} = p^*_{2H} = t - \tfrac{v - \gamma_H}{2} \tag{22}$$

$$p^*_{1L} = p^*_{2L} = t - \tfrac{v + \gamma_H}{2} \tag{23}$$

$$f^*_1 = f^*_2 = v, \tag{24}$$

and H-type consumers' IC constraint is binding in equilibrium: $p^*_{kH} = p^*_{kL} + \gamma_H \alpha^*_k$. For both sets of equilibrium prices, the mass of consumers joining each platform is given by $D_{kL} = D_{kH} = \frac{1}{4}$, and each platform's equilibrium profits are:

$$\Pi^*_1 = \Pi^*_2 = \tfrac{t}{2} \tag{25}$$

4.1.4 Subgame 3: Asymmetric Pricing Strategies

Now we turn to the case where one platform implements a uniform pricing strategy while the other platform uses a tiered pricing strategy for consumers. Without loss of generality, we

[10] IC constraints should also specify the conditions under which neither H-type consumers pay the low price nor L-type consumers pay the high price of the other platform. In equilibrium, since the prices are symmetric across platforms, these conditions are automatically satisfied as long as (18) holds. This is because moving to the other platform decreases the utility by an amount equal to the transportation cost.

assume that platform 1 charges a uniform price for both types of consumers whereas platform 2 charges tiered prices for the two types of consumers.[11] Both platforms set a uniform price for advertisers.

Because platform 2 offers tiered prices, H-type consumers can insulate themselves from advertising by choosing platform 2. This decreases the customer base of platform 2. Since $\alpha_1 = \alpha_2 = 1$, the marginal consumer of type $\lambda \in \{H, L\}$ who is indifferent between the two platforms is as follows:

$$\theta_L = \tfrac{1}{2t}(p_{2L} - p_1) + \tfrac{1}{2} \tag{26}$$

$$\theta_H = \tfrac{1}{2t}(p_{2H} - p_1 - \gamma_H) + \tfrac{1}{2}. \tag{27}$$

Furthermore, in this subgame the mass of consumers of each type joining each platform is as follows: $D_1 = \frac{\theta_L+\theta_H}{2}$, $D_{2L} = \frac{1-\theta_L}{2}$, and $D_{2H} = \frac{1-\theta_H}{2}$. Then each platform's profits are given by:

$$\Pi_1 = D_1 \cdot p_1 + \alpha_1 \cdot f_1 \cdot D_1 \tag{28}$$

$$\Pi_2 = D_{2L} \cdot p_{2L} + D_{2H} \cdot p_{2H} + \alpha_2 \cdot f_2 \cdot D_{2L}. \tag{29}$$

Using these profits and considering the IC constraints of consumers joining Platform 2, we derive the following two sets of equilibrium prices (see Lemma 4 of the online appendix for the detailed derivation): When $\gamma_H > v$, we have:

$$p_1^* = t - \tfrac{\gamma_H+5v}{6}, \quad p_{2H}^* = t + \tfrac{5(\gamma_H-v)}{12}, \quad p_{2L}^* = t - \tfrac{\gamma_H+11v}{12}, \quad f_1^* = f_2^* = v \tag{30}$$

$$\Pi_1^* = \tfrac{(6t-\gamma_H+v)^2}{72t}, \quad \Pi_2^* = \tfrac{t}{2} + \tfrac{\gamma_H-v}{6} + \tfrac{13(\gamma_H-v)^2}{288t}. \tag{31}$$

When $\gamma_H \leq v$, we have:

$$p_1^* = t - \tfrac{\gamma_H+5v}{6}, \quad p_{2H}^* = t - \tfrac{2(v-\gamma_H)}{3}, \quad p_{2L}^* = t - \tfrac{\gamma_H+2v}{3}, \quad f_1^* = f_2^* = v \tag{32}$$

$$\Pi_1^* = \tfrac{(6t-\gamma_H+v)^2}{72t}, \quad \Pi_2^* = \tfrac{(6t+\gamma_H-v)^2}{72t} \tag{33}$$

4.1.5 Platform Pricing Strategy

Using the equilibrium profits of the preceding three subgames, we investigate the pricing strategy that competing platforms may adopt in a two-sided market. The full derivation of

[11] Because both platforms are symmetric, the equilibrium results will remain the same if the strategy choices of the two platforms are reversed.

the equilibrium pricing strategy is presented in the appendix, and here we discuss the key implications of the equilibrium. For ease of exposition, let abbreviations UU and TT refer to both platforms adopting symmetric uniform pricing strategies and symmetric tiered pricing strategies, respectively. Furthermore, let TU or UT denote platforms using asymmetric pricing strategies.

Given the three possible strategies (UU, TT, and UT/TU), one may wonder when platforms may adopt these strategies. We have the following result.

Proposition 1. *When $\delta < \delta^*$, platforms pursue only symmetric pricing strategies (TT or UU) in equilibrium. Furthermore, a symmetric tiered pricing strategy (TT) is adopted if and only if $\gamma_H \geq v$.*

To follow the rationale for the proposition, note that while choosing its pricing strategy, each platform needs to make a trade-off between (a) earning a higher advertising revenue by charging a higher ad price based on its larger consumer base and (b) earning a higher consumer revenue by charging a higher price for H-type consumers. By adopting a uniform pricing strategy, a platform could provide advertisers access to H-type consumers in addition to L-type consumers and exploit advertisers' high desire for consumers. Thus, platforms adopt a uniform pricing strategy when advertisers' valuation for consumer reach is more than H-type consumers dislike for ads, namely $v > \gamma_H$.

Next, to understand why both platforms adopt only symmetric pricing strategies, recall that when $\delta < \delta^*$, all consumers single-home and it induces all advertisers to multi-home. When advertisers multi-home, platforms do not compete for advertisers and hence charge an advertising fee $f_k = v$. This implies that when a platform switches from a uniform pricing strategy to a tiered pricing strategy, the platform loses the ability to earn advertising revenue v from each H-type consumer irrespective of the competing platform's pricing strategy. The very same switch in strategy increases the platform's consumer revenue by γ_H for each H-type consumer. This is because H-type consumers are willing to pay γ_H to avoid advertisements. Thus, the relative profitability of the two pricing strategies is a function of the difference $\gamma_H - v$, again regardless of the pricing strategy that the competing platform chooses. Therefore, if a platform finds it profitable to adopt a tiered pricing strategy instead of a uniform pricing strategy (or vice versa), it is profitable for the other platform also to do so. Hence, in equilibrium, symmetric platforms adopt only symmetric pricing strategies.

In general, one would expect a tiered pricing strategy to yield more profits than a uniform pricing strategy because a tiered pricing strategy permits a platform to take advantage of two pricing levers instead of just one pricing lever under a uniform pricing strategy. Yet, when platforms compete in a two-sided market, we observe a different result in the context of our model.

Proposition 2. *When $\delta < \delta^*$, both a symmetric uniform pricing strategy (UU) and a symmetric tiered pricing strategy (TT) are equally profitable for the competing platforms.*

To understand the rationale for this result, note that in a two-sided market, platforms adjust their price for each side of the market to reflect the externality one side induces on the other side of the market (Armstrong 2006). In our model, consumers exert positive externality on advertisers. Thus, when consumers are exposed to ads, the consumer price is reduced by an amount equal to the additional ad revenue generated by these consumers. Because of the additional ad revenue that each consumer generates, platforms compete harder for consumers. The resulting lower consumer price reduces the consumer revenue of both platforms. On the advertiser side of the market, because advertisers are multi-homing, platforms do not compete for advertisers and thus, charge an advertising fee as high as $f_k = v$. Consequently, the gain in advertising revenue cancels out the loss in consumer revenue under either symmetric pricing strategy (i.e., TT or UU).[12] Moreover, under both the symmetric pricing strategies, consumers' dislike for ads has no influence on consumers' choice of platforms because the amount of ads on both platforms is the same. Consequently, the overall influence of the cross-side effects is zero and the equilibrium profits remain the same under both of the symmetric pricing strategies.

This result could lead one to wonder whether it is a consequence of the Hotelling formulation. Other models of competition would also yield the same result when $\delta < \delta^*$. To see this, note that when δ is small, consumers single-home which motivates advertisers to multi-home, implying D_{MH}=$D_{ML} = 0$ and $\alpha_1 = \alpha_2 = 1$ with $f_k^* = v$ as discussed earlier. Hence, the platform's profits given in (8) simplify to $\Pi_k = D_k \cdot (p_k + v)$ for uniform pricing

[12] If platforms compete for advertisers, the additional ad revenue will be dissipated by the competition, in which case the platform profits are lowered by advertisers' valuation for consumer eyeballs.

and $\Pi_k = D_{kL} \cdot (p_{kL} + v) + D_{kH} \cdot p_{kH}$ for tiered pricing. The incremental v in the profit function motivates symmetric platforms to compete for consumers. This, in turn, lowers the consumer price by v in equilibrium, thus nullifying the effect of v.

Thus far, we have investigated the pricing strategies of platforms when the incremental value that consumers derive from joining both platforms is not large. This is indeed the case in some markets, such as the streaming music market. However, in some other markets, such as the streaming video market, consumers may obtain greater benefit from joining multiple platforms. We next explore the strategic implications of such markets where the incremental value is large.

4.2 Large Incremental Value for Consumers

In this section, we consider the case when consumers derive a sufficiently large incremental value from multi-homing on both platforms instead of single-homing on one platform. As in the previous section, we first discuss the homing decisions of consumers and advertisers, and then examine the pricing strategies.

4.2.1 Homing Decisions

Assume $\delta > \delta^{**}$, where δ^{**} is defined in Lemma 9 of the online appendix. Clearly, a large δ will motivate some consumers to join both platforms.[13] When multi-homing consumers are present in the market, advertisers choose to either single-home or multi-home depending on the advertising fees set by the two platforms.

First, suppose the advertising fees of both platforms are sufficiently high. In this case, advertisers will choose to single-home. Specifically, the advertisers' utility given in (5), (6), and (7) suggests that when both platforms charge an advertising fee $f_k > f_k^{**}$, where

$$f_k^{**} \equiv \begin{cases} \left(1 - \frac{D_M}{4D_k + 2D_M}\right) \cdot v & \text{under a uniform pricing strategy } (k \in \{1,2\}) \\ \left(1 - \frac{D_{ML}}{4D_{kL} + 2D_{ML}}\right) \cdot v & \text{under a uniform pricing strategy } (k \in \{1,2\}) \\ \left(1 - \frac{D_{ML}}{4(D_{1L}+D_{1H}) + 2(D_{ML}+D_{MH})}\right) \cdot v & \text{under an asymmetric pricing strategy } (k = 1) \\ \left(1 - \frac{D_{ML}}{4D_{2L} + 2D_{ML}}\right) \cdot v & \text{under an asymmetric pricing strategy } (k = 2) \end{cases} \tag{34}$$

we have both $V_1 > V_M$ and $V_2 > V_M$, implying that advertisers single-home. The high advertising fee makes it unprofitable for advertisers to reach some of the additional consumers

[13]See Lemmas 6, 7, and 8 of the online appendix for the proof.

through multi-homing on both platforms. This is because reaching the same consumer for the second time is of zero value to advertisers. Now given that all advertisers single-home, the two platforms compete for advertisers by lowering their advertising fees. This competition pushes down the advertising fees of both platforms so low that advertisers find multi-homing more attractive than single-homing. Consequently, advertisers will not single-home in equilibrium.

Now consider the case when the advertising fees are sufficiently low that advertisers choose to multi-home. Then, because the two platforms are not competing with each other on the advertiser side of the market, they can raise the advertising fee to the highest level at which advertisers still find multi-homing attractive (i.e., $f_k = f_k^{**}$). Therefore, when $\delta > \delta^{**}$, all advertisers multi-home though consumers may either single-home or multi-home.

4.2.2 Subgame Analyses

Based on the homing decisions of consumers and advertisers, we consider three subgames and identify the equilibrium pricing strategies of competing platforms. Note that because consumers could choose to multi-home or single-home, we have two marginal consumers: one indifferent between joining platform 1 only and joining both platforms 1 and 2 ($\theta_{1\lambda}$), and the other indifferent between joining platform 2 only and multi-homing ($\theta_{2\lambda}$). Then, upon solving $U_{1\lambda}(\theta) = U_{M\lambda}(\theta)$ and $U_{2\lambda}(\theta) = U_{M\lambda}(\theta)$, we find that the marginal consumers $\theta_{1\lambda}$ and $\theta_{2\lambda}$ are as follows:

$$\theta_{1\lambda} = 1 - \tfrac{1}{t} \cdot (\delta - p_{2\lambda}) - \tfrac{\kappa\gamma_\lambda}{2t}(\alpha_1 - \alpha_2) \tag{35}$$

$$\theta_{2\lambda} = \tfrac{1}{t} \cdot (\delta - p_{1\lambda}) + \tfrac{\kappa\gamma_\lambda}{2t}(\alpha_1 - \alpha_2). \tag{36}$$

Since $\delta > \delta^{**}$ ensures that at least one consumer multi-homes, we have $\theta_{1\lambda} \leq \theta_{2\lambda}$, where $\lambda \in \{H, L\}$. Consumers in the interval $[0, \theta_{1\lambda})$ join only platform 1, consumers in the interval $[\theta_{1\lambda}, \theta_{2\lambda}]$ join both platforms, and consumers in the interval $(\theta_{2\lambda}, 1]$ join only platform 2. Define the "average" marginal consumers as $\theta_1 \equiv \frac{\theta_{1H}+\theta_{1L}}{2}$ and $\theta_2 \equiv \frac{\theta_{2H}+\theta_{2L}}{2}$. As in the previous sections, we have the following consumer demand corresponding to the three subgames:

- In Subgame 1 (a symmetric uniform pricing strategy):

$$D_1 = \theta_1, \;\; D_2 = 1 - \theta_2, \;\; D_M = \theta_2 - \theta_1 \tag{37}$$

- In Subgame 2 (a symmetric tiered pricing strategy):

$$D_{1\lambda} = \tfrac{\theta_{1\lambda}}{2},\ \ D_{2\lambda} = \tfrac{1-\theta_{2\lambda}}{2},\ \ D_{M\lambda} = \tfrac{\theta_{2\lambda}-\theta_{1\lambda}}{2},\ \ (\lambda = H, L) \tag{38}$$

- In Subgame 3 (an asymmetric pricing strategy):

$$D_1 = \theta_1,\ \ D_{2\lambda} = \tfrac{1-\theta_{2\lambda}}{2},\ \ D_{M\lambda} = \tfrac{\theta_{2\lambda}-\theta_{1\lambda}}{2},\ \ (\lambda = H, L) \tag{39}$$

Each platform's profits are given in (8), and the IC constraints remain the same as in (18). While details of the derivation of the equilibrium corresponding to the three subgames are presented in the online appendix (see Section B3), we discuss below the platforms' choice of pricing strategies and its implications below.

4.2.3 Platform Pricing Strategy

Proposition 1 tells us that when δ is small, all consumers single-home and competing platforms adopt only symmetric pricing strategies. However, when δ is large enough to motivate some consumers to multi-home, we obtain a different result.

Proposition 3. *When $\delta > \delta^{**}$, platforms may adopt an asymmetric pricing strategy in equilibrium.*

The proposition suggests that when consumers derive a sufficiently large value from multi-homing (i.e., $\delta > \delta^{**}$), platforms adopt an asymmetric pricing strategy (UT or TU) besides a symmetric pricing strategy (UU and TT) in equilibrium. To understand why platforms can adopt an asymmetric pricing strategy, it is essential to understand that platforms now compete for both consumers and advertisers.

Notice that a large δ induces some consumers to multi-home. The existence of multi-homing consumers, in turn, makes the two platforms compete for advertisers. To understand the rationale, note that it is not cost efficient for an advertiser to reach the same consumer through both platforms. Hence, in contrast to the situation where all consumers single-home, we find that if consumers multi-home, the utility an advertiser derives from joining a platform depends on whether the advertiser has also joined the other platform. Consequently, each platform is motivated to discount the ad fee it charges for each impression in an attempt to attract advertisers. We observe this inter-platform competition for advertisers despite advertisers ending up multi-homing on both platforms in equilibrium.

Next, turning attention to the consumer side of the market, notice that platforms do not compete on consumer price to increase consumer demand because consumers multi-home when δ is large. It is easy to see in (37)-(39) that each platform's consumer demand (i.e., $D_1 + D_M$ for platform 1 and $D_2 + D_M$ for platform 2) depends only on its own consumer price, not on the competing platform's consumer price. For example, under a symmetric uniform pricing strategy, $D_1 + D_M = \theta_2 = \frac{\delta - p_1}{t} - \frac{\gamma_H}{4t}(\alpha_1 - \alpha_2)$ and $D_2 + D_M = 1 - \theta_1 = \frac{\delta - p_2}{t} + \frac{\gamma_H}{4t}(\alpha_1 - \alpha_2)$, suggesting that both platforms' consumer demand is affected by its own price, not the competitor's price. Thus, the inter-platform competition on consumer prices does not have a direct effect on consumer demand. Yet platforms compete on consumer prices to increase the advertising impressions that they could offer advertisers. Specifically, a platform's advertising revenue increases with the consumer impressions it offers. Hence, each platform is motivated to attract more consumers by lowering consumer price. Moreover, the number of impressions ($D_k + \frac{D_M}{2}$ under uniform pricing and $D_{kL} + \frac{D_{ML}}{2}$ under tiered pricing) is sensitive to the consumer prices set by both platforms. Therefore, the two platforms end up competing on both consumer prices and advertising fees.

Given the aforementioned competition on both sides of the market, both platforms can be better off if they were to focus on one side of the market and let the other platform cater to the other side of the market. Under an asymmetric pricing strategy, the platform offering consumers tiered prices focuses on the consumer side of the market, attracts H-type consumers, insulates them from advertisements, and raises the price for these consumers. The platform offering consumers a uniform price focuses on the advertiser side of the market, provides advertisers access to H-type consumers, and increases the advertising fee. Thus, by committing to an asymmetric pricing strategy, platforms could avoid head-on competition on both sides of the market and earn higher profits.

The advantage accruing to platforms on adopting an asymmetric pricing strategy is weakened when γ_H is too small or when δ is either too large or too small. To see this, first notice that when the disutility of ads (γ_H) is too small, H-type consumers are less motivated to join the platform offering tiered prices, making both platforms turn their attention toward the advertiser side of the market and offer a uniform price. Next, note that if the incremental value that consumers derive from multi-homing on both platforms (δ) is too small, only a few consumers multi-home, which makes it more attractive for advertisers to multi-home on both platforms. This encourages platforms to charge a relatively high advertising fee and a relatively low consumer price, thus generating more ad revenue than consumer revenue. Hence, both platforms adopt a uniform pricing strategy. Finally, if the value that consumers obtain from joining both platforms (δ) is too large, many consumers multi-home, which makes it less attractive for advertisers to multi-home. Consequently, platforms charge a relatively high consumer price but a relatively low advertising fee, and both platforms adopt a tiered pricing strategy. In sum, an asymmetric pricing strategy can be observed when γ_H is not too small and δ is neither too large nor too small.[14]

We next examine the equilibrium profits of both platforms. We find that when both platforms adopt symmetric tiered pricing strategies in equilibrium, the following prisoner's dilemma arises.

Proposition 4. *When $\delta > \delta^{**}$, both platforms adopting a tiered pricing strategy (TT) may emerge as a dominant strategy equilibrium, even though both platforms could be better off on adopting a uniform pricing strategy (UU).*

The proposition shows that though each platform may unilaterally prefer a tiered pricing strategy, both platforms are worse off by adopting together a symmetric tiered pricing strategy. To understand why, suppose a platform unilaterally deviates from uniform pricing to tiered pricing. Given H-type consumers' dislike for advertising, the defecting platform charges these consumers a higher price, generates more demand from them, and earns larger consumer revenue. On the advertiser side of the market, we note that the defecting platform provides advertisers access to only L-type consumers and earns lower ad revenue. However, the gain in consumer revenue more than offsets the loss in ad revenue when H-type consumers' dislike for advertising is high and the incremental value that consumers derive from multi-homing is large. Thus, under this condition, it is *individually* profitable for a platform to unilaterally choose to adopt a tiered pricing strategy.

However, when both platforms adopt a tiered pricing strategy, the relative advantage on

[14] The precise condition is $\gamma_H > \frac{v}{6}$ and $\frac{24tv - v^2 + 3v\gamma_H - 2\gamma_H^2}{8(v+\gamma_H)} \leq \delta \leq \frac{64tv + 7v^2 - 36v\gamma_H + 4\gamma_H^2}{32\gamma_H}$ (see the proof of Proposition 3 in the appendix).

the consumer side of the market disappears. This is because when both platforms insulate H-type consumers from ads, neither platform gains additional demand from them. Moreover, since each platform provides advertisers access to only L-type consumers, the smaller base of consumers leads to lower advertising revenue. This loss in advertising revenue cannot be offset by the consumer revenue generated from H-type consumers. Therefore, when each platform unilaterally chooses tiered pricing and thus makes a symmetric tiered pricing strategy (TT) the equilibrium, both platforms may earn lower profits than those under a symmetric uniform pricing strategy (UU). Broadly, our analysis reaffirms the naive intuition that it will be *individually* more profitable for platforms to adopt a tiered pricing strategy rather than a uniform pricing strategy. However, when platforms compete, this naive intuition does not necessarily hold.

It is useful to note that the relative profitability of the two symmetric pricing strategies (UU and TT) are not the same in Proposition 2 and Proposition 4. According to Proposition 2, when $\delta < \delta^*$, the two symmetric pricing strategies are always equally profitable. However, Proposition 4 shows that when $\delta > \delta^{**}$, a symmetric uniform pricing strategy is *more* profitable than a symmetric tiered pricing strategy. Yet both platforms unilaterally defect to tiered pricing and end up earning lower profits. Counter to our intuition, when platforms compete, a symmetric tiered pricing strategy may not yield higher profits than a symmetric uniform pricing strategy.

Next, we proceed to investigate the specific prices that a platform charges under a tiered pricing strategy. Note that when $\delta > \delta^{**}$, some consumers may multi-home and each platform's demand is affected by its own price, not the competing platform's price. Consequently, each platform acts as a local monopolist on the consumer side of the market. We know from monopolistic screening models (e.g., Mussa and Rosen 1978) that a monopolist sets tiered prices such that H-type consumers' IC constraint is binding. In other words, the price premium charged for the H-type consumers is equal to their additional willingness to pay. This could lead us to think that a media platform too can set tiered prices for the two segments of consumers such that the price premium for H-type consumers is equal to the disutility H-type buyers experience from being exposed to ads (i.e., $\gamma_H \cdot \alpha_k^* = \gamma_H$) and the H-type consumers' IC constraint is binding. However, we obtain a different result.

Proposition 5. *(a) When platforms pursue a symmetric tiered pricing strategy, H-type consumers' price premium is influenced only by advertisers' valuation for consumer eyeballs; (b) However, when platforms adopt an asymmetric pricing strategy, H-type consumers' price premium depends on both types of cross-side externalities; (c) Moreover, H-type consumers' IC constraint is not binding irrespective of platforms' pricing strategy.*

To follow the rationale for the first part of the proposition, consider the case where both platforms adopt a tiered pricing strategy. Our analysis shows that in equilibrium each media platform charges H-type consumers $p^*_{kH} = \frac{\delta}{2}$. But each media platform charges L-type consumers $p^*_{kL} = \frac{\delta}{2} - \frac{v}{8}$, implying that L-type consumers receive a discount of $\frac{v}{8}$ based on the ad revenue they generate, which depends on the advertisers' valuation for consumer eyeballs. Hence, the price premium paid by H-type consumers is $p^*_{kH} - p^*_{kL} = \frac{v}{8}$, suggesting that the price premium is not influenced by H-type consumers' dislike for advertising (γ_H). To further grasp this finding, note that platforms adopt a tiered pricing strategy only when consumers' dislike for advertising is large (that is, $\gamma_H > \frac{v}{6}$ as shown in the proof of Proposition 3 of the appendix). Otherwise, platforms would find it profitable to adopt a uniform pricing strategy, provide advertisers access to all consumers, and generate a larger advertising revenue. Furthermore, as a platform permits advertisers to reach only L-type consumers under a tiered pricing strategy, the advertisers are providing a subsidy for only L-type consumers. Consequently, the difference in the price paid by the two types of consumers depends only on advertisers' valuation of consumers' eyeballs.

Now to understand the second part of proposition, consider the case where platforms adopt an asymmetric pricing strategy. Without loss of generality, assume that platform 1 adopts a uniform pricing strategy whereas platform 2 pursues a tiered pricing strategy. Then the equilibrium prices of the two platforms are given by:

$$p^*_1 = \frac{\delta}{2} - \frac{\gamma_H}{8} - \frac{v}{8} \tag{40}$$

$$p^*_{2H} = \frac{\delta}{2} + \frac{\gamma_H}{4}, \quad p^*_{2L} = \frac{\delta}{2} - \frac{v}{8} \tag{41}$$

On comparing the tiered prices of platform 2, we find that the price premium depends on both cross-side externalities: $p^*_{kH} - p^*_{kL} = \frac{\gamma_H}{4} + \frac{v}{8}$. The price premium paid by H-type buyers is lower than the disutility they experience from being exposed to ads because platforms adopt asymmetric pricing strategies only when $\gamma_H > \frac{v}{6}$. As before, the L-type consumers receive a discount of $\frac{v}{8}$ due to the ad revenue generated through their attention, which depends on the advertisers' valuation for consumer eyeballs. In addition, H-type consumers are charged more according to their dislike for ads because now their outside option is joining the platform offering a uniform price and not being insulated from ads. Because of the resulting reduction in L-type consumers' price and the increase in H-type consumers' price, the overall difference in the price paid by H-type and L-type consumers is influenced by both types of cross-side externalities.

Finally, note that under both a symmetric pricing strategy and an asymmetric pricing strategy, the price premium paid by H-type consumers is less than γ_H. Thus, the equilibrium price premium paid by H-type consumers is always less than their willingness to pay for being shielded from ads. Therefore, counter to some of our intuition, the IC constraint of H-type consumers is not binding.[15]

4.3 Discussion

In the preceding analysis, we have examined the pricing strategy of competing platforms when consumers and advertisers endogenously make homing decisions. To facilitate this analysis, we have made a few simplifying assumptions. Specifically, we assumed that advertisers are homogeneous; advertisers choose to join one or both platforms after observing the realized consumer demand; platforms compete on ad fees on the advertiser side of the market; consumers exhibit distaste for the features of the platforms (rather than contents); and reaching a multi-homing consumer in one platform is independent of the reach in the other platform. In this section, we relax these assumptions in order and assess the robustness of our findings.

4.3.1 Advertiser Heterogeneity

The main model assumes that advertisers have the same valuation for consumer eyeballs. However, in reality advertisers may be heterogeneous in their valuation for consumer eyeballs. To study the strategic implications of this possibility, we consider an advertiser market

[15] We obtain the same result in the case of $\delta < \delta^*$ (see Claim 1 of the appendix). Recall that when δ is small, platforms do not adopt an asymmetric pricing strategy. All the results as well as the intuition discussed above for the case of symmetric tiered pricing hold when δ is small.

comprised of two equal-sized segments with one segment having a higher valuation than the other, implying $v_H > v_L$. Upon analyzing this model, we find that competing platforms always pursue the same consumer pricing strategy as in the main model. In particular, symmetric platforms always adopt symmetric pricing strategies when δ is small, but may choose asymmetric pricing strategies when δ is large. Moreover, offering tiered prices for consumers does not necessarily improve platforms' profits beyond the profits they could earn by adopting a uniform pricing strategy. Also, under tiered pricing, H-type consumers' IC constraint is never binding (see Section B4.1 in the online appendix for details). To follow the intuition for these findings, note that consumers correctly anticipate the likely behavior of advertisers and accordingly make their participation decisions. Consequently, although the advertising fee alters the participation decisions of some advertisers and the amount of ads on the platform, the change is correctly accounted for on the consumer side of the market without inducing the platforms to modify their pricing strategy. Thus, the qualitative insights of the main model hold even if advertisers are heterogeneous.

4.3.2 Decision Sequence

The decision sequence in the main model captures the reality that advertisers' decision to join one or both platforms is based on the realized demand (e.g., Athey et al. 2018). However, it is conceivable that advertisers' decisions could be based on expected consumer demand rather than the realized consumer demand of the two competing platforms. To explore the theoretical implications of this possibility, we consider an alternate decision sequence where both consumers and advertisers simultaneously decide to join one or both platforms. Specifically, the platforms first choose the pricing strategy, the consumer price, and the advertising fee in the given order. Then both consumers and advertisers simultaneously decide on which platform(s) to join. Thus, in this alternate decision sequence, platforms set their advertising fees based on expected consumer demand rather than the realized demand. Yet in equilibrium platforms still continue to induce advertisers to multi-home in most cases. Note that when δ is large, it is possible that advertisers may single-home if platforms adopt a symmetric uniform pricing strategy. We observe this because when a platform lowers its ad fee, it earns more ad revenue but the resulting increase in advertisements hurts consumer demand. Consequently, platforms may become indifferent between advertisers' single-homing on their own platform and the competing platform. Despite this change in advertisers' homing decisions, we recover all the main results of the paper (see Section B4.2 in the online appendix for details). When δ is small, there is no change in the equilibrium results. When δ is large, all the original results hold. Specifically, the IC constraint need not be binding when both platforms adopt a tiered pricing strategy. Also, as in the main model, platforms could adopt an asymmetric pricing strategy. Furthermore, when advertisers multi-home, platforms may face a prisoner's dilemma: both platforms adopt a tiered pricing strategy even though they would be better off pursuing a uniform pricing strategy.

4.3.3 Capacity-Setting Game

Our model assumes that platforms compete on consumer price on the consumer side of the market and on ad fee on the advertiser side of the market. However, platforms could compete on ad capacity (instead of on ad fee) on the advertiser side of the market. When platforms compete on ad capacity, the equilibrium ad fee is given by the price at which advertising demand (from advertisers) meets advertising supply (from platforms). On examining this model extension, we recover all the original results of the main model (see Section B4.3 in the online appendix for details). To appreciate the intuition for this finding, first note that every advertiser is motivated to reach as many consumers as possible on the two platforms. Given this, if the ad capacity of a platform falls short of the level that can serve the needs of advertisers, the platform can earn more ad revenue by expanding its capacity. Recognizing this, both platforms are motivated to increase their respective capacity, but only to the extent that they serve all advertisers just once. This is because it is cost inefficient for advertisers to have multiple exposures to the same consumer. Therefore, the equilibrium capacity will be exactly $\alpha_1^* = \alpha_2^* = 1$, implying that all advertisers multi-home. This equilibrium outcome is exactly the same as that of the main model where advertisers set the advertising fee. Thus, whether the platforms compete on the advertiser side of the market by charging an ad fee or setting ad capacity, we obtain the same qualitative insights.

4.3.4 Transportation Cost

In our main model, consumers' distaste for features of a platform are reflected in the transportation cost. Hence, consumers incur the transportation cost t for each platform irrespective of the attention they allocate for each platform. Alternatively, the transportation cost could reflect consumers' distaste for the contents of a platform rather than the platform's features. In this alternate scenario, single-homing consumers still incur a transportation cost t, whereas multi-homing consumers incur a transportation cost $\frac{t}{2}$ as they divide their attention equally between the two platforms. On examining this alternative formulation of transportation cost, we find that the equilibrium solution remains the same when δ is small. This is because all consumers single-home in equilibrium when δ is small. Consequently, platforms continue to pursue only symmetric pricing strategies (UU/TT) and both the symmetric pricing strategies yield the same profits. When δ is large, however, some consumers multi-home and the equilibrium price corresponding to each pricing strategy changes. Yet, we obtain qualitatively same results as in the main model. Specifically, we may observe an asymmetric pricing equilibrium, platforms face a prisoner's dilemma under a symmetric tiered pricing strategy equilibrium, and H-type consumers' IC constraint is never binding (see Section B4.4 in the online appendix for details).

4.3.5 Correlated Reach

Finally, recall that in the main model, a single-homing advertiser reaches a multi-homing consumer with probability $\frac{1}{2}$ whereas a multi-homing advertiser reaches a multi-homing consumer with probability $\frac{3}{4}(= 1 - \frac{1}{2} \cdot \frac{1}{2})$. An underlying assumption of this formulation is that reaching a multi-homing consumer on each platform is an independent event. However, recent developments in ad-serving technology permits advertisers to better target their advertising campaigns. In particular, advertisers could reduce duplicated advertising reach. If needed, advertisers could send the same advertisements to the same set of consumers (Shin and Shin 2022). This implies that the act of reaching a multi-homing consumer on each platform could be correlated. Let the the correlation in reaching a multi-homing consumer between the two platforms be $\rho \in (-1, 1)$. Then, the probability of a multi-homing advertiser reaching a multi-homing consumer at either platform is $\frac{3-\rho}{4}(= 1 - \frac{1}{2} \cdot \frac{1}{2} - \frac{\rho}{4})$, which can take values ranging from $\frac{1}{2}$ to 1. Upon analyzing this model extension, we obtain results akin to that of the main model (see Section B4.5 in the online appendix for details). First, when δ is small, consumers single-home and hence the change in the probability of reaching a multi-homing consumer has no bearing on the equilibrium outcome. Second, when δ is large, any non-zero correlation changes the utility that advertisers derive from multi-homing on both platforms. Even in this case, we recover the results of the main model. In particular, platforms face prisoner's dilemma and H-type consumers' IC constraint is not binding. Moreover, asymmetric pricing strategies emerge as an equilibrium unless the correlation in reaching a multi-homing consumer on both platforms is too negative. Note that when the correlation is extremely negative, double exposure on both platforms is rare, and hence advertisers find it attractive to multi-home on both platforms. This softens inter-platform competition for advertisers, and reduces platforms' incentive to differentiate by pursuing asymmetric pricing strategies. Hence, platforms will not adopt asymmetric pricing strategies in equilibrium if the correlation is extremely negative. This discussion reaffirms our intuition that asymmetric pricing strategies are driven by the intensity of competition on the advertiser side of the market.

5 Conclusion

Two-sided media markets are rapidly growing. We interact with them in our daily lives while listening to streaming music, reading news, and watching videos. However, each particular instantiation of these two-sided markets is different from the others in subtle ways, such as the service offered, heterogeneity in consumers' dislike for advertising, and advertisers' desire to reach these consumers. Moreover, the platforms competing in these markets adopt a variety of pricing strategies. In this paper, we propose a parsimonious model that captures the key features of a two-sided media market. Using the model, we analyze how a platform's pricing strategy is shaped by inter-platform competition and the two-sided nature of a media market. Our analysis addresses a few questions of managerial significance.

- *As in one-sided markets, does tiered pricing improve media platforms' profits?*

  In a one-sided market, tiered pricing gives the firm more pricing levers to earn higher profits. In a two-sided media market, platforms need to deal with advertisers and their cross-side effect on consumers. This additional consideration can overturn the traditional result observed in one-sided markets. When the incremental value that consumers derive from multi-homing on both platforms is small, uniform pricing can be as profitable as tiered pricing (see Proposition 2). This is because when platforms adopt tiered pricing, the gain in consumer revenue is offset by the loss in advertising revenue.

However, when the incremental value a consumer gains from joining both platforms is large, individual platforms may find that adopting a uniform pricing strategy is more profitable and yet they adopt tiered pricing strategy (see Proposition 4). We obtain this result when it is more profitable for a platform to unilaterally defect from uniform pricing to tiered pricing. In such cases, by unilaterally switching to a tiered pricing strategy, a platform can charge H-type consumers a higher price and increase their demand although the advertising revenue declines because of the smaller base of consumers that advertisers can access. However, if both platforms adopt tiered pricing, H-type consumers' demand does not increase since both platforms insulate them from advertisements. Thus, the gain in consumer revenue from H-type consumers cannot offset the drop in ad revenue.

In practice, we note that several streaming video platforms, such as HBO, Hulu and Disney Plus, have switched from charging a uniform price to all consumers to charging tiered prices. Moreover, consumers of streaming videos tend to multi-home because the incremental value that they derive from multi-homing on both platforms is large. In such instances, our analysis suggests that platforms may find it profitable to unilaterally defect from adopting a uniform pricing strategy to pursuing a tiered pricing strategy (see Proposition 4). Moreover, competing platforms would be better off if all of them could pursue a uniform pricing strategy. This raises the possibility that the adoption of tiered pricing in this market could be a consequence of Prisoner's Dilemma.

- *Consistent with standard screening models, will the IC constraint be always binding for the high-type consumers in media markets?*

  We know that H-type consumers dislike advertising and are willing to pay more to be insulated from advertising. We also know that when the incremental value that consumers derive from joining a second platform is large, consumers multi-home and platforms act as local monopolists. Yet the IC constraint of H-type consumers is not binding (see Proposition 5). To follow the rationale for this finding, consider both platforms adopting a tiered pricing strategy. Under a symmetric tiered pricing strategy, each platform monetizes the attention from L-type consumers and, in turn, gives them a discount. But neither platform offers such a discount to H-type consumers because these consumers are insulated from advertising. Hence the price premium paid by H-type consumers does not depend on consumers' dislike for advertising. We observe a different pattern of results when platforms adopt an asymmetric pricing strategy. Like before, the platform offering tiered prices discounts the price for L-type consumers because it earns advertising revenue from them. But the platform raises the price for H-type consumers since it shields them from advertising (compared to the competing platform offering uniform prices). Consequently, the resulting difference in the price paid by H-type and L-type consumers depends on both cross-side externalities. Both of these cases arise in equilibrium only when consumers' dislike for advertising is large; otherwise, both platforms would pursue a uniform pricing strategy (rather than a tiered pricing strategy). Therefore, the price premium is less than consumers' dislike for advertising, implying that the IC constraint is not binding.

- *Is it optimal for symmetric platforms to adopt asymmetric pricing strategies?*

The answer is no if the incremental value that consumers derive from multi-homing on both platforms is small, but yes if the incremental value is large. In the streaming music market, consumers either subscribe to Pandora or Spotify because the incremental value from joining both platforms is low. In such cases, it is not optimal for platforms to adopt asymmetric pricing strategies (see Proposition 1). We would either observe a symmetric tiered pricing strategy or a symmetric uniform pricing strategy. Consistent with this result, both Pandora and Spotify offer tiered prices. The intuition for this finding is that when all consumers are single-homing, platforms compete for consumers but not for advertisers. This implies that each platform's choice of pricing strategy solely depends on the net benefit of gaining (or losing) consumers. When $\gamma_H > v$, the high-type consumers' willingness to pay for ad-free content is more than the loss in ad revenue due to these consumers, and hence platforms pursue tiered pricing. Because this trade-off does not depend on the competing platform's strategy choice, if it is profitable for one platform to adopt a tiered pricing strategy then it is profitable for the other platform to adopt the same strategy. Thus, both platforms adopt symmetric pricing strategies depending on the relative sizes of γ_H and v.

However, if the incremental value that consumers derive from joining both platforms is large, platforms compete for consumers on one side of the market and for advertisers on the other side of the market. This makes it profitable for one platform to offer tiered prices and for the other platform to offer uniform prices (see Proposition 3). Then, the platform offering tiered prices focuses on H-type consumers, insulates them from advertising, and earns higher consumer revenue. The platform offering a uniform price focuses on advertisers, offers them access to all consumers, and generates more advertising revenue. Hence, asymmetric pricing strategies enhance the differentiation between the two platforms and soften competition on both sides of the market. We notice that in the local newspaper market, San Francisco Chronicle pursues a uniform pricing strategy whereas The Mercury News adopts a tiered pricing strategy. To the extent that local newspapers offer content that is sufficiently differentiated and consumers find it quite valuable to multi-home on these platforms, this pricing pattern is directionally consistent with our analysis.

In developing our model, we focused on the essential features of media platforms so that we could examine the pricing strategies of competing platforms. We also extended the model in a few directions to assess the robustness of our findings. These markets have many more additional features which present avenues for further research. For instance, consumers may use ad blockers. While our analysis pertains to a world where platforms ban ad blockers, the implications of allowing ad blockers can be examined (Despotakis et al. 2021). Moreover, advertisers may have a preference for the type of consumers they want to reach. While Lin (2020) notes that this preference could weaken a monopolist's incentive for price discrimination, it may have a different implication for competing platforms. Our formulation is agnostic about who produces the content. Instead of producing its own content, a platform could procure the content from independent suppliers (e.g., Amaldoss et al. 2021, Jain and Qian 2021), creating a need for the platform to balance the proportion of content (in relation to ads) and also designing contracts that will motivate content suppliers to improve content quality. Finally, there is also an opportunity to empirically validate our model predictions using field data (e.g., Tucker and Zhang 2010) as well as lab experiments (e.g., Lim and Ho 2007, Amaldoss and Shin 2011).

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Appendix

In this appendix, we prove propositions. The lemmas used in the proofs are presented and proved in the online appendix.

Proof of Proposition 1

By Lemma 5, both platforms serve both the consumer market and the advertiser market. Given this, based on Lemmas 2, 3, and 4, we have the following payoff matrix.

		Platform 2: Uniform Price	Platform 2: Tiered Prices
Platform 1	Uniform Price	$\frac{t}{2}$, $\frac{t}{2}$	Π_1^{UT*}, Π_2^{UT*}
	Tiered Prices	Π_2^{UT*}, Π_1^{UT*}	$\frac{t}{2}$, $\frac{t}{2}$

- If $v < \gamma_H$, then $\Pi_1^{UT*} = \frac{(6t+v-\gamma_H)^2}{72t}$ is as given in (B62) and $\Pi_2^{UT*} = \frac{13(v-\gamma_H)^2}{288t} + \frac{t}{2} + \frac{\gamma_H - v}{6}$ as given in (B63). Given the constraint $-6t \le \gamma_H - v \le \frac{12t}{5}$ (see (B70)), we have $\frac{t}{2} - \Pi_1^{UT*} = \frac{(\gamma_H - v)(12t+v-\gamma_H)}{72t} > 0$ and $\frac{t}{2} - \Pi_2^{UT*} = \frac{(v-\gamma_H)(48t-13v+13\gamma_H)}{288t} < 0$. Hence both platforms using tiered pricing strategies is the only equilibrium.
- If $v \ge \gamma_H$, we have $\Pi_1^{UT*} = \frac{(6t+v-\gamma_H)^2}{72t}$ as given in (B68) and $\Pi_2^{UT*} = \frac{(6t-v+\gamma_H)^2}{72t}$ as given in (B69). Given the constraint $-6t \le \gamma_H - v \le \frac{12t}{5}$ (see (B70)), we have $\frac{t}{2} - \Pi_1^{UT*} = \frac{(\gamma_H - v)(12t+v-\gamma_H)}{72t} \le 0$ and $\frac{t}{2} - \Pi_2^{UT*} = \frac{(v-\gamma_H)(12t-v+\gamma_H)}{72t} \ge 0$. This implies that both platforms using uniform pricing strategies is the only equilibrium.

Therefore, when $\delta < \delta^*$, the asymmetric pricing strategies will not be seen in equilibrium. Furthermore, a symmetric tiered pricing strategy is adopted if and only if $\gamma_H > v$. $\square$

Proof of Proposition 2

By Lemmas 2 and 3, the equilibrium profits are given as $\Pi_1^{UU*} = \Pi_2^{UU*} = \frac{t}{2}$ under a symmetric uniform pricing strategy, and as $\Pi_1^{TT*} = \Pi_2^{TT*} = \frac{t}{2}$ under a symmetric tiered pricing strategy. This proves the proposition. $\square$

Proof of Proposition 3

By Lemma 9, both platforms serve both the consumer market and the advertiser market. Given this, based on Lemmas 6, 7, and 8, we have the following payoff matrix:

		Platform 2: Uniform Price	Platform 2: Tiered Prices
Platform 1	Uniform Price	Π^{UU**}, Π^{UU**},	Π_1^{UT**}, Π_2^{UT**}
	Tiered Prices	Π_2^{UT**}, Π_1^{UT**}	Π^{TT**}, Π^{TT**}

Below, we consider three cases:

- *Case 1:* $v < 6\gamma_H$

  For Case 1, Π^{UU**} is as given in (B87); Π^{TT**} is as given in (B112); Π_1^{UT**} is as given in (B153); Π_2^{UT**} is as given in (B154).

  Note that $\Pi^{UU**} - \Pi_2^{UT**} \geq 0$ if and only if $\delta \leq \frac{24tv - v^2 + 3v\gamma_H - 2\gamma_H^2}{8(v+\gamma_H)}$, while $\Pi^{TT**} - \Pi_1^{UT**} \geq 0$ if and only if $\delta \geq \frac{64tv + 7v^2 - 36v\gamma_H + 4\gamma_H^2}{32\gamma_H}$. Therefore,

  - A symmetric uniform pricing strategy is the equilibrium if $\delta \leq \frac{24tv - v^2 + 3v\gamma_H - 2\gamma_H^2}{8(v+\gamma_H)}$.
  - A symmetric tiered pricing strategy is the equilibrium if $\delta \geq \frac{64tv + 7v^2 - 36v\gamma_H + 4\gamma_H^2}{32\gamma_H}$.
  - An asymmetric pricing strategy is the equilibrium if $\frac{24tv - v^2 + 3v\gamma_H - 2\gamma_H^2}{8(v+\gamma_H)} \leq \delta \leq \frac{64tv + 7v^2 - 36v\gamma_H + 4\gamma_H^2}{32\gamma_H}$.

  To see that none of the above equilibrium regions is a null set, consider the parameter values $\{t = 1, v = \frac{1}{2}, \gamma_H = \frac{1}{2}\}$. In this case, the parameter space for δ: $(\delta^{**}, \delta^{***})$ becomes $\delta \in (1.09, 1.69)$. Furthermore, if $\delta \in [1.09, 1.5]$, a symmetric uniform pricing strategy is the equilibrium; if $\delta \in [1.5, 1.61]$, an asymmetric pricing strategy is the equilibrium; and if $\delta \in [1.61, 1.69)$, a symmetric tiered pricing strategy is the equilibrium.

- *Case 2:* $6\gamma_H \leq v < 8\gamma_H$

  In Case 2, Π^{UU**} is as given in (B87); Π^{TT**} is as given in (B112); Π_1^{UT**} is as given in (B159); Π_2^{UT**} is as given in (B160).

  Note that the demand conditions corresponding to the asymmetric pricing subgame requires that $\delta < 2t - \frac{3v}{8} - \frac{\gamma_H}{4}$ (see (B166)). Given this, we have $\Pi^{UU**} - \Pi_2^{UT**} > 0$ and $\Pi^{TT**} - \Pi_1^{UT**} < 0$. Hence, when $6\gamma_H \leq v < 8\gamma_H$, the only equilibrium is a symmetric uniform pricing strategy.

  To see that Case 2 does not happen in a null set, consider $\{t = 1, v = \frac{1}{2}, \gamma_H = \frac{7}{100}\}$. Then the parameter space $\delta \in (\delta^{**}, \delta^{***})$ becomes $\delta \in [1.094, 1.795)$, which is not a null set.

- *Case 3:* $v \geq 8\gamma_H$,

  In Case 3, Π^{UU**} is given in (B87); Π^{TT**} is as given in (B116); Π_1^{UT**} is as given in (B159); Π_2^{UT**} is as given in (B160).

  The demand condition corresponding to the asymmetric pricing subgame requires $\delta < 2t - \frac{3v}{8} - \frac{\gamma_H}{4}$ (see (B166)). Given this, we have $\Pi^{UU**} - \Pi_2^{UT**} > 0$ and $\Pi^{TT**} - \Pi_1^{UT**} < 0$. Therefore, when $v \geq 8\gamma_H$, the only equilibrium is a symmetric uniform pricing strategy.

  To see that Case 3 does not happen in a null set, consider $\{t = 1, v = \frac{1}{2}, \gamma_H = \frac{6}{100}\}$. Then the parameter space $\delta \in (\delta^{**}, \delta^{***})$ becomes $\delta \in (1.092, 1.798)$ which is not a null set.

In summary, when $\delta^{**} < \delta < \delta^{***}$, all three strategies can be observed in equilibrium, depending on the parameter values. In particular, the asymmetric pricing strategies are chosen in equilibrium if $v < 6\gamma_H$ and $\frac{24tv - v^2 + 3v\gamma_H - 2\gamma_H^2}{8(v+\gamma_H)} \le \delta \le \frac{64tv + 7v^2 - 36v\gamma_H + 4\gamma_H^2}{32\gamma_H}$. This completes the proof. $\square$

Proof of Proposition 4

According to the proof of Proposition 3, a symmetric tiered pricing strategy can emerge as the equilibrium only when $v < 6\gamma_H$, in which case, it is a dominant strategy equilibrium as long as $\Pi_2^{UT**} \ge \Pi^{UU**}$ or equivalently, $\delta \ge \frac{24tv - v^2 + 3v\gamma_H - 2\gamma_H^2}{8(v+\gamma_H)}$. Now assume $v < 6\gamma_H$. Then, each platform's profits under a symmetric uniform pricing strategy, Π^{UU**}, are as given in (B87). The corresponding platform's profits under a symmetric tiered pricing strategy, Π^{TT**}, are as given in (B112).

Now note that $\Pi^{UU**} > \Pi^{TT**}$ if and only if $\delta < 3t - \frac{5v}{16}$. We will show that $\Pi^{UU**} > \Pi^{TT**}$ always holds by showing that $\delta < 3t - \frac{5v}{16}$ always holds when $v < 6\gamma_H$.

First, by definition, $\delta^{***} \le \delta_{6U} = (2t - \frac{v}{4}) \cdot I[t > \frac{v}{8}]$. Since $\delta < \delta^{***}$, we have $\delta < (2t - \frac{v}{4})$ as long as $t > \frac{v}{8}$ holds. Second, the proof of Lemma 7 shows that when $v < 6\gamma_H$ (and thus, $v < 8\gamma_H$), the pricing equilibrium under the symmetric tiered pricing strategy is valid only when $t > \frac{(9+\sqrt{139})v}{32}$ (see (B128)). Now note that when $t > \frac{(9+\sqrt{139})v}{32}$, $2t - \frac{v}{4} < 3t - \frac{5v}{16}$ always holds, implying that $\delta < 3t - \frac{5v}{16}$ also always holds. Therefore, $\Pi^{UU**} > \Pi^{TT**}$ always holds. $\square$

Proof of Proposition 5

Part (a) and Part (b) are shown by the euqilibrium prices reported in the text below the proposition. We now prove Part (c). According to the proof of Proposition 3, both symmetric tiered pricing strategy and asymmetric pricing strategies can emerge as the equilibrium only when $v < 6\gamma_H$, in which case, according to the proof of Lemmas 7 and 8, the H-type consumers' IC constraints are not binding. $\square$

Proof of the claim in Footnote 15

Claim 1. *When $\delta < \delta^*$, (a) the IC constraint of H-type consumers is not binding and (b) H-type consumers' price premium is influenced only by advertisers' valuation for consumer eyeballs.*

Proof. Proposition 1 suggests that tiered pricing is observed only when $v < \gamma_H$, in which case, according to the analysis of Section 4.1.3 (see also Lemma 3 of the online appendix), the equilibrium prices are given as in (19) and (20) and the IC constraint is not binding. In this case, it is also easy to see $p^*_{kH} - p^*_{kL} = v$ ($k \in \{1, 2\}$). This completes the proof. $\square$