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# Homing Choice and Platform Pricing Strategy*

Shiva Shekhar†

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**Abstract**

We compare a discriminatory pricing regime with a non-discriminatory regime in a competitive bottleneck model where content providers endogenously sort into single or multi-homers. We find that consumer prices rise when the share of single-homers increases in the non-discriminatory case, while they stay constant in the discriminatory pricing regime. A discriminatory pricing regime leads to higher platform profits than the non-discriminatory regime when the share of single-homers are relatively high. When the share of single-homers is relatively high (low), the discriminatory pricing regime leads to higher (lower) consumer surplus and social welfare when compared with the non-discriminatory regime.

JEL-Classification: D43, L14, L82, L13

*Keywords: Price Discrimination, two-sided markets, platforms, platform competition, network effects.*

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# 1 Introduction

Platforms, nowadays have both single-homing and multi-homing agents who develop content on a platform. For instance, two competing platforms such as Apple's App Store and Google's Playstore, have applications that are exclusive to one platform as well as applications that are common on both platforms. One can notice similar trends in music streaming as well as on gaming platforms. This decision to single-home by content developers could stem from their strong preferences to develop on a particular platform arising from either technical difficulties or contractual terms that offer monetary or non-monetary benefits in exchange for exclusivity. Technical difficulties could be a result of different programming languages as well as other platform idiosyncratic requirements like a lack of home button on the iOS platform that creates the necessity for iOS developers to create on-screen buttons.[1]

On the other hand, content developers like Facebook, Google, EA games etc, are present on both the platforms and prefer access to a larger pool of consumers. This homing behavior could arise due to lower development costs due to synergies as well as the ability to access a larger pool of consumers. Other additional benefits could include payoffs that are independent from being at a platform. This could comprise positive externalities in other independent markets due to overlap of consumers across these markets. For example, Microsoft offers the full suite of MS Office tools for free on both Android and iOS ecosystem so as to nudge consumers towards the windows ecosystem in the personal computing market.[2] We call these benefits as "independent payoffs", large independent payoffs suggest greater tendency to multi-home among the pool of content providers.

In this article, we look at how this market structure influences platform profits under two pricing regimes, namely, discriminatory pricing and non-discriminatory pricing. These pricing regimes are present in different platform markets; for example, in gaming platforms we find that discriminatory pricing regime is common, while pricing in app stores is less transparent.[3] The precise terms of a

[1]Another example of content provider preference for a platform is the programming languages needed to develop an app. Android requires a C/C++ based Integrated Development Environment (IDE) called Android Studio, while iOS developers require a Java based IDE called Xcode which can be used only on Apples' macs.

[2]http://www.techrepublic.com/article/3-reasons-microsoft-made-office-free-for-iphone-and-android/

[3]For example, Wired magazine published an article on how Sony was offering seed funding, developer kits to Indie game developers on its gaming platform. In some cases, this funding was in return for either limited exclusivity

contract between app developers and content providers such as Apple and Google are confidential. While information which is publicly provided on the App store website suggests uniform pricing, exclusivity of an app is an important factor when deciding on offering promotional assistance and recommendations by their app store editorial team.[4]

A discriminatory pricing regime is relevant if there is no possibility of arbitrage between the two types of agents. Fortunately, public observability of homing behavior is a realistic assumption for most platforms that we focus on like the online streaming services, mobile operating systems and the gaming market. This is justified as the costs of verifying the deviation from contract terms for exclusive content on a competing platform are negligible.[5] It is important to note that we abstract away from cloning and piracy of content on competing platforms.

We consider a model with two competing platforms. Consumers are single-homing while content providers can multi-home or single-home. Platforms are horizontally differentiated a la Hotelling for agents on both sides. Content providers endogenously sort themselves into multi-homers and single-homers. This endogenous homing behavior is a consequence of horizontal differentiation of the platforms. A larger independent payoff obtained by content providers on a platform results in a greater proportion of multi-homing and a lower share of single-homing content providers. We consider two pricing regimes, a benchmark non-discriminatory pricing regime and a discriminatory pricing regime contingent on homing behavior.

In our model, we have demonstrated a new channel through which competition between platforms could be viewed. The independent payoff has an impact on platform profits as well as platform affiliation decisions made by content providers. A rise in independent payoffs results in an increase of the share of multi-homing as well as the total number of content providers on a platform. In the non-discriminatory case, the price charged to content providers rise with a rise in these payoffs, while consumer price falls in the non-discriminatory regime. A rise in profits due to higher revenue from content providers outweighs the fall in profits from lower consumer price. On the other hand, in the discriminatory regime, price to single-homing content providers and consumers do not vary with a change in independent payoffs, while multi-homing price along with total number of content providers rise with independent payoffs. This demonstrates that profits

or full exclusivity.

[4]https://www.wsj.com/articles/SB10001424052702304626304579510020273541060

[5]Sony could always verify the presence of a deviating content provider.

under the non-discriminatory regime are more sensitive to a change in the independent payoffs than the discriminatory regime. As a result, when these payoffs are high (low) enough, discriminatory regime is less (more) profitable than a non-discriminatory pricing regime.

Secondly, a discriminatory regime in comparison to the non-discriminatory regime is consumer surplus and welfare enhancing when independent payoffs are low enough. In the discriminatory regime, total number of content providers are higher along with the consumer price being lower than the non-discriminatory regime when independent payoffs are low enough. As a result, we obtain higher consumer surplus in the discriminatory pricing regime than in non-discriminatory regime for independent payoffs being low enough. Welfare in our setting is the sum of consumer surplus, content provider surplus and platform profits. For low independent payoffs the sum of consumer surplus and platform profits is higher in the discriminatory regime than the non-discriminatory regime, while content provider surplus is lower in the discriminatory regime. The positive effect on welfare due to higher consumer surplus and platform profits outweighs the negative effect due to lower content provider surplus in the discriminatory regime in comparison to the non-discriminatory regime.

In the extensions, we first look at the long term equilibrium if the pricing regimes were chosen simultaneously by the platforms. We find that the discriminatory pricing regime will be chosen by both the content providers. This pricing regime game resembles a prisoner's dilemma for independent payoffs being large enough. We then look at collusion on non-discriminatory pricing regimes to correct for the prisoner's dilemma and improve welfare. We employ grim trigger strategies and find that collusion is harder with an increase in independent payoffs and cross network benefits. Secondly, we look at the case where consumers obtain different marginal utility from single-homing content than multi-homing content on a platform. Thirdly, we look at the case when multi-homing and single-homing content providers obtain different independent payoffs. Finally, we focus on the case where multi-homers have economies of scale. We find that our main result that with large enough independent payoffs, non-discriminatory pricing regime result in higher platform profits is robust to all these variations.

The remainder of this paper is organized as follows. In section 2, we provide the literature review and compare my results to those known in the literature. In section 3, we present the basic model. In section 4, we provide the analysis for the two pricing regimes. In section 5, we discuss some extensions. Finally, we conclude in section 6.

## 2 Related Literature

Seminal contributions to the topic of two sided markets are Rochet and Tirole (2003) and Armstrong (2006). In Rochet and Tirole (2003), platforms levy per-transaction charges with no fixed subscription fee. The two agents, consumers and retailers, are present on either sides of the platforms. Though retailers can ex-ante choose whether to multi-home or single-home, in equilibrium they are all multi-homers. They show that the share of total transaction charge borne by the either sides depends on how closely consumers view the two platforms as substitutes. Armstrong (2006), considers competition in two sided markets in different market settings like multi-homing on both sides, competitive bottleneck models etc. This paper assumes content providers can either multi-home or single-home. Though platform choice is endogenous, homing choice (multi-homing or single-homing) is not. In our model, we allow for endogenous homing decision among content providers i.e. content providers can either be multi-homers or single-homers. Then we look at impact of price discrimination in such a setting.

Another strand of literature, we contribute to, is spatial competition among firms and price discrimination. Thisse and Vives (1988) look at two pricing regimes discriminatory and non-discriminatory within a Hotelling framework. They find that price discrimination will be chosen when the pricing policy is a simultaneous choice. They further find that consumer prices are lower under price discrimination. While they look at the impact of first degree price discrimination, we focus on homing behavior based price discrimination in a two-sided setting. We confirm their result that a discriminatory pricing regime will be the long term equilibrium in a two-sided setting with spatial competition. We obtain the prisoner's dilemma in pricing regime decision stage as in their model when the independent payoff is sufficient large. Liu and Serfes (2013) further look at first degree price discrimination among the different types of agents within a group. They find that price discrimination results in softening of competition in a two sided market setting when the marginal costs are low relative to network externalities. We obtain similar results and find that competition is lowered when independent payoff of content providers is low enough.

Another paper very close to our work is Belleflame and Peitz (2010). Similar to our paper, they take the decision for multi-homing and single-homing as endogenous. They focus on the impact of for profit and not for profit intermediation on the seller investment incentive. In contrast, we focus on the impact of price discrimination on competition in a two-sided market setting.

Choi (2010) looks at the impact of tying in the presence of exclusive content and common content. The presence of these two types of content providers are exogenously assumed in their model while consumers endogenously decide to multi-home or single-home. Our model focuses on endogenous determination of content provider homing behavior in presence of uniform and discriminatory pricing regimes.

Thomes (2015) shows that platform independent payoff through investment in in-house apps lead to higher consumer surplus and welfare. While he focuses on adding content, we look at the independent payoff of an agent from being on a platform in the two pricing regimes (discriminatory and non-discriminatory regime). We find that when the platform independent payoff is high non-discriminatory regime results in higher platform profits.

In two-sided markets there is an issue of coordination between agents i.e. platform demand on one side depends on expectations about agent participation on the other side. Suleymanova and Wey (2012) look at how different belief structures (strong, weak or mixed expectations) impact competition in the presence of network effects. They find that strong expectation of agents results in lesser competition. Our paper, utilizes what they term as weak expectations (Nash equilibrium) in the presence of indirect network effects of two-sided markets.

# 3 The Model

We consider a two-sided-market model framework along the lines of Belleflame and Peitz (2010) and Armstrong (2006). There exist two sides of the market, the consumer side and the content provider side. Each side of the market has unit mass. Our benchmark model is a competitive bottleneck model with two platforms. Consumers only single-home while content providers either single-home or multi-home. This market structure is very common in the mobile industry or music streaming industry. Consumers typically use only one mobile phone (and operating system such as Android/Google or iOS/Apple) or subscribe to a single music streaming service (e.g., Spotify or Apple Music). At the same time the platform provides access to common and exclusive content. The latter mirrors the fact that content providers both single-home and multi-home.

On the other hand, content providers may also be differentiated in their costs for development of content for a platform. For technical reasons some platform may be preferred by some developers. For example, Google's android platform is more fragmented making it difficult to develop games for it. While iOS is considerably less fragmented but has other issues that create difficulties for some developers. The lack of a back button in iOS forces app developers to introduce it in the user interface and hence making it costlier for some of them to create content for iOS. As a result, some content providers have a strong preference to develop an app for a certain platform, while others do not have such preferences, and therefore, develop apps for both platforms. Developing apps for both platforms allows them to access a larger customer base. We use a Hotelling set-up to model these homing preferences of the content providers.

There exist two competing platforms, $i \in \{1, 2\}$, which act as intermediaries through which consumers interact with content providers. A platform $i$ sets a price, $p_i$, to consumers for access to its content.[6] Vis-à-vis content providers we consider two pricing regimes $D$ and $ND$ utilized by platforms, where $D$ is the discriminatory pricing regime and $ND$ stands for the non-discriminatory pricing regime. Under regime $D$ the platform can charge different prices from a content provider depending on whether it single-homes or multi-homes. Under regime $ND$ the platform sets a uniform price to all content providers. Let the price offered to content providers in the non-discriminatory case be denoted as $l_i$ resulting in platforms charging a pair of prices $(p_i, l_i)$. In the discriminatory regime, content providers are charged different prices according to their homing behavior. Let $l_i^S$ be the price for single-homing content providers and $l_i^M$ the price for multi-homing content providers. Thus, under regime $D$, a platform charges three prices $\{p_i, l_i^S, l_i^M\}$. Firstly, we examine the regime where platforms charge non-discriminatory prices and then compare it to the case where platforms charge discriminatory prices contingent on homing behavior.

From the consumer perspective, platforms are differentiated. To account for platform differentiation, we consider a Hotelling set-up of horizontal product differentiation as in Anderson and Coate (2005), Armstrong (2006), Rasch and Wenzel (2013) and Reisinger (2014). Consumers are uniformly distributed on the unit interval. Thus every consumer has an address $x$ with $x \in [0, 1]$. Platforms are located on the opposite ends of the unit interval, with platform 1 at $x_1 = 0$ and platform 2 at $x_2 = 1$. A consumer incurs linear "transportation" costs proportional to the distance from his preferred platform. A consumer located at $x$ who buys access to platform 1 (2) located

[6] This can be understood as buying a gaming console or an Iphone.

at 0 (1) at a price $p_1$ ($p_2$) gets the following utility

$$u_i = \mu + \theta n_i - p_i - t_C \cdot |x - x_i| > 0, \text{ for } i = 1, 2, \tag{1}$$

where $t_C$ is the constant transportation cost parameter. Consumers derive a "stand-alone" utility of $\mu > 0$ from accessing content (and other services) on a platform. The term $\theta n_i$ stands for the utility consumers get from getting access to $n_i$ content providers on platform $i$.[7] Each additional content provider at a platform raises consumer utility by $\theta > 0$.

Content providers are uniformly distributed on a Hotelling line of unit length. This modeling choice is made to take into account that content providers may have a strong preference towards a platform and be single-homers or they may prefer to port content on both platforms and be multi-homers. Content providers obtain a marginal benefit $\phi$ for an additional consumer at a given platform $i$ and incur a transportation cost of affiliating with a platform. They choose an optimal strategy among multi-homing and single-homing given their location $y$. A content provider's payoff from affiliating with only platform $i$ under the non-discriminatory pricing regime is given by

$$U_i = k + \phi m_i - l_i - t_S \cdot |y_i - y|, \tag{2}$$

with $y_1 = 0$ and $y_2 = 1$ being the address of platform 1 and platform 2 respectively. We denote $k$ as the independent payoff from affiliating to a platform and $m_i$ is the total mass of consumers at platform $i$.[8] We assume that platforms have a fixed benefit as well as a linear benefit from joining a platform. The term $\phi m_i$ is the benefit a content provider gets from having access to $m_i$ consumers on platform $i$.[9] The payoff of a content provider affiliating with both platforms under

[7] An implicit assumption in our set-up is that each consumer which joins a platform $i$ interacts with all the content providers on that platform. As in Reisinger (2014), consumers are homogeneous in their trading behavior and demand all the content offered at a platform.

[8] $k$ can be thought of the benefits consumers get from accessing a platform. For example, by entering a platform creates a doorway for developers to expand their product into more diverse markets. Apple for instance allows some mobile telephony apps to be used in their mac products. This provides them with a bigger market access than just the app platform. This fixed term encompasses all the fixed benefits from joining a platform.

[9] Consumers may buy the content directly or content providers get revenues through advertisements placed in their content. Another source of revenue comes from generating personal consumer data and selling it to data collection firms/advertisers or interested firms.

non-discriminatory prices is given by[10]

$$U^M = 2k + \phi - l_1 - l_2 - t_S. \tag{3}$$

Note that multi-homers' payoff is simply the sum of single-homing content providers.[11] Under discriminatory prices, the payoff of a single-homer is given by

$$U_i = k + \phi \cdot m_i - l_i^S - t_S \cdot |y_i - y|, \tag{4}$$

correspondingly, the payoff of a multi-homer is given by

$$U^M = 2k + \phi - l_1^M - l_2^M - t_S. \tag{5}$$

Further, we assume that both market sides are symmetric with regard to the transportation cost parameters (with $t_C = t_S$) and the (indirect) network effect parameters (with $\theta = \phi$). This symmetry assumption reduces the number of cases and allows to derive clear-cut results in our model. We ensure that second order conditions are satisfied by assuming $t_S > \phi$ . We assume that participation is sufficiently attractive so that all agents on both sides participate in the market. We also invoke the following assumption, which ensures that both single-homing and multi-homing content providers coexist in equilibrium.

**Assumption 1** $2t_S - \phi > k > t_S - \phi$.

According to assumption, the independent value $k$ from affiliating with a platform should neither be too low not too high. If it is too low, then there exist only single-homers while in the opposite case there would be only multi-homers. Note also that a higher value of $k$ implies a higher share of multi-homing content providers (given that Assumption 1 holds).

Given the pricing regime which is either $D$ or $ND$, we analyze the following two-stage game: In the first stage, platforms simultaneously choose the prices they charge content providers and consumers for affiliating with their platform. In the second stage, content providers sort themselves into single-homers and multi-homers and consumers decide simultaneously which platform to join.

[10] We assume that the market is fully covered; see below.

[11] This is of course a simplifying assumption. Note, however, that all the results below remain qualitatively valid if we assume $U^M = U_1 + U_2 - \rho$, where $\rho$ can be positive or negative.

# 4 Analysis

We first analyze the non-discriminatory case and then the discriminatory case. In the next step we compare the results and derive welfare results with regard to consumer and social welfare.

## 4.1 Non-Discriminatory Pricing Regime

The prices charged by platform $i$ are given as $\{p_i, l_i\}$. Using (1), we can find the indifferent consumer $\tilde{x}$, which implies the consumer demand $m_1$ for access to platform 1 as

$$m_1 := \tilde{x} = \frac{1}{2} + \frac{p_2 - p_1 + \theta(n_1 - n_2)}{2t_S}. \tag{6}$$

The demand at platform 1 depends on the difference in consumer prices on the two platforms and on the difference in the total number of content providers on the two platforms. It is noteworthy that this difference matters and not the total number of content providers on a single platform. If content providers are allowed to multi-home as well as single-home then this difference is essentially between the number of single-homing content providers on each platform. Accordingly, if all content providers are multi-homers, then this difference would cancel out. Put differently, single-homing content providers are the driving force for consumer demand, while multi-homers have no impact in this regard. From (6) we obtain consumer demand for access to platform 2 as

$$m_2 := 1 - \tilde{x}. \tag{7}$$

Content providers can multi-home or single-home. Multi-homers are present only if the payoff from multi-homing is larger than from single-homing. Using (2) and (3) this is the case if the following two conditions hold:

$$U^M \geq U_1 \implies y \geq y_1^* = \frac{-k + l_2 + t_S - \phi m_2}{t_S}$$

and

$$U^M \geq U_2 \implies y \leq y_2^* = \frac{k - l_1 + \phi m_1}{t_S}.$$

This results in total content provider demand at platform 1 and 2 as

$$n_1 = y_2^* = \frac{k - l_1 + \phi m_1}{t_S} \text{ and } n_2 = 1 - y_1^* = \frac{k - l_2 + \phi m_2}{t_S}. \tag{8}$$

Note that Assumption 1 will ensure that in equilibrium $0 < y_1 < y_2 < 1$ holds. Figure 1 shows a possible constellation how content providers may select into single-homers and multi-homers.

There are three intervals with different types of agents. The interval on the right consists of single-homing content providers on platform 1, the interval in the middle is the area of multi-homing content providers and the interval on the left side gives the single-homing content providers on platform 2. This suggests that multi-homers are the ones that do not have strong preferences

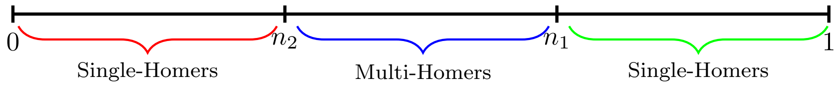


Figure 1: Distribution of Content Providers

for either platforms and therefore prefer to have access to a larger population of consumers. The total number of content providers on a platform includes both the multi-homers as well as the single-homers. The total number of content providers on a platform is falling in the price charged to them and rising in the network benefit. Interestingly, it is independent of the price of the other platform.

We solve simultaneously (6), (7) and (8) to get the demands on the two market sides in terms of prices only. We obtain

$$m_i = \frac{1}{2} + \frac{t_S(p_j - p_i) - \phi(l_i - l_j)}{2(t_S - \phi)(t_S + \phi)} \text{ and} \tag{9}$$

$$n_i = \frac{k}{t_S} + \frac{2(-l_i)t_S^2 + t_S(p_j - p_i + t_S)\phi + (l_i + l_j)\phi^2 - \phi^3}{2t_S(t_S - \phi)(t_S + \phi)}, \text{ for } i = 1, 2. \tag{10}$$

Equations (9)-(10) describe consumers' and developers' decision to join a platform for given prices. Note that content provider as well as the consumer demands decrease in prices charged by a platform $(p_i, l_i)$ but increase in the rival platform's prices $(p_j, l_j)$. The total number of content providers on platform $i$ falls in the prices charged to agents on either side. This hinges on the positive externality exerted by the two sides on each other.

Platforms choose prices on both sides of the market to maximize total profits given as

$$\max_{l_i, p_i} \Pi_i^{ND} = p_i m_i + l_i n_i, \text{ for } i \in 1, 2. \tag{11}$$

Solving the first order conditions for a symmetric equilibrium, we get the following price relations

$$p_i = p_j = t_S - \frac{\phi(l_i + \phi)}{t_S} \text{ and} \tag{12}$$

$$l_i = l_j = \frac{-p_i t_S \phi + (2k + \phi)\left(t_S^2 - \phi^2\right)}{4t_S^2 - 3\phi^2}, \text{ for } i = 1, 2. \tag{13}$$

One can notice that consumer price is falling in the cross network externality as well as in the price charged to content providers. The first effect is due to the feedback effect of two-sided markets with positive externalities. The fall in consumer prices due to a rise in prices to the content providers is due to prices being substitutes. A rise in price on content providers' side has to be compensated with greater cross-network benefit through a larger consumer base and hence a fall in prices on the consumers' side. The content provider prices also follow similar characteristics. They fall with a rise in consumer prices. Solving equations (12) and (13) simultaneously, we get the equilibrium prices as stated in the following lemma.

**Lemma 1** *In the non-discriminatory pricing regime, prices and platform profits are* $l^* = \frac{k}{2}$, $p^* = t_S - \frac{\phi(k+2\phi)}{2t_S}$ *and* $\Pi^{ND,*} = \frac{t_S}{2} + \frac{k^2-2\phi^2}{4t_S}$ *respectively. The total number of consumers and content providers on platform* $i = 1, 2$ *are the same and given by* $m_i^* = \dfrac{1}{2}$ *and* $n_i^* = \frac{(k+\phi)}{2t_S}$*, respectively.*

From Lemma (1) is follows that the number of single-homers and multi-homers on a platform are given by $n_i^{S,*} = \dfrac{2t_S - \phi - k}{2t_S}$ and $n_i^{M,*} = \dfrac{k - t_S + \phi}{t_S}$, respectively. Intuitively, we can see that the number of single (multi)-homers fall (rise) in $k$. We describe a rise in $k$ as a rise in share of multi-homing content providers. The price to the content providers rise as the number of multi-homers rise through an increase in independent payoff and do not change in the cross network benefit. A higher content provider independent payoff increases the share of multi-homers on a platform. Due to higher total content provider demand as well as relatively greater multi-homing demand the retailer has higher market power on the content providers' side. A relatively larger share of multi-homing content providers through independent payoff implies lower number of single-homers, this suggests that there is competition for a lesser proportion of content providers. So, prices can be raised to increase profits. On the consumer's side, platforms charge the hotelling price less a term that is function of the cross network externality and the platform affiliation benefit. It is interesting to note that consumer prices fall with a rise in multi-homing resulting from a rise in content provider independent payoff. This result is in contrast with the prices charged to content providers. The reason behind this is due to the difference in homing behavior of the two types of agents. A fall in $k$ results in lesser number of multi-homers and a relatively larger number of single-homers. This allows platforms to charge higher prices to consumers. A larger base of single-homers on one side allows platforms to reduce competition on consumers' side and hence increase prices to consumers due to exclusivity of content.

The total number of content providers rise in both $k$ and $\phi$ and fall in the transportation costs. A rise in $k$ results in two things, a rise in multi-homers as well as a fall in single-homers and a rise in prices for content providers. It is interesting though that a rise in content provider price still leads to an increase in total number of content providers. The reason behind it is that the increase in value from a rise in $k$ outweighs the price effect due to a rise in $k$.

Platform profits are falling in the cross network benefits and rising as multi-homers rise due to a rise in content provider independent payoff. We know that a rise in $k$ reduces consumers prices and increases content provider prices. A fall in profit from the reduction in consumer prices is outweighed by the rise in profits from the content providers. In particular, fall in profits from the reduction in prices to consumer is given by

$$\frac{\phi}{4t_S},$$

and the rise in profit from increased price to content providers as well as a higher total number of content providers is given by

$$\frac{2k+\phi}{4t_S}.$$

We can clearly see the rise in profits from content providers with an increase in $k$ is larger than the fall in profits on the consumer side. Even though consumer prices fall a rise in content provider independent payoff allows subsidization of consumers as well as a rise in platform profits. In the next section, we look at the discriminatory pricing regime.

### 4.2 Discriminatory Pricing Regime

We now turn to the discriminatory pricing regime. Platforms charge discriminatory prices contingent on homing behavior. It has been a trend that platforms provide different incentive schemes to content providers in exchange for exclusivity. For example, Apple had an understanding with some of the app developers to provide free marketing on the app-store in exchange for exclusivity on their platforms.[12] Marketing as well as visibility is a big factor for content-providers on mobile platforms in their homing decision. Another example is the video game industry, where independent ("indie") game developers are provided with free marketing as well as material support like software plus equipment.[13]

[12] http://appleinsider.com/articles/14/04/21/apple-and-google-bring-fight-for-exclusive-games-to-mobile

[13] https://www.wired.com/2013/04/sony-indies/

Let $l_i^M$ be the price charged to multi-homers and $l_i^S$ be the price charged to single-homers. We know that multi-homing occurs when utility from multi-homing is larger than from single-homing

$$U^M > U_1^S \implies y > y_1^* = \frac{-k + l_1^M - l_1^S + l_2^M + t_S - \phi m_2}{t_S} \text{ and}$$

$$U^M > U_2^S \implies y < y_2^* = \frac{k - l_1^M - l_2^M + l_2^S + m_1\phi}{t_S}.$$

As before the total number of content providers on a platform is composed of both single-homers and multi-homers. The total number of content providers, single- homers and multi-homers respectively on platform $i \in \{1, 2\}$ are given by

$$n_1 = y_2^*,\ n_2 = 1 - y_1^*,\ n^M = y_2^* - y_1^*, \text{ and } n_i^S = n_i - n^M. \tag{14}$$

Consumer demands are given by (1) and (2). We solve these demands simultaneously to express them in terms of prices,

$$\begin{aligned}
n_i &= \frac{(2(k - l_i^M - l_j^M + l_j^S) + \phi)(t_S^2 - \phi^2) - \phi((p_i - p_j)t_S + \phi(l_i^S - l_j^S))}{2t_S(t_S^2 - \phi^2)},\\
m_i &= \frac{t_S(-p_i + p_j + t_S) - \phi(l_i^S - l_j^S + \phi)}{2t_S^2 - 2\phi^2},\\
n^M &= \frac{2k - 2l_i^M + l_i^S - 2l_j^M + l_j^S - t_S + \phi}{t_S},\\
n_i^S &= n_i - n^M.
\end{aligned}$$

We substitute these demands into the profit expression of platform $i$, the platform maximizes

$$\max_{l_i^S, l_i^M, p_i} \Pi_i^D = p_i m_i + l_i^S n_i^S + l_i^M n^M,$$

for $i \in \{1, 2\}$. Solving the first-order conditions under a symmetric equilibrium results in the following price relations

$$p_i = \frac{t_S^2 - \phi(l_i^S + \phi)}{t_S} \text{ and } l_i^M = \frac{(2k + 3l_i^S - t_S + \phi)}{6}, \tag{15}$$

$$l_i^S = \frac{2(t_S^2 - \phi^2)(-k + 3l_i^M + t_S - \frac{\phi}{2}) - t_S p_i \phi}{4t_S^2 - 3\phi^2}. \tag{16}$$

Consumer price is falling in the price charged to single-homers and is independent of the price charged to multi-homers. This again demonstrates the positive effect single-homers have on consumer demand on a platform. While consumer prices and single-homing prices are substitutes, it is interesting to note that single-homing price and multi-homing price are complements. A rise in multi-homing price results in higher single-homing price and vice versa. Discriminatory prices help us clearly view which agents impact consumer demands on a platform. Solving the price relations in equations (15)-(16) simultaneously results in the following equilibrium prices as described in the lemma below.

**Lemma 2** *In the discriminatory pricing regime, prices and platform profits are* $l^{S,*} = p^* = t_S - \phi$, $l^{M,*} = \frac{(k+t_S-\phi)}{3}$ *and* $\Pi^{D,*} = \frac{4k^2-4kt_S+19t_S^2+4(k-5t_S)\phi+\phi^2}{18t_S}$ *respectively. The total number of consumers, multi-homing content providers and single-homing content providers on platform* $i$ *are* $m_i^* = \dfrac{1}{2}$, $n_i^{M,*} = \frac{2k-t_S+\phi}{3t_S}$, $n_i^{S,*} = \frac{4t_S-2k-\phi}{6t_S}$ *respectively.*

The total number of content providers on a platform is given as $n_i^* = n_i^{M,*} + n_i^{S,*} = \frac{2(k+t_S)+\phi}{6t_S}$. Consumer prices and the single-homing content provider price are qualitatively similar as in Armstrong (2006) and in Belleflame and Peitz (2010). Specifically, without network effects these prices would be as in the standard hotelling model. In the presence of network effects, they are discounted by the cross network benefits each side obtains. The price charged to the multi-homing content providers is larger (smaller) than those for single-homers when $k > (<) 2(t_S - \phi)$. With $k$ being large enough multi-homing price is larger than single-homing price because multi-homing agents obtain double the independent payoff from joining a platform and this could be extracted through higher prices. Single-homing price falls in the marginal network benefit on a platform and is independent of $k$. Single-homing content providers as well as consumers are charged the same price. When $k$ is small, multi-homing price is low while single-homing price remains unchanged. This results in $l^{S,*}$ being higher than the prices charged to multi-homers. A small $k$ implies shopping costs are relatively high, single-homing content providers being closer to their preferred platform are less elastic. A higher price can be charged to them to extract their surplus and is independent of $k$. When $k$ increases, single-homers become more elastic as transportation cost is low relative to $k$ and may want to multi-home. The additional benefit from multi-homing increases and transforms the marginal single-homers into multi-homers. Price are increased for the multi-homers to discourage single-homers becoming multi-homers.

The share of multi-homers rise in the independent payoff and cross network benefit. While the share of single-homers falls and is transformed into multi-homers with a rise in content provider independent payoff as well as cross-network benefit. The fall in number of single-homers in $\phi$ is interesting. The intuition behind this is that a rise in $\phi$ makes the presence of a larger base of consumers lucrative for content providers. Since single-homing of consumers allows access of consumers on only one platform, a rise in marginal cross network benefit encourages single-homers to multi-home. Surprisingly, total number of content providers rise in all the parameters discussed above. Even though single homers are falling in $k$, total number of content providers rises. Again, we find that the price effect is outweighed by the increase in value due to an increase in $k$. Profit of platform $i$ is given as

$$\Pi^{D,*} = \frac{4k^2 - 4kt_S + 19t_S^2 + 4(k - 5t_S)\phi + \phi^2}{18t_S}.$$

Platform profits rise in the transportation costs, content provider independent pay off and fall in cross-network. This is a standard result in two-sided markets. The rise in platform profits occurs due to extraction of higher independent payoff from the content providers or lowering of price elasticity of agents due to increase in transportation costs.The fall in profits is due to increased competitive pressures from higher cross-network benefits. We compare the profits in the two pricing regimes. Taking the difference in platform profits between the discriminatory regime and non-discriminatory regime

$$\Pi^{D,*} - \Pi^{ND,*} = -\frac{(k + 10(t_S - \phi))(k - 2t_S + 2\phi)}{36t_S}.$$

**Proposition 1** *When $k < (>) 2(t_S - \phi)$, platform profits in the discriminatory pricing regime is higher (lower) than in the non-discriminatory pricing regime.*

We know profits in both the regimes are rising in $k$. Platform profits in the discriminatory pricing regime are higher than in the non-discriminatory pricing regimes when $k < 2(t_S - \phi)$. This suggests that non-discriminatory regime profits are more sensitive to a change in $k$. This is because a rise or fall in $k$ affects both sides of the market in the non-discriminatory pricing regime, while in the discriminatory pricing regime it affects only the content provider side. In the discriminatory pricing regime, a fall in $k$ results in lower multi-homing prices while single homing as well as consumer prices remain unchanged. While in the non-discriminatory regime, price incident on both types of content providers fall while consumer prices are rising. When $k$ is relatively small, the total number of content providers on a platform are higher in the discriminatory pricing regime along with single-homing prices being higher. While consumers prices in the non-discriminatory regime rise with a fall in $k$, consumer price in the discriminatory regime stays constant. Increase in profits due to higher content provider price and larger amount of total number of content providers in the discriminatory pricing regime outweighs the higher consumer prices in the non-discriminatory regime. As $k$ falls this difference gets larger due to greater difference in total number of content providers in the two regimes while consumers which single-home divide equally between platforms.

### 4.3 Consumer Surplus and Welfare Implications

In this subsection, we examine at the welfare and consumer surplus implications of the two pricing regimes. Consumer surplus is denoted as

$$\begin{aligned} CS^g &= 2\int_0^{\frac{1}{2}} (\mu + \phi n^* - p^* - t_S x)dx \\ &= \mu + \phi n^* - p^* - \frac{t_S}{4}, \end{aligned}$$

for $g \in \{D, ND\}$. It is multiplied by two to take into account the symmetry as well as consumer surplus on both the platforms. Consumer surplus in the two regimes is given as

$$\begin{aligned} CS^{ND} &= \mu + \phi\frac{2k + 3\phi}{2t_S} - \frac{5t_S}{4}, \\ CS^D &= \mu + \phi\frac{2k + \phi + 8t_S}{6t_S} - \frac{5t_S}{4}, \end{aligned}$$

where $CS^{ND}$ is the consumer surplus in the non-discriminatory regime and $CS^D$ is the consumer surplus in the discriminatory regime. Consumer surplus is rising in platform affiliation benefit, cross-network externality and falling in transportation costs. Comparing the consumer surplus in the two regimes, we get

$$CS^{ND} - CS^D = \frac{2\phi(k - 2(t_S - \phi))}{3t_S}.$$

It is interesting to note that consumer surplus is higher in the discriminatory pricing regime than in the non-discriminatory pricing regime when $k < 2(t_S - \phi)$. The intuition is straightforward because a low $k$ results in lower consumer prices in the discriminatory regime than in the non-discriminatory regime (i.e., $p^{ND} > p^D$).

Turning to social welfare, we get for the content provider surplus, $CPS^g$ for $g \in \{ND, D\}$, the following expressions under the two regimes:

$$\begin{aligned} CPS^{ND} &= 2\int_0^{n^S} (k + \phi m^* - l_1 - t_S y)dy + (2k + \phi - l_1 - l_2 - t_S)(n^M) = \frac{(k+\phi)^2}{4t_S}, \\ CPS^D &= 2\int_0^{n^S} (k + \phi m^* - l_1^S - t_S y)dy + (2k + \phi - l_1^M - l_2^M - t_S)(n^M) \\ &= \frac{4k^2 - 44t_S^2 + 52t_S\phi + \phi^2 + 4k(8t_S + \phi)}{36t_S}, \end{aligned}$$

comparing the content provider surplus we get

$$CPS^{ND} - CPS^{D} = \frac{(k - 2t_S + 2\phi)(5k - 22t_S + 4\phi)}{36t_S}.$$

Using the above we get the welfare in the regimes as

$$\begin{aligned}
W^g &= CS^g + CPS^g + 2\Pi^g \text{ for } g \in \{D, ND\}, \\
W^{ND} &= \frac{3(k+\phi)^2 - t_S(t_S - 4\mu)}{4t_S}, \\
W^{D} &= \frac{20k^2 + 16k(t_S + 2\phi) - 13t_S^2 + 4t_S(9\mu + 5\phi) + 11\phi^2}{36t_S}, \\
W^{ND} - W^{D} &= \frac{(k - 2t_S + 2\phi)(7k - 2t_S + 8\phi)}{36t_S}.
\end{aligned}$$

**Proposition 2** *Consumer surplus and social welfare are higher in the discriminatory (non - discriminatory) pricing regime when $k < (>) 2(t_S - \phi)$ than the non-discriminatory (discriminatory) pricing regime.*

When $k$ is relatively large then non-discriminatory pricing regime results in larger platform profits as well as greater consumer surplus in comparison to discriminatory pricing regime. This is because under the non-discriminatory regime consumer prices are lower and platform profits are higher. Platform profits rise due to increase in the total number of content providers as well as the prices charged to them. When $k$ is relatively low, we obtain an interesting result that discriminatory pricing regime is welfare as well as consumer surplus enhancing. Furthermore, the content provider surplus is lower in the discriminatory pricing regime, this negative effect on the social welfare is smaller than the positive effect of platform profits and consumer surplus. Hence, we obtain the increase in welfare.

# 5 Extensions

## 5.1 Endogenous Pricing Regimes

We add a new initial stage zero to our two-stage game in which the platforms decide simultaneously about their pricing regime vis-à-vis content providers which can be either discriminatory, $D$, or non-discriminatory, $ND$. This pricing policy stage is similar as in Thisse and Vives (1988). We first start with calculating payoffs when firms set asymmetric tariff regime i.e., one firm decides on a discriminatory regime and the other on a non-discriminatory regime. Let us denote profit of the firm charging non-discriminatory prices as $\Pi^{nd,*}$, while the profit of its rival that charges a discriminatory tariff is given as $\Pi^{d,*}$.

Using our results of the previous section we get the following reduced profits in the first stage of the game (in the Appendix, platform profits for the asymmetric constellations of pricing regimes are derived). Figure 2 is the payoff matrix for the simultaneous regime choice of the two platforms.

| | | Player 2 | |
|---|---|---|---|
| | | $ND$ | $D$ |
| Player 1 | $ND$ | $(\Pi^{ND,*}, \Pi^{ND,*})$ | $(\Pi^{nd,*}, \Pi^{d,*})$ |
| | $D$ | $(\Pi^{d,*}, \Pi^{nd,*})$ | $(\underline{\Pi^{D,*}}, \underline{\Pi^{D,*}})$ |

Figure 2: Payoff matrix for different pricing regime constellations

We compare profits in the payoff matrix and get the following profit relations.

$$\Pi^{D,*} - \Pi^{nd,*} = \Pi^{d,*} - \Pi^{ND,*} = \frac{(k - 2t_S + 2\phi)^2}{9t_S} > 0 \tag{17}$$

We can clearly notice that the above expression is positive for all feasible parameter configurations. This suggests that a discriminatory pricing strategy is clearly the dominant strategy for both agents. This gives us the result that the nash equilibrium is unique and is given by the pricing strategy $(D, D)$.

**Proposition 3** *If platforms choose pricing strategies simultaneously, a discriminatory pricing strategy will be chosen in equilibrium.*

This results echoes the result as in Thisse and Vives that suggest a discriminatory pricing regime is an equilibrium when firms that compete spatially decide on the pricing regime. The reason behind this result is that discriminatory pricing is more flexible and does better against any generic pricing strategy of a rival. This can be clearly seen in equation (17). Moreover, we also confirm that when $k < 2(t_S - \phi)$ the platform profits, consumer surplus and welfare are higher in the discriminatory tariff regime than in the non-discriminatory pricing regime. This result implies that the above equilibrium is Pareto optimal for low values of $k$.

When $k > 2(t_S - \phi)$, the pricing strategy game resembles a prisoner's dilemma where $\Pi^{d,*} > \Pi^{ND,*} > \Pi^{D,*} > \Pi^{nd,*}$. Furthermore, prices charged to the two types of content providers are lower in the discriminatory case than in the non-discriminatory case, while prices for consumers are higher in the discriminatory pricing regime. This result again fits with the discussion as in Thisse and Vives (1988). This hurts the consumers and social welfare is lower. It is inefficient from a social planner's perspective. We look at pricing regime collusion as a remedy to solve this inefficiency in the market. This is done through allowing pricing regime collusion among the platforms. We use grim trigger strategies towards this where $\sigma$ is the discount factor of the repeated game. We obtain that for pricing regime collusion to be sustainable

$$\sigma > \tilde{\sigma} = \frac{\Pi^{d,*} - \Pi^{ND,*}}{\Pi^{d,*} - \Pi^{D,*}} = \frac{4(k - (2t_S - \phi))}{5k + 2(t_S - \phi)} \in [0, 1].$$

This minimum discount factor $\tilde{\sigma}$ is rising in $k$ and $\phi$, while it falls in the transportation cost parameter. Pricing regime collusion is harder when content provider independent benefit is higher $k$ or marginal cross-network benefit $\phi$ is higher. On the other hand, pricing regime collusion is easier when platforms are more differentiated through the increase in transportation costs. Furthermore, a decrease in $k$ implies a greater share of single-homers and hence greater differentiation between platforms resulting in easier pricing regime collusion.

## 5.2 Heterogeneous Consumer Utility Contingent on Homing Behavior

In this subsection, suppose consumers have different utilities for different types of content providers. Let consumers obtain $\gamma$ from single-homing content providers and $\phi$ from multi-homing content providers. The utility of a consumer on platform $i$ will be given as

$$u_i = k + \phi(n^M) + \gamma(n^S) - p_i - t_S|x - x_i|,$$

and solving for the indifferent consumer we get consumer demands as,

$$m_1 = \tilde{x} = \frac{1}{2} + \frac{p_2 - p_1 + \gamma(n_1^S - n_2^S)}{2t_S} \text{ and } m_2 = 1 - \tilde{x}. \tag{18}$$

The above indifferent We clearly notice that the single-homing content providers are critical for consumer competition. We need to make an assumption on the permitted range of platform affiliation benefit such that both the types of content providers exist on equilibrium.

**Assumption 2** $\dfrac{2t_S - \gamma - \phi}{2} < k < \dfrac{4t_S - \gamma - \phi}{2}$.

We solve the game and obtain the following lemma.

**Lemma 3** *For the two pricing regimes, we get the following equilibrium outcomes.*

- *In non-discriminatory pricing regime, equilibrium prices and the platform profits are given as* $p^* = t_S - \dfrac{\phi(2k+3\gamma+\phi)}{4t_S}$, $l^* = \dfrac{(2k-\gamma+\phi)}{4}$, $\Pi^* = \dfrac{t_S}{2} + \dfrac{4k^2-(\gamma+\phi)^2-2\gamma\phi}{16t_S}$ *respectively. Total number of content providers are given as* $n^* = \dfrac{2k+\gamma+\phi}{4t_S}$.

- *In the discriminatory pricing regime, equilibrium prices and the platform profits are given as* $p^* = t_S - \phi$, $l^S = t_S - \gamma$, $l^{M,*} = \dfrac{(2k-3\gamma+\phi+2t_S)}{6}$, $\Pi^* = \frac{-9\gamma t_S+4k^2-4kt_S+4k\phi+19t_S^2-11t_S\phi+\phi^2}{18t_S}$ *respectively. Total number of content providers are given as* $n^* = \dfrac{2(k+t_S)+\phi}{6t_S}$.

Non-discriminatory platform profits are higher than discriminatory when $k$ is relatively large. Specifically, for $k > \dfrac{4t_S - 3\gamma - \phi}{2}$, the non-discriminatory regime results in higher platform profits than the discriminatory regime. This confirms our benchmark results. Furthermore, comparing platform profits in the two regimes with profits when consumers have homogeneous marginal network benefit. We obtain the following proposition.

**Proposition 4** *When $\gamma > (<)\phi$ exclusive content is valued more (less) than common content, platform profits are lower (higher) in both the regimes than the platform profits when consumers have homogeneous marginal network benefits.*

This is an interesting but counterintuitive result. It suggests that higher consumer value for single-homing content results in lower platform profits. The reason behind this is that higher utility for exclusive content results in greater competition for content providers and this leads to feedback effects where consumer price as well as content provider price falls.

## 5.3 Heterogeneous Intrinsic Benefit for Content Providers

In this subsection, we suppose that different independent payoff are provided to multi-homing and single-homing content providers. For example, platforms could provide better consumer accessibility to single homers. Spotify for instance, was found discriminating against artists who released songs on Spotify after releasing on another platform by burying their results or not promoting a song on their play lists.[14] Let's denote $k_S$ as the independent payoff for single-homers and $k$ the independent payoff for multi-homers.

**Assumption 3** $2k - 2t_S + \dfrac{\phi}{2} < k_S < 2k - (t_S - \phi)$.

[14]https://www.bloomberg.com/news/articles/2016-08-26/spotify-said-to-retaliate-against-artists-with-apple-exclusives

This assumption is made so that both types of agents exist in the market. The utility of a single-homing content provider on platform $i$ and address $y$ is given as

$$U_i = k_S + \phi m_i - l_i - t_S|y_i - y|,$$

while the utility of the multi-homers and consumers do not change. We solve for the equilibrium prices in the two pricing regimes and obtain the following lemma.

**Lemma 4** *For the two pricing regimes we get the following equilibrium outcomes.*

- *In the non-discriminatory pricing regime, equilibrium prices and platform profits are given as* $l^* = k - \dfrac{k_S}{2}$, $p^* = t_S - \dfrac{(2k - k_S + 2\phi)\phi}{2t_S}$, $\Pi^* = \frac{(k_S-2k)^2+2(t_S-\phi)(t_S+\phi)}{4t_S}$ *respectively. Total number of content providers are given as* $n^* = \frac{2k-k_S+\phi}{2t_S}$.
- *In the discriminatory pricing regime, equilibrium prices and platform profits are given as* $p^* = l^S = t_S - \phi$, $l^{M,*} = \dfrac{(2k - k_S - \phi + t_S)}{3}$, $\Pi^* = \frac{4((k-k_S)^2+(k_S-2k)(t_S-\phi))+\phi^2+19t_S^2-20t_S\phi}{18t_S}$ *respectively. Total number of content providers are given as* $n^* = \frac{4k-2k_S+2t_S+\phi}{6t_S}$.

Comparative statics on the profits in the two-regimes give some interesting results. When $k_S > 2k - 2(t_S - \phi)$, then discriminatory pricing regime results in higher profits. This gives us the interesting result that high platform independent payoff of single-homers in discriminatory pricing regime result in higher platform profits. The reason behind this is that in the non-discriminatory case platforms are unable to charge the single-homers separately. This results in a fall in prices for the single-homers along with single-homers comprising a higher proportion of the total number of content providers. In the discriminatory pricing regime, platforms are able to charge different prices to the content providers and hence result in higher profits as the prices to single-homing content providers are not impacted by a rise in $k_S$. This results in higher profits in the discriminatory regime with a large $k_S$. Moreover, we can notice that a higher platform independent payoff $k$ for multi-homers confirms our previous idea that with higher $k$ discriminatory prices are lower. This is due to the fact that $k$ and $k_S$ act in the opposite direction on the platform profits. This section shows us how higher single-homing platform independent payoff can impact platform profits.

Comparing these profits with our benchmark case, when $k_S > k$, platform profits in this setting is lower than in our benchmark setting where content providers obtain homogeneous independent payoff. This result of ours echoes with the previous result that if exclusivity is valued more either on the content provider's side or on consumer's side, we get lower platform profits.

### 5.4 Economies of Scale

Here we look at the impact of economies of scale in our model. Let's suppose that multi-homers have economies of scale when moving from one platform to another i.e., multi-homing. This can be understood as reduction in planning and creativity costs or also ease of porting content onto another platform. Let $\delta \in [0, 1]$ be the parameter describing economies of scale for multi-homers.

**Assumption 4** $t_S - \phi < k < (2 - \delta)t_S - \phi$.

The above assumption ensures that both types of content providers are present in the market. The payoff of a multi-homer in the non-discriminatory regime is then given as

$$U^M = 2k + \phi - l_1 - l_2 - t_S(1 - \delta),$$

while in the discriminatory regime, the corresponding prices are just replaced by $l_1^M$ and $l_2^M$.

**Lemma 5** *For the two pricing regimes, we get the following equilibrium outcomes.*

- *In the non-dicriminatory regime, equilibrium prices and platform profits are given as* $l^* = \frac{(\delta t_S + k)}{2}$, $p^* = t_S - \frac{(k+2\phi+\delta t_S)\phi}{2t_S}$, $\Pi^{D,*} = \dfrac{t_S}{2} + \frac{(k+\delta t_S)^2 - 2\phi^2}{4t_S}$ *respectively. Total number of content providers are given as* $n^* = \frac{\delta t_S + k + \phi}{2t_S}$
- *In the discriminatory regime, equilibrium prices and platform profits are given as* $p^* = l^S = t_S - \phi$, $l^{M,*} = \frac{(k-\phi+t_S(1+\delta))}{3}$, $\Pi^{ND,*} = \frac{(4(\delta-1)\delta+19)t_S^2 + 4(\delta-5)t_S\phi + 4k^2 + 4k((2\delta-1)t_S+\phi)+\phi^2}{18t_S}$. *Total number of content providers are given as* $n^* = \frac{2(\delta t_S + k + t_S) + \phi}{6t_S}$.

We find that for $k > 2(t_S - \phi) - \delta t_S$, profit under the non-discriminatory pricing regime results in higher profits in comparison to the discriminatory pricing regime. As $\delta$ rises this result is feasible for a larger parameter range. This result provides us with the insight that greater compatibility between platforms non-discriminatory pricing regime would be preferred by platforms. Further, comparing the platform profits in these two pricing regime along with economies of scale with our benchmark case we find that economies of scale result in higher platform profits.

## 6 Conclusions

We analyze the effects of price discrimination based on homing behavior on the competition in markets with indirect network effects. In particular, we develop a variant of the competitive bottleneck model with single-homing consumers and where content providers endogenously decide on their homing behavior given their compatibility towards a platform.

This analysis was motivated by the prevailing condition in the mobile phone OS market as well as the gaming industry where two main competing platforms exist. In these industries, we notice the presence of both exclusive as well as common content on a platform. In our setting, on the Hotelling line there exist two types of content providers: the multi-homers in the center and single-homers on the extreme ends. Content providers who are more compatible with a platform prefer single-homing while content providers in the center who are relatively indifferent between joining the two platforms port their content on both the platforms and multi-home.

We find that in a model with non-discriminatory pricing regime, consumer prices fall with a rise in content provider independent payoff. As content providers' independent payoff falls there exists a relatively larger share of single-homers and lower share of multi-homers. This allows platforms to charge higher consumer prices due to the presence of a larger gamut of exclusive content. The profits of platforms are rising in this independent payoff. This is because the price effect due to an increase in content providers' independent payoff is outweighed by the value effect resulting in larger number of total content providers. This allows platforms to obtain a larger payoff from a bigger pool of content providers. The main result of our paper is that a discriminatory pricing regime leads to lower profits than the non-discriminatory regime for large independent payoff. The intuition here is that platform profits in the non-discriminatory are more susceptible to changes in independent payoffs as they cannot discriminate between content providers. Since profits are rising in independent payoffs, large independent payoffs imply greater profits in the non-discriminatory regime than the discriminatory regime. On the other hand, low independent payoffs result in lower platform profits in the non-discriminatory regime than the discriminatory regime. Price discrimination and its impact on competition in a one-sided setting has been debated extensively. We add to this debate in a two-sided framework. We find that content provider independent payoff is crucial when making homing decisions and hence influences platform profits. We further find that consumer surplus and welfare are higher in the discriminatory pricing regime for low levels of content provider independent payoff.

We then look at some extensions of our model. Firstly, we let pricing regime be endogenous and decided simultaneously at stage zero. We find that the price discrimination regime is a long run equilibrium outcome. Then we look at variants of our model and show that our results are robust. We start by looking at the case when consumers obtain different marginal benefits from multi-homing and single-homing agents on the other side. Then we analyze the case where single-homers are provided different independent payoff of being on a platform than multi-homers. Finally, we look at how our results vary with economies of scale. All of these variations of our benchmark model confirm our main result that relatively higher content provider independent payoffs result in lower platform profits in the discriminatory pricing regime.

In our model, we have assumed that homing behavior is common knowledge and contracts are perfectly enforceable. This assumption is justified as in the mobile-industry as well as gaming industry a platform can confirm the presence of specific content on the rival platform with little or no cost. This allows platforms to formulate binding contracts.

An extension to our model could focus on the direction where content providers obtain negative network benefits from a larger presence of content providers. Another direction for further research could be where consumers are charged different prices for single-homing and exclusive content. This may provide interesting intuition into the pricing strategies of premium content on a platform and its implications on competition.

# 7 Appendix

**Proof of Lemma 3.** *Non-Discriminatory Pricing Regime:* We solve the consumer and content provider demands in (18) and (8) simultaneously and get the following reduced demands.

$$\begin{aligned} n_i &= \frac{-\gamma\phi^2 + \phi(\gamma(-2k + l_i + l_j) + t_S(-p_i + p_j + t_S)) + 2t_S^2(k - l_i)}{2\left(t_S^3 - \gamma t_S \phi\right)}, \\ m_i &= \frac{\gamma(l_i - l_j + \phi) + t_S(p_i - p_j - t_S)}{2\gamma\phi - 2t_S^2}. \end{aligned}$$

The resulting profit of each platform in the non-discriminatory pricing regime is given as

$$\Pi_i^{ND} = p_i m_i + l_i n_i,$$

Solving the first order conditions with respect to $p_i$ and $l_i$ we get the following price relations

$$\begin{aligned} p_i &= \frac{-\gamma\phi - l_i(\gamma + \phi) + \gamma l_j + t_S(p_j + t_S)}{2t_S}, \\ l_i &= \frac{2k\left(t_S^2 - \gamma\phi\right) + \phi(\gamma(l_j - \phi) + t_S(p_j + t_S)) - p_i t_S(\gamma + \phi)}{4t_S^2 - 2\gamma\phi}. \end{aligned}$$

Using symmetry and solving simultaneously we get

$$p^* = t_S - \frac{\phi(2k+3\gamma+\phi)}{4t_S},$$
$$l^* = \frac{(2k-\gamma+\phi)}{4},$$

and the resulting platform profits as $\Pi^{ND,*} = \frac{t_S}{2} + \frac{4k^2-(\gamma+\phi)^2-2\gamma\phi}{16t_S}$, total number of content providers are given as $n^* = \frac{2k+\gamma+\phi}{4t_S}$.

*Discriminatory Pricing Regime:* We solve simultaneously the content provider and consumer demands as in (4.2) and(18) and obtain the following reduced demands

$$\begin{aligned}
n_i &= \frac{-\gamma\phi^2+\phi(t_S(-p_i+p_j+t_S)-\gamma(2k-2l_i^M+l_i^S-2l_j^M+l_j^S))+2t_S^2(k-l_i^M-l_j^M+l_j^S)}{2\left(t_S^3-\gamma t_S\phi\right)}, \\
m_1 &= \frac{\gamma(l_1^S-l_2^S+\phi)+t_S(p_1-p_2-t_S)}{2\gamma\phi-2t_S^2} \text{ and } m_2 = 1-m_1, \\
n_i^S &= 1-n_j \text{for } i \neq j \in \{1,2\} \\
n^M &= n_1 - n_1^S = n_2 = n_2^S
\end{aligned}$$

profit of the platform is given as

$$\Pi_i^D = p_i m_i + l_i^S n_i^S + l_i^M n^M,$$

taking first order conditions with respect to $p_i$, $l_i^S$ and $l_i^M$ we get the following price relations,

$$p_i = \frac{-\gamma\phi-l_i^S(\gamma+\phi)+\gamma l_j^S+t_S(p_j t_S)}{2t_S},$$
$$l_i^S = \frac{\gamma\phi^2+\phi\left(-2\gamma t_S+\gamma(2k-4l_i^M-2l_j^M+l_j^S)+p_j t_S-t_S^2\right)+2t_S^2(-k+2l_i^M+l_j^M+t_S)-p_i t_S(\gamma+\phi)}{4t_S^2-2\gamma\phi},$$
$$l_i^M = \frac{(2k+2l_i^S-2l_j^M+l_j^S-t_S+\phi)}{4}.$$

Using symmetry and solving simultaneously we get

$$p^* = t_S - \phi,$$
$$l^S = t_S - \gamma,$$
$$l^{M,*} = \frac{(2k-3\gamma+\phi+2t_S)}{6}.$$

The resulting platform profits and total number of content provider are

$$\Pi^{D,*} = \frac{-9\gamma t_S+4k^2-4kt_S+4k\phi+19t_S^2-11t_S\phi+\phi^2}{18t_S} \text{ and } n^* = \frac{2(k+t_S)+\phi}{6t_S} \text{ respectively.}$$

Taking the difference between platform profits in the two regimes, we obtain

$$\Pi^{ND,*} - \Pi^{D,*} = \frac{(-3\gamma + 2k + 20t_S - 17\phi)(3\gamma + 2k - 4t_S + \phi)}{144t_S}$$

we can see that the above expression is positive for $k > \frac{4t_S - 3\gamma - \phi}{2}$.

**Proof of Lemma 4.** *Non-Discriminatory Pricing Regime:* The payoff of a single-homer on platform 1 in the non-discriminatory regime is then given as

$$U_1 = k_S + \phi m_1 - l_1 - t_S(y),$$

and on platform 2 is

$$U_2 = k_S + \phi m_2 - l_2 - t_S(1 - y).$$

The corresponding demands of the content providers are given by

$$U^M > U_1 \implies y > y_1^* = \frac{-2k + k_S + l_2 + t_S + m_1\phi - \phi}{t_S}$$

and

$$U^M > U_2 \implies y < y_2^* = \frac{2k - k_S - l_1 + m_1\phi}{t_S}$$

This results in the following content provider demands on the two platforms as $n_1 = y_2^*$ and $n_2 = 1 - y_1^*$. We solve simultaneously $n_1$, $n_2$ and consumer demands are as in (6) and (7) to get the following demands

$$\begin{aligned}
m_1 &= \frac{t_S(-p_1 + p_2 + t_S) - \phi(l_1 - l_2 + \phi)}{2(t_S - \phi)(t_S + \phi)}, \\
m_2 &= 1 - m_1 \\
n_i &= \frac{\phi^2(-4k + 2k_S + l_i + l_j) - 2t_S^2(-2k + k_S + l_i) + t_S\phi(-p_i + p_j + t_S) - \phi^3}{2t_S(t_S - \phi)(t_S + \phi)}
\end{aligned}$$

The resulting profit of each platform in the non-discriminatory pricing regime is given as

$$\Pi_i^{ND} = p_i m_i + l_i n_i.$$

We solve first-order conditions with respect to $p_i$ and $l_i$ and obtain the following price relations

$$\begin{aligned}
p_i &= \frac{\phi(-2l_i + l_j - \phi) + t_S(p_j + t_S)}{2t_S}, \\
l_i &= \frac{\phi^2(-4k + 2k_S + l_j) + 2t_S^2(2k - k_S) + t_S\phi(-2p_i + p_j + t_S) - \phi^3}{4t_S^2 - 2\phi^2}.
\end{aligned}$$

Using symmetry and solving simultaneously, we get

$$p^* = t_S - \frac{(2k - k_S + 2\phi)\phi}{2t_S},$$
$$l^* = k - \frac{k_S}{2},$$

and the resulting platform profits as $\Pi^{D,*} = \frac{(k_S - 2k)^2 + 2(t_S - \phi)(t_S + \phi)}{4t_S}$, total number of content providers are given as $n^* = \frac{2k - k_S + \phi}{2t_S}$.

*Discriminatory Pricing Regime:* The payoff of a single-homer of platform in the discriminatory regime is then given by

$$U_1 = k_S + \phi(m_1) - l_1^S - t_S(y),$$

and on platform 2 is

$$U_2 = k_S + \phi * m_2 - l_2^S - t_S(1 - y).$$

The corresponding demands of the content providers are given by

$$U^M > U_1 \implies y > y_1^* = \frac{-2k + k_S + l_1^M - l_1^S + l_2^M + t_S + m_! \phi - \phi}{t_S}$$

and

$$U^M > U_2 \implies y < y_2^* = \frac{2k - k_S - l_1^M - l_2^M + l_2^S + m_1\phi}{t_S}$$

This results in the following content provider demands on the two platforms as $n_1 = y_2^*$ and $n_2 = 1 - y_1^*$. We solve simultaneously $n_1$, $n_2$ and consumer demands are as in (6) and (7) to get the following demands

$$\begin{aligned}
m_1 &= \frac{t_S(-p_1 + p_2 + t_S) - \phi(l_1 - l_2 + \phi)}{2(t_S - \phi)(t_S + \phi)}, \\
m_2 &= 1 - m_1, \\
n_i &= \frac{1}{4}\left(\frac{2(4k - 2k_S - 2l_i^M + l_i^S - 2l_j^M + l_j^S)}{t_S} + \frac{-l_i^S + l_j^S - p_i + p_j}{t_S - \phi} + \frac{-l_i^S + l_j^S + p_i - p_j}{t_S + \phi} + \frac{2\phi}{t_S}\right), \\
n_i^S &= 1 - n_j, \\
n^M &= n_i - n_i^S.
\end{aligned}$$

the profit of the platform is given by

$$\Pi_i^D = p_i m_i + l_i^S n_i^S + l_i^M n^M.$$

Solving the first order conditions with respect to $p_i$ and $l_i$, we get the following price relations,

$$
\begin{aligned}
p_i &= \frac{\phi(-2l_i^S + l_j^S - \phi) + t_S(p_j + t_S)}{2t_S}, \\
l_i^S &= \frac{\begin{array}{r}\phi^2(4k - 2k_S - 4l_i^M - 2l_j^M + l_j^S - 2t_S) + 2t_S^2(-2k + k_S + 2l_i^M + l_j^M + t_S) \\ + t_S\phi(-2p_i + p_j - t_S) + \phi^3\end{array}}{4t_S^2 - 2\phi^2}, \\
l_i^M &= \frac{(4k - 2k_S + 2l_i^S - 2l_j^M + l_j^S - t_S + \phi)}{4}.
\end{aligned}
$$

Using symmetry and solving simultaneously we get

$$
\begin{aligned}
p^* = l^S &= t_S - \phi, \\
l^{M,*} &= \frac{(2k - k_S - \phi + t_S)}{3},
\end{aligned}
$$

and the resulting platform profits and total number of content providers are respectively given as

$$
\Pi^{D,*} = \frac{4((k - k_S)^2 + (k_S - 2k)(t_S - \phi)) + \phi^2 + 19t_S^2 - 20t_S\phi}{18t_S} \text{ and } n^* = \frac{4k - 2k_S + 2t_S + \phi}{6t_S}.
$$

**Proof of Lemma 5.** *Non-Discriminatory Pricing Regime:* The payoff of a multi-homer in the non-discriminatory regime is then given as

$$
U^M = 2k + \phi - l_1 - l_2 - t_S(1 - \delta),
$$

The corresponding demands of the content providers are given by

$$
U^M > U_1 \implies y > y_1^* = \frac{-\delta t_S - k + l_2 + t_S + m_1\phi - \phi}{t_S}
$$

and

$$
U^M > U_2 \implies y < y_2^* = \frac{\delta t_S + k - l_1 + m_1\phi}{t_S}.
$$

This results in the following content provider demands on the two platforms as $n_1 = y_2^*$ and $n_2 = 1 - y_1^*$. We solve simultaneously $n_1$, $n_2$ and consumer demands are as in (6) and (7) to get the following demands

$$
\begin{aligned}
m_1 &= \frac{t_S(-p_1 + p_2 + t_S) - \phi(l_1 - l_2 + \phi)}{2(t_S - \phi)(t_S + \phi)}, \\
m_2 &= 1 - m_1 \\
n_i &= \frac{2t_S^2(\delta t_S + k - l_i) + \phi^2(-2\delta t_S - 2k + l_i + l_j) + t_S\phi(-p_i + p_j + t_S) - \phi^3}{2t_S(t_S - \phi)(t_S + \phi)}
\end{aligned}
$$

Given the demands above, the profit of each platform in the non-discriminatory pricing regime is given as

$$
\Pi_i^{ND} = p_i m_i + l_i n_i.
$$

We solve first-order conditions with respect to $p_i$ and $l_i$ we get the following price relations

$$p_i = \frac{\phi(-2l_i + l_j - \phi) + t_S(p_j + t_S)}{2t_S},$$
$$l_i = \frac{2t_S^2(\delta t_S + k) + \phi^2(-2\delta t_S - 2k + l_j) + t_S\phi(-2p_i + p_j + t_S) - \phi^3}{4t_S^2 - 2\phi^2}.$$

Using symmetry and solving simultaneously, we get

$$p^* = -\frac{\delta t_S\phi + \phi(k + 2\phi) - 2t_S^2}{2t_S},$$
$$l^* = \frac{1}{2}(\delta t_S + k).$$

and the resulting platform profits as $\Pi^{ND,*} = \frac{t_S}{2} + \frac{(k+\delta t_S)^2 - 2\phi^2}{4t_S}$, total number of content providers are given as $n^* = \frac{\delta t_S + k + \phi}{2t_S}$.

*Discriminatory Pricing Regime:* The payoff of the single-homer remains as in (4). The payoff of a multi-homer in the discriminatory regime is then given by

$$U^M = 2k + \phi - l_1^M - l_2^M - t_S(1 - \delta),$$

The corresponding demands of the content providers are given by

$$U^M > U_1 \implies y > y_1^* = \frac{-\delta t_S - k + l_1^M - l_1^S + l_2^M + t_S + m_1\phi - \phi}{t_S}$$

and

$$U^M > U_2 \implies y < y_2^* = \frac{\delta t_S + k - l_1^M - l_2^M + l_2^S + m_1\phi}{t_S}.$$

This results in the following content provider demands on the two platforms as $n_1 = y_2^*$ and $n_2 = 1 - y_1^*$. We solve simultaneously $n_1$, $n_2$ and consumer demands are as in (6) and (7) to get the following demands

$$\begin{aligned}
m_1 &= \frac{t_S(-p_1 + p_2 + t_S) - \phi(l_1^S - l_2^S + \phi)}{2(t_S - \phi)(t_S + \phi)},\\
m_2 &= 1 - m_1,\\
n_i &= \frac{1}{4}\left(4\delta + \frac{2(2k - 2l_i^M + l_i^S - 2l_j^M + l_j^S)}{t_S} + \frac{-l_i^S + l_j^S - p_i + p_j}{t_S - \phi} + \frac{-l_i^S + l_j^S + p_i - p_j}{t_S + \phi} + \frac{2\phi}{t_S}\right),\\
n_i^S &= 1 - n_j,\\
n^M &= n_i - n_i^S.
\end{aligned}$$

Given the demands above, the profit of each platform in the discriminatory pricing regime is given as

$$\Pi_i^D = p_i m_i + l_i^S n_i^S + l_i^M n^M.$$

We solve first-order conditions with respect to $p_i$ and $l_i$ we get the following price relations

$$p_i = \frac{\phi(-2l_i^S + l_j^S - \phi) + t_S(p_j + t_S)}{2t)S},$$
$$l_i^S = \frac{2t_S^2(-\delta t_S - k + 2l_i^M + l_j^M + t_S) + \phi^2(2(\delta - 1)t_S + 2k - 4l_i^M - 2l_j^M + l_j^S) + t_S\phi(-2p_i + p_j - t_S) + \phi^3}{4t_S^2 - 2\phi^2}$$
$$l_i^M = \frac{1}{4}(2\delta t_S + 2k + 2l_i^S - 2l_j^M + l_j^S - t_S + \phi).$$

Using symmetry and solving simultaneously, we get

$$p^* = l^{S,*} = t_S - \phi,$$
$$l^{M,*} = \frac{1}{3}(\delta t_S + k + t_S - \phi).,$$

and the resulting platform profits as $\Pi^{D,*} = \frac{(4(\delta-1)\delta+19)t_S^2+4(\delta-5)t_S\phi+4k^2+4k((2\delta-1)t_S+\phi)+\phi^2}{18t_S}$, total number of content providers are given as $n^* = \frac{2(\delta t_S+k+t_S)+\phi}{6t_S}$.

Taking the difference between the profits in the two pricing regimes, we obtain the following expression

$$\Pi^{D,*} - \Pi^{ND,*} = -\frac{((\delta + 10)t_S + k - 10\phi)((\delta - 2)t_S + k + 2\phi)}{36t_S}.$$

This expression clearly implies that when $k < 2(t_S - \phi) - \delta t_S$, the discriminatory pricing regime results in higher profits. When $k > 2(t_S - \phi) - \delta t_S$ the non-discriminatory pricing regime results in higher profits.

**Derivation of platform profits in the table in section 5.1** Without loss of generality let us assume that firm 2 is the firm that discriminatory pricing regime and firm 1 chooses the non-discriminatory pricing regime. The payoff of single-homer at platform 1 is given by

$$U_1 = k + \phi m_1 - l_1 - t_S(y)$$

and payoff of the single-homing content provider at platform 2 is given by

$$U_2 = k + \phi m_2 - l_2^S - t_S(1 - y)$$

The payoff of a multi-homer is then given by

$$U^M = 2k + \phi - l_1 - l_2^M - t_S,$$

The corresponding demands of the content providers are given by

$$U^M > U_1 \implies y > y_1^* = \frac{-k + l_2^M + t_S + m_1\phi - \phi}{t_S}$$

and

$$U^M > U_2 \implies y < y_2^* = \frac{k - l_1 - l_2^M + l_2^S + m_1\phi}{t_S}.$$

This results in the following content provider demands on the two platforms as $n_1 = y_2^*$ and $n_2 = 1 - y_1^*$. We solve simultaneously $n_1$, $n_2$ and consumer demands are as in (6) and (7) to get the following demands

$$\begin{aligned}
m_1 &= \frac{t_S(-p_1 + p_2 + t_S) - \phi(l_1 - l_2^S + \phi)}{2(t_S - \phi)(t_S + \phi)}, \\
m_2 &= 1 - m_1, \\
n_1 &= \frac{2t_S^2(k - l_1 - l_2^M + l_2^S) + \phi^2(-2k + l_1 + 2l_2^M - l_2^S) + t_S\phi(-p_1 + p_2 + t_S) - \phi^3}{2t_S(t_S - \phi)(t_S + \phi)}, \\
n_2 &= \frac{\phi^2(-2k + l_1 + 2l_2^M - l_2^S) + 2t_S^2(k - l_2^M) + t_S\phi(p_1 - p_2 + t_S) - \phi^3}{2t_S(t_S - \phi)(t_S + \phi)}, \\
n_i^S &= 1 - n_j, \\
n^M &= n_1 - n_2.
\end{aligned}$$

Given the demands above, the profit of platform 1 is given by

$$\Pi_1^{nd} = p_1 m_1 + l_1 n_1.$$

We solve the first-order conditions and get the following price relations

$$\begin{aligned}
p_1 &= \frac{\phi(-2l_1 + l_2^S - \phi) + t_S(p_2 + t_S)}{2t_S}, \\
l_1 &= \frac{2t_S^2(k - l_2^M + l_2^S) - \phi^2(2k - 2l_2^M + l_2^S) + t_S\phi(-2p_1 + p_2 + t_S) - \phi^3}{4t_S^2 - 2\phi^2}.
\end{aligned}$$

Profit of platform 2 is given by

$$\Pi_2^d = p_2 m_2 + l_2^S n_2^S + l_2^M n_2^M.$$

We solve first-order conditions with respect to $p_2$, $l_2^S$ and $l_2^M$ we get the following price relations

$$\begin{aligned}
p_2 &= \frac{\phi(-2l_2^S + l_1^S - \phi) + t_S(p_1 + t_S)}{2t)S}, \\
l_2^S &= \frac{2t_S^2(-k + l_1 + 2l_2^M + t_S) - \phi^2(-2k + l_1 + 4l_2^M + 2t_S) + t_S\phi(p_1 - 2p_2 - t_S) + \phi^3}{4t_S^2 - 2\phi^2}, \\
l_2^M &= \frac{1}{4}(2k - l_1 + 2l_2^S - t_S + \phi).
\end{aligned}$$

We solve the above price relations simultaneously and get the following equilibrium prices.

$$\begin{aligned} p_1^* &= -\frac{\phi(k+2\phi) - 3t_S^2 + t_S\phi}{3t_S}, \\ l_1^* &= \frac{1}{3}(k + t_S - \phi), \\ p_2^* &= -\frac{\phi(k+2\phi) - 6t_S^2 + 4t_S\phi}{6t_S}, \\ l_2^{S,*} &= \frac{1}{6}(k + 4t_S - 4\phi), \\ l_2^{M,*} &= \frac{k}{2}. \end{aligned}$$

and the resulting platform profits for platform 1 and 2 are given by $\Pi_1^{nd,*} = \frac{2k^2-4\phi(k+t_S)+4kt_S+11t_S^2-7\phi^2}{18t_S}$ and $\Pi_2^{d,*} = \frac{13k^2+16k(\phi-t_S)+2(t_S-\phi)(17t_S+\phi)}{36t_S}$. The total number of content providers on platform 1 are given as $n_1^* = \frac{2(k+t_S)+\phi}{6t_S}$ and on platform 2 is given by $n_2^* = \frac{k+\phi}{2t_S}$ .

We get the following platform profit relations.

$$\Pi^{D,*} - \Pi_1^{nd,*} = \Pi_2^{d,*} - \Pi^{ND,*} = \frac{(k - 2t_S + 2\phi)^2}{9t_S} > 0.$$

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