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To Port or Not to Port?
Availability of Exclusivity in the Digital Service Market

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Abstract

The digital service market is vast and constantly expanding. In the digital service market, platforms such as Netflix, Steam, etc. often seek to enter into exclusivity deals with service providers or developers in order to get exclusive access rights to their digital services in the hopes that offering exclusive access to a digital product will entice new consumers to use their platform and thus generate increased profits. In this study we focus on this phenomenon in the mobile gaming market. For example, the game developer Electronic Arts agreed to offer Apple iOS a four-month exclusive deal for the well-known mobile game *Plants vs. Zombies 2*. The benefits of exclusivity deals for both platforms and digital service developers are unclear and have not been studied in the extant literature. We develop an analytical model of digital service profits to examine the optimal conditions of exclusivity for platforms and digital service developers. Our result shows that platforms prefer exclusivity while developers prefer offering their product on multiple platforms. We further explore the strategies that platforms and digital service developers can employ by analyzing three simultaneous and sequential game pricing and release scenarios. We find that higher profits can be generated by whichever party determines the price of a game first. However, we also found that in the presence of a leasing fee, platforms may prefer a simultaneous pricing and release scenario to even a platform-led pricing and release scenario. We conclude with implications for research and practice and suggestions for future research.

Keywords: Digital service platform, exclusivity, two-sided market, network externalities

“Apple gave us a truckload of money to delay the Android version [of Plants vs. Zombies 2].”

— Frank Gibeau, President of Electronic Arts (EA) Labels

1. Introduction

In spite of the vast scope of the increasingly popular digital services market, there remains great potential for future growth in this market (Bhattacharjee et al., 2011). The digital service market is generally composed of three major and interrelated elements: platforms, developers, and customers. Platforms offer an access point to customers, where they can purchase the digital services provided by the developer. In this paper, we focus on a typical digital service market, namely the rapidly expanding mobile games market. App Annie (2015) reports that gaming companies dominated its list of the top grossing app publishers for both iOS and Android platforms in 2014. While over half of mobile digital media use is devoted to apps, 32% of app use comprises gaming (Shields, 2014). The mobile gaming market is expected to grow by an additional 51% in North America, 47% in Western Europe, and 86% in China (Gaudiosi, 2015). According to Newzoo’s report, in 2014, global mobile gaming revenues reached $25 billion, an increase of 43% over 2013 (Gaudiosi, 2015).

An endless argument in the mobile games market concerns exclusivity; because there are two major platforms (i.e., iOS and Android), developers may strategically release products on one platform but not the other. For instance, the success of *Plants vs. Zombies* has attracted much attention not only from customers but also from platforms. *Plants vs. Zombies 2: It’s About Time* was first released worldwide on the *Apple App Store* on August 15, 2013. After more than four months, the Android version was made available on *Google Play* on October 23, 2013. Frank Gibeau, head of Electronic Arts (EA) Labels, mentioned *the “truckload of money” quotes* in one of his presentations, which reveals an open secret in the mobile game industry—developers and platforms sometimes cooperate by using platform exclusivity as a co-marketing strategy.

More generally in the digital services industry, platforms attempt to gain exclusivity on titles for their own platforms in order to attract customers. For example, the streaming service, Netflix, entered into an exclusive agreement with ABC Television Group to make Netflix the exclusive streaming platform of the series *How to Get Away with Murder* (Netflix, 2015), which secures demand for the platform among fans of this series as long as it hold exclusive streaming rights . More examples can be found across many different platforms and digital services. For example, Square Enix granted Google Android a month of exclusive access for both the games *Final Fantasy VI* and *Gree's Rage of the Immortals* (Newman, 2014). In another example, Amazon Web Services developed a course on its service and infrastructure and offered this course exclusively on Coursera (AWS, 2018).

For digital services developers, the major consideration is whether to offer an exclusive deal or not. If a digital services developer chooses to make a limited-time exclusive deal with a platform, they may jeopardize the user demand generated from other competing platforms during the period of exclusivity. On the other hand, multi-homing developers must bear porting and migration costs in order to make their digital services available on different platforms. The tradeoffs involved in such choices drive the following research question: *Is exclusivity of digital services profitable for platforms and developers?*

In addition the network externality is widely recognized as one key driving force for information products as well as the interactions among developers, platforms, and players in our research content. A digital service or a platform becomes more valuable when increasing number of users (including developers and customers) participate. The customers may benefit more and achieve higher utilities when the network size is expanding, for example, bringing friends together, sharing playing experience and skills, enhancing teamwork skills and etc. Developers also benefit greatly from a growing players' base by establishing good reputations or selling their apps / services. Thus we re-consider the above-mentioned research question in presence of the network effects.

To further reconcile the conflict of interest between platforms and developers, one possible solution is the "truckload of money" strategy, as used, for example, with *Plants vs. Zombies 2: It's About Time*—that is, a "truckload of money," in the forms of leasing fees, was provided by platforms to compensate developers for expected costs associated with exclusivity. However, platforms must consider the tradeoffs associated with such leasing fees. While an appropriate leasing fee secures exclusive rights to a popular app or service, thus boosting the overall profits of a platform, an excessively high leasing fee may, in turn, reduce platform profits. These considerations lead us to our second set of research questions: *1. What is an appropriate leasing fee level? 2. Will the presence of a leasing fee change platform or developer preferences?*

To answer these research questions, we establish an analytical model to examine the preference for exclusivity for both the digital service developers and platforms. Our baseline model assumes that digital service developers prefer multi-homing strategies and that platforms prefer having exclusive access to digital services. We further explore the interaction between developers and platforms based on the sequence of product release and price revelation. For both developers and platforms, revealing prices before the other respective party results in higher profits. In our stylized model we further analyze the dynamics among developers, platforms and customers in presence of the network externality – the findings are largely consistent with our baseline analysis.

Next we explore the threshold values of the leasing fee (i.e., exclusivity payments) in three different game release contexts: (1) simultaneous release—i.e., the developer and platform simultaneously release and price a game; (2) developer-led release—i.e., a game is released and priced by a developer before becoming available on a platform; (3) platform-led release—i.e., a game is priced by a platform before it is released by the developer. First, there exists an appropriate level of the leasing fee under conditions. Particularly in each game release context, if the final profit of the platform is beyond the threshold value, the leasing fee level plays a role – that is, when the lowest acceptable level of the exclusivity payment for the developer, is affordable for the platform, then the leasing fee level is appropriate and the preference of the developer is changed due to the presence of the leasing fee. Surprisingly, we also found that if the leasing fee is feasible, meaning that it is equal to the profit lost by developers because of platform exclusivity, platforms prefer simultaneous release scenarios to platform-led release scenarios. This finding contrasts with our expectation. One potential reason for this is that the platform can exploit the utility of the digital service engendered by exclusivity better in the simultaneous release context than in the platform-led context because the simultaneous release context enables the platform to take better advantage of the network-effect intensity, i.e., the consumer’s utility before purchase and the utility of the digital service per unit of time.

The remainder of the paper is organized as follows. Section 2 conducts a comprehensive review of the related literature. Section 3 outlines the stylized analytical models of exclusivity, Section 3.1

investigates profitability for platforms and digital services developers independently, and Section 3.2 explores the preference of platforms and digital services developers interactively in simultaneous and sequential release scenarios. Section 4 examines the tradeoff between exclusivity and the leasing fee. Section 5 concludes the paper by summarizing the managerial insights of our analyses and provides some possible directions for future research.

2. Related Work

Our research is related to the following research topics: two-sided market, network externality, and exclusive contracts and exclusive distribution literature. The theory of two-sided markets provides a solid framework to analyze the pricing and competition strategies for platforms and developers, and our stylized model integrates the theory of two-sided markets with network externality, to study the phenomenon of exclusive deals with leasing fee in the digital service markets. We highlight our contributions by comparing and contrasting our work with prior studies.

The concept of the two-sided market originates from the research on "two-sided matching markets", which studies a function of the market that matches one type of agent with another. Gale and Shapley (1962) are the earliest researchers to study the two-sided matching model. They analyze college admission and marriage and show that there is always a stable matching status. Although they do not give the definition of two-sided market, this is the first time the idea of type of market was introduced to the field of economics. Demange and Gale (1985) provide a model that describes a two-sided matching market. In a matching market, agents are buyers and sellers (or firms and workers, or men and women) who form partnerships based on satisfaction and make pecuniary transactions. Examples of matching markets are the housing market, academic markets, and the marriage market. These markets still represent traditional tangible markets with two-sided transactions that seem to have a unilateral market structure. However, they actually have the form of a strict two-sided matching market even though people focus on the platform less than on the two agent sides and, consequentially, the two-sided aspect of the transaction is less obvious. With the emergence of housing agents, labor mediation, and marriage intermediaries, the nature of these two-sided markets become more transparent.

Several discussions define the "two-sided market" from different angles. Roson (2005a) indicates that from an environmental point of view, two-sided networks, markets or platforms can be defined as economic environments. This type of market has one key economic feature, bilateral network externality, which means the increase of number of agents on one side would lead to the increase in the utility of agents on the other side. He adopts a market for meal voucher services in Italy to illustrate a formal model of the optimal auction scheme. Roson (2005b) demonstrates that in the two-sided market, the two (or more) groups interact with each other through the platform, affected by indirect network effects. This study considers the number of agents on the opposite side as "a sort of quality parameter" in choosing a platform, and as this parameter depends on the price charged to this opposite side, the utility of an agent is actually affected by prices charged to agents on both sides of the market. Rochet and Tirole (2004a, 2004b, 2006) defines a two-sided market as a platform that provides goods to two distinct groups of end users. The platforms have to set price for each side to "get both sides on board". Chakravorti and Roson (2006) adopt the same concept. They studied a competing payment networks by examining a two-sided market model and found that competition increases welfare on both sides.

Scholars seem to have reached a consensus with respect to characteristics of two-sided markets. Most articles study the platforms' pricing structure and strategy, while some involve the economic behavior of agents. Markets with the features described above can be classified into different types. Rochet and Tirole (2004a) examine markets based on functionalities and discuss three different situations: (1) when the platform is the price regulator, (2) when the platform is a licensing authority, and (3) when the platform is a competition authority. Evans (2003) argues that there are three categories of market organization in practice: coincident platforms, intersecting platforms and monopoly platforms. Evans and Schmalensee (2005) review four types of two-sided platforms: exchanges, advertiser supported media, transaction devices, and software platforms. Armstrong (2006) suggests that agents can be single-homing or multi-homing, depending on whether they choose to use one platform or several platforms and considers three cases: both sides single-homing, both sides multi-homing, and mixed case scenarios. "Competitive bottlenecks" can occur in the third case scenario. Armstrong analytically constructs models for the three types of two-sided markets to identify equilibrium prices and discusses examples of various specific industries. Kaiser and Wright (2006) present a model describing the market of magazine readership and advertising. They find the evidence that the price for readers is “subsidized” by advertisers based on the value they place on readers. Chakravorti and Roson (2006) studies payment networks in different market structures: duopolistic competition and cartel, symmetric and asymmetric networks, and alternative multi-homing and consumer preference structures. Mergers of two-sided markets are analyzed by Chandra and Collard-Wexler (2009), who use mergers in the Canadian newspaper industry as an example and find that greater concentration does not lead to higher prices for either newspaper subscribers or advertises. Adner, Chen and Zhu (2020) consider the compatibility decisions when there are two competing platforms in the hardware and content sales.

In terms of network externalities, the basic feature of a two-sided market is the existence of two distinct sides interacting through a platform. Rochet and Tirole (2003) point out that network externalities are the reason two-sided markets exist. They attempt to shift the perspective of analysis from the economic behavior of both sides to the business behavior and strategy of the platform, especially regarding competition between platforms. Armstrong (2006) indicates cross-group externalities and shows that one group’s benefit from joining a platform depends upon the platform’s ability to attract customers from the other group. He proposes three determining factors that affect the price structure of platform(s): relative size of cross-group externalities, fixed fees or per-transaction charges, and single-homing/multi-homing strategies. Cheng and Liu (2012) explore the optimal trial time for time-locked software versions. They created a framework demonstrating the effect of network externality to help software providers make binary decisions between limited-function software versions and time-locked versions. They further indicate the existence of a threshold of the binary decision variable and identify its value. Li, Liu and Bandyopadhyay (2010) discuss the the benefit of the two-sided market platforms in presence of the network effects and suggest the platforms should increase the relative differentiation. Yu, Hu and Fan (2011) study the pricing strategy when the underlying firms offer digital content and digital devices simultaneously. Wu and Chamnisampan (2020) investigate the two platforms compete in a two-sided market with cross-sided network effects, and further analyze the pricing problem. Lin, Pan and Zheng (2020) explore the dynamic pricing strategies of a two-sided monopoly platform on both sides with the effect of the network externalities.

Exclusive contracts and exclusive distribution literature are close to our work since we study the phenomenon of exclusive deals with leasing fee in the digital service markets. An earlier work by Mantena et al. (2010), examines the influence of exclusive contracting on the interaction between vendors of platforms and vendors of complements. They find that in the platform market, exclusivity is more likely in the mature stages, and non-exclusivity is in the intermediate stages. Jhang-Li and Chiang (2015) examine the impact of capacity planning and service versioning on service provider profit and social welfare, and Chiang and Jhang-Li (2020) study the phenomenon of windowing and the market dynamics between content owners, cable networks and streaming providers. Windowing is a way to create temporal exclusivities in digital content distribution. Our work examines the availability of exclusivities in digital service markets and can be regarded as a windowing study similar to Chiang and Jhang-Li (2020).

Very few studies explore the effect of exclusive time in analytical form - our model examines the influences of exclusive time and network externality in the interactions among platforms, developers and customers. Different pricing strategies for platforms and service developers are also investigated, particularly when a leasing fee is available to the service developers - to our best knowledge, our study is among the very few ones that study the leasing-fee impact in the exclusive deals.

3. The Model

Adopting the works of Armstrong and Wright (2004) and Armstrong (2006), we consider one developer providing a digital service to two competing platforms: A and B (as shown in Figure 1). The developer chooses whether to offer an exclusive deal to Platform A or not. If an exclusive deal is offered, the developer will not partner with Platform B until the end of the period of exclusivity. Consumers use either Platform A or Platform B exclusively. We assume that all the players are rational, i.e., the developer, Platform A, and Platform B all seek the maximum profits, and assume that consumers do not use the digital service until they purchase it.

Let the duration of the exclusivity be denoted by τ. Without loss of generality, τ is normalized between 0 and 1 by dividing the exclusive time by the expected lifespan of the digital service. The platforms receive payments from consumers, and both of the platforms charge consumers price p for access. The notation Q_τ represents the network size of the digital service—that is, the install base or the number of users that purchase the digital service given that the length of the exclusivity time is τ. Each consumer's valuation for the digital service is denoted by θ uniformly distributed over [0,1] (Cheng and Tang, 2010; Cheng and Liu 2012). Network externality increases each consumer's valuation θ by γQ_τ, where γ is the network effect intensity and captures the willingness to pay when an extra consumer joins the network (Cheng and Liu 2012). Table 1 provides a list of notations.

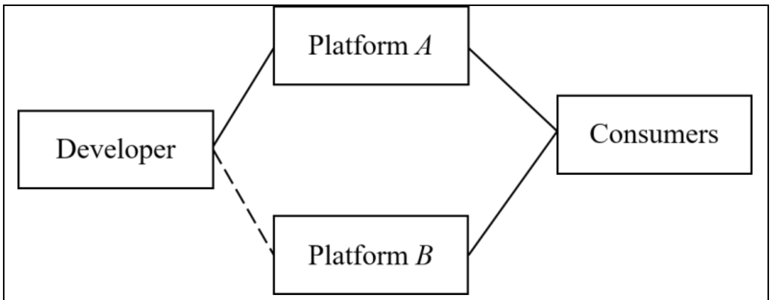

Figure 1. Market Structure

Each consumer has prior belief μ about the utility of the digital service before purchasing it. In general, consumers are initially inexperienced in a new digital service's settings and control system but become increasingly familiar with it and thus increase their utility after playing for a period of time. Let δ capture the increment of the utility of the digital service per unit of time and let each consumer's perceived utility about the digital service after playing for the exclusive time τ be $\mu + \delta\tau$. A consumer with valuation θ obtains the following net utility after purchasing the digital service:

$$U = (\theta + \gamma Q_\tau)(\mu + \delta\tau) - p - c \quad (1)$$

where c is the aggregate cost spent by consumers to play the digital service, including the cost involved with acquiring a mobile device, setting up the digital service deployment, and so on (ref. Eq. (1) in

Cheng and Liu 2012). The first term $\theta + \gamma Q_\tau$ describes the network effect, while the second term $\mu + \delta\tau$ captures each consumer's perceived utility about using the digital service, assuming that the increment of consumer's utility is linearly proportional to the duration of the exclusivity, consistent with the assumptions from extant literature (Pynadath and Marsella 2004; Cheng and Liu 2012). We further discuss the two cases in the following section.

Table 1. Summary of Notations	
p	Price of the digital service
τ	Duration of the exclusive deal, $\tau \in [0,1]$
Q_τ	Network size of the digital service
γ	Network effect intensity
μ	Consumer's utility before purchasing
δ	Increment of the utility of the digital service per unit of time
c	Consumer's aggregate cost to use the digital service, e.g. effort cost
c_p	Developer's cost when porting to another platform
θ	Consumer type

Table 1. Summary of Notations

3.1. Single Leading Player: Either Developer or Platform A

We first explore the preferences of the developer and platform when they perform individually and independently. We discuss two different cases - Case ***D***[1], the case that indicates **Developer's** preference for exclusivity, and Case ***A***[2], the scenario in which **Platform *A*** has a period of exclusivity.

[1] We name the case as "Case [D]" because the [D]eveloper's preference is studied in this case.
[2] We name the case as "Case [A]" because the platform [A]'s preference is studied in this case.

Case *D*: *D*eveloper's Preference for Exclusivity

We first discuss the scenario in which the developer leads the exclusivity arrangement. As shown in Figure 2, the developer offers an exclusive deal to Platform A. The exclusive deal is sustained for τ units of time. We let θ_τ denote the marginal consumer type who is indifferent between an exclusive versus nonexclusive deal for the period $[0, \tau]$, and let θ_0 denote the same consumer type if the exclusive deal is not offered. The developer releases the digital service to different platforms after the exclusive time τ has passed. At this point, the developer has more porting and developing cost c_p associated with simultaneously offering the product on different platforms even though the developer can now elicit increased demand from different platform offerings. Note that during the exclusivity time $[0, \tau]$, Platform B's consumers are unable to access the digital services. Adopting from Cheng and Liu (2012), both θ and τ are uniformly distributed, the area under the product of two subintervals $[0, \theta_\tau] \times [0, \tau]$ corresponds to platform B's consumers in the exclusivity period. Hence, the demand for the digital service is the total consumer size minus the platform B's consumers during the exclusivity period, i.e. $Q_\tau = 1 - \tau\theta_\tau$. Figure 2 also demonstrates the demand for the digital service as the shadow region. The two competing forces in the demand function are the exclusive duration (τ) and the marginal consumer type (θ_τ). Intuitively, one can derive that the marginal consumer type (θ_τ) decreases in the exclusive duration (τ) by Eq. (1). Thus an increase in the exclusive duration shift itself up but also shift the marginal consumer type to the left, the indeterminateness of the change in demand occurring a tradeoff to be explored. The developer seeks to set one decision variable, the price of the digital service p, to maximize the profit as follows:

$$\max_{p_D} \pi_D = p_D \cdot Q_\tau - c_p \tag{2}$$

subject to

$$0 \leq Q_\tau \leq 1 \tag{3}$$

$$p_D \geq 0 \tag{4}$$

Eq. (2) describes the developer's profit function. Inequality (3) ensures the demand is nonnegative and no larger than the total number of consumers. Inequality (4) requires that the price p be nonnegative.

Recall that θ_τ represents the marginal consumer who is indifferent between purchasing the digital service or not. Setting the net utility function in Equation (1) to zero, we derive the marginal consumer type as $\theta_\tau = \frac{p+c}{\mu+\delta\tau} - \gamma Q_\tau$. Hence, the demand for the digital service is described by $Q_\tau = 1 - \tau\theta_\tau$. Substituting $\theta_\tau = \frac{p+c}{\mu+\delta\tau} - \gamma Q_\tau$ into the demand function, we derive the demand of the digital service as $Q_\tau = \frac{\mu+\delta\tau-\tau(p+c)}{(1-\tau\gamma)(\mu+\delta\tau)}$. In this case, the above problem establishes the optimal price as ${p_D}^* = \frac{1}{2}(\frac{\mu}{\tau} + \delta - c)$ and the maximum profit as ${\pi_D}^* = \frac{1}{4}\frac{(\mu+\delta\tau-\tau c)^2}{\tau(1-\tau\gamma)(\mu+\delta\tau)} - c_p$. After examining the maximum profit, we obtain the following proposition.

Proposition 1. Over the entire lifespan of a digital service, the developer prefers release across multiple platforms rather than exclusive release on only one platform.

Proof. Please see the Appendix.

Our research goal of this study is to explore whether or not the exclusivity of digital services benefits the platforms and/or the service developers. The existence of the tradeoff between the total user demand and porting & migration cost, makes the research question deserve to be explored. *Proposition 1* provides the answer and shows that developer can obtain the maximum profit by offering the digital service across different platforms at the beginning of the releasing rather than joining Platform A in an exclusive deal, i.e., $\tau = 1$. Apparently, service providers tend not to offer an exclusive deal and not to stick to only one platform. In order to receive a complete answer to the research question, we keep examining the platform's strategy and preference for exclusivity under the second scenario below.

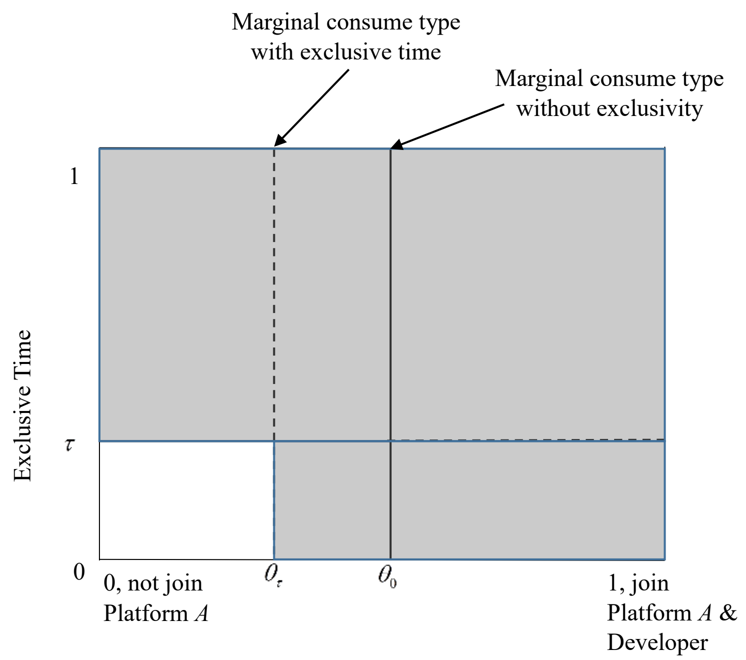

Figure 2. Distribution of Potential Consumers in Case D

Case <u>A</u>: Platform <u>A</u>'s Preference of the Exclusivity

Before moving to the model in this case, we would like to discuss the motivation for the platform to gain the exclusivity agreement first. Platform tries to induce users by attracting the consumers of the digital service through the exclusivity agreement, and this feature has been well incorporated in our stylized model. Recall that θ_0 denotes the marginal consumer type without the exclusive deal – under such circumstances, the consumer size on platform A and the consumer size not on platform A (i.e., the consumer size on platform B) are $1-\theta_0$ and θ_0, respectively. If the exclusive deal is introduced to platform A, the consumer size on platform A increases to $1-\theta_\tau$, as $\theta_\tau \leq \theta_0$, while the consumer size on platform B decreases to θ_τ, the area under the product of two subintervals $[0,\theta_\tau]\times[0,\tau]$ corresponds to platform B's consumers in the exclusivity period (Cheng and Liu, 2012). Please note that the aggregate cost (c) in the utility function includes the cost of acquiring a mobile device, our model enables the platform to induce consumers from its competitive platform through its exclusive access right to the digital service. A similar setting has been introduced by Anderson Jr et al. (2014), in which they assume that each user purchases one unit of the digital service on the platforms they joined, which can be relaxed by assuming that every certain number of users purchase one unit of the digital service, without changing the analytical results. Based on the assumption, an increase of the number of consumers on platform A due to the exclusive deal infers the increase of the number of users of platform A, while the number of users of platform B decreases.

In this case scenario, Platform A leads the exclusivity arrangement. Because of switching costs, we note that most consumers are unlikely to transfer to another platform if they have already been using one platform. Taking the example of the mobile phone market, we assume that if consumers choose to use one platform (i.e., Android vs. iOS), they will use the same platform until the end of the device lifespan. Figure 3 shows the consumer distribution for this case scenario, i.e. $Q_t^A = 1 - \theta_\tau$. The profit maximization problem is as follows:

$$\max_{p_A} \pi_A = p_A \cdot Q_t^A \tag{5}$$

subject to

$$0 \leq Q_t^A \leq 1 \tag{6}$$

$$p_A \geq 0 \tag{7}$$

Eq. (5) describes the developer's profit function in Case A. Inequality (6) ensures the demand is nonnegative and no larger than the total number of consumers. Inequality (7) requires that the price p_A, the price set by the digital service platform A, be nonnegative. The above problem conducts the following optimal price ${p_A}^* = \frac{1}{2}(\mu + \delta\tau - c)$ and profit of scenario ${\pi_A}^* = \frac{1}{4}\frac{(\mu+\delta\tau-c)^2}{(1-\gamma)(\mu+\delta\tau)}$. We thus propose the following:

Proposition 2. In order to obtain the maximum profit, Platform A's best strategy is to arrange exclusivity for the developer's digital service on its own platform.

Proof. Please see the Appendix.

Proposition 2 shows that platforms prefer totally exclusive deals, i.e., $\tau = 1$, where the platform can realize maximum profit, as the platform's profit is positively related to the duration of the period of exclusivity. Therefore, a totally exclusive deal is the optimal strategy for the platform.

Proposition 1 and Proposition 2 reveal the preferences of the developer and the platform and give optimal strategies accordingly. However, these optimal strategies are given under the assumption that the player (developer or platform) can make a decision without interference from another player (platform or developer). However, this is not necessarily the case in the real world. Their decisions—in this case, the price set for the digital service—will interact with each other and cooperate to change the utility of the digital service, thus making the situation more complex. The next section will discuss these situations.

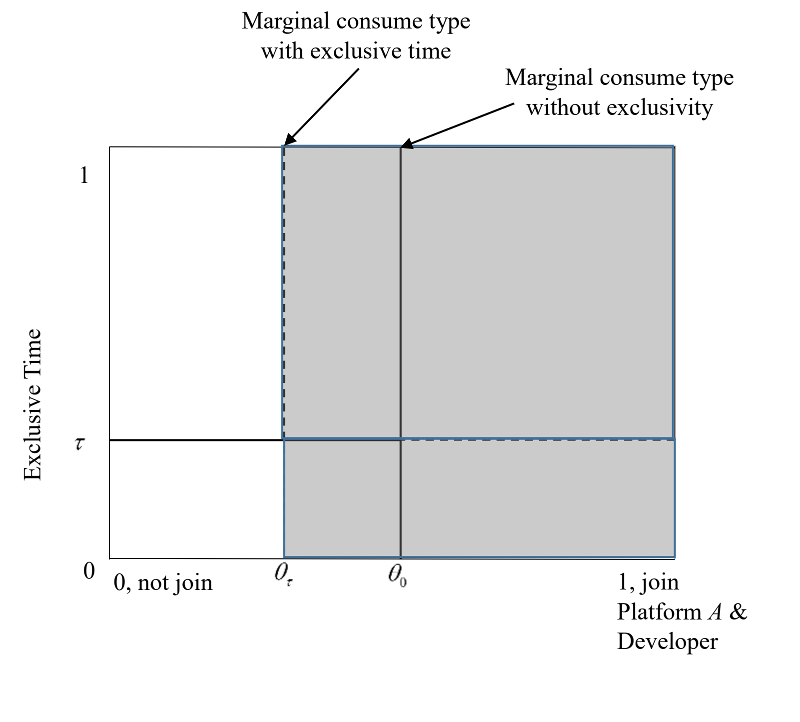

Figure 3. Distribution of Potential Consumers in Case A

3.2. Cooperative Players: Developer and Platform A

To explore the interactions between the digital service developer and the platform, we divide the cost of the digital service in consumer utility function into two distinct parts—p_D, the price set by the digital service developer, and p_A, the price set by the digital service platform. In addition, the network size of the digital service (Q_τ) still follow the demand function mentioned above—namely, for the developer, the network size of the digital service (Q_t^D) represents the consumer distribution as $Q_t^D = 1 - \tau\theta_\tau$ and, for the platform, the network size of the digital service (Q_t^A) shows the consumer demands as $Q_t^A = 1 - \theta_\tau$. According to these variables, we examine the maximum profit for both the digital service developer and Platform A. In addition, we focus on their respective maximum profits based on three difference sequences of price revelation: In Case 1, the developer and the platform determines the prices simultaneously; in Case 2.1, the developer set his price first; and, in Case 2.2., the platform gives its price before the developer's pricing decision (Case 2.2). The result of the simultaneous and two sequential pricing scenarios are also compared to give a deeper insight into the preferences of the developer and Platform A.

Profit maximization problem:

To maximize the profits of the developer and the platform, the network size of the digital service (Q_τ) is a substantial component. Noting the network size of the digital service for the developer (Q_t^D) as $Q_t^D = 1 - \tau\theta_\tau$ and the network size of the digital service for the platform as (Q_t^A) as $Q_t^A = 1 - \theta_\tau$, we can obtain the demand functions (Q_t^D and Q_t^A) in the terms of prices (p_D and p_A) according to the consumers type (θ_τ) who is indifferent between the exclusive and nonexclusive deal:

$$\begin{cases} U_t = (\theta_\tau + \gamma Q_t^A)(\mu + \delta\tau) - (p_D + p_A) - c = 0 \\ Q_t^D = 1 - \tau\theta_\tau \\ Q_t^A = 1 - \theta_\tau \end{cases}$$

Hence, we have the demand functions in the terms of prices as

$$\begin{cases} Q_t^D = 1 - \dfrac{\tau(p_D + p_A + c - \mu\gamma - \delta\tau\gamma)}{(1-\gamma)(\mu + \delta\tau)} \\ Q_\tau^A = \dfrac{\mu + \delta\tau - p_A - p_D - c}{(1-\gamma)(\mu + \delta\tau)} \end{cases}$$

Based on the developer's demand, namely the network size of the digital service for the developer (Q_t^D), and the developer's price (p_D), we derive the profit maximization problem of the digital service developer as:

$$\max_{p_D} \pi_D = p_D \cdot Q_t^D \tag{8}$$

subject to

$$0 \leq Q_t^D \leq 1 \tag{9}$$

$$p_D \geq 0 \tag{10}$$

Eq. (8) represents the developer's profit maximization function. The inequality (9) ensures that the demand is nonnegative and no larger than the total number of consumers. Moreover, the inequality (10) requires the developer's price (p_D) to be nonnegative.

In addition, based on the platform's demand—in other words, the network size of the digital service for the platform (Q_t^A), and the platform's price (p_A), the profit maximization function for the platform A and its constraints are also like those in Case A:

$$\max_{p_A} \pi_A = p_A \cdot Q_t^A \tag{11}$$

subject to

$$0 \leq Q_t^A \leq 1 \tag{12}$$

$$p_A \geq 0 \tag{13}$$

The equation (11) shown above describes the platform's profit maximization problem, and the inequality (12) gives constraints on the demand of the platform. In addition, the inequality (13) ensures that the platform's price is nonnegative. According to the two profit maximization problems mentioned in this section, we give Lemma 1 as follows:

Lemma 1. When the digital service developer and the platform interact with each other:

(i) For the developer, the optimal price is $P_D^* = \frac{1}{2}(\frac{μ}{τ} + δ - \frac{μγ}{τ} - δγ - p_A - c + μγ + δτγ)$, and the maximum profit is $π_D{}^* = \frac{1}{4}\frac{(μ+δτ-μγ-δτγ-τp_A-τc+τμγ+δτ^2γ)^2}{τ(1-γ)(μ+δτ)}$.

(ii) For the platform, the optimal price is $P_A^* = \frac{1}{2}(μ + δτ - p_D - c)$ and the maximum profit for the platform is $π_A{}^* = \frac{1}{4}\frac{(μ+δτ-p_D-c)^2}{(1-γ)(μ+δτ)}$.

Proof. Please see the Appendix.

Lemma 1 describes the relationship between the optimal price of the digital service developer and the optimal price of the platform, both of which influence their maximum profits. We further analyze their maximum profits according to the two different sequences of the pricing decisions based on Lemma 1.

Case 1: Developer and Platform A make decisions simultaneously

We first discuss the simultaneous pricing case—in this case, the digital service developer and the platform set their prices simultaneously. Analytically, we represent the developer's optimal price (P_D^*) and the platform's optimal price (P_A^*) at the same time as:

$$\begin{cases} \max\limits_{p_D} π_D \ = \ p_D \cdot Q_t^D \\ \max\limits_{p_A} π_A \ = \ p_A \cdot Q_t^A \end{cases}$$

The profit maximization problems mentioned above can be solved directly from Lemma 1 by analyzing the Lemma 1 Case (i) and the Lemma 1 Case (ii) simultaneously. Therefore, we present Lemma 2 as:

Lemma 2. In the simultaneous pricing case, the digital service developer's optimal price is ${p_{D1}}^* = \mu + \delta\tau - \frac{2}{3}\left(-\frac{\mu}{\tau} - \delta + \frac{\mu\gamma}{\tau} + \delta\gamma - c - \mu\gamma - \delta\tau\gamma + 2\mu + 2\delta\tau\right) - c$ and the maximum profit of the developer is ${\pi_{D1}}^* = \frac{1}{9}\frac{(2(\mu+\delta\tau-\mu\gamma-\delta\tau\gamma+\tau\mu\gamma+\delta\tau^2\gamma)-\tau c-\mu\tau-\delta\tau^2)^2}{\tau(1-\gamma)(\mu+\delta\tau)}$. The platform's optimal price is ${p_{A1}}^* = \frac{1}{3}(-\frac{\mu}{\tau} - \delta + \frac{\mu\gamma}{\tau} + \delta\gamma - c - \mu\gamma - \delta\tau\gamma + 2\mu + 2\delta\tau)$ and the maximum profit of the platform as ${\pi_{A1}}^* = \frac{1}{9}\frac{(-\frac{\mu}{\tau}-\delta+\frac{\mu\gamma}{\tau}+\delta\gamma-c-\mu\gamma-\delta\tau\gamma+2\mu+2\delta\tau)^2}{(1-\gamma)(\mu+\delta\tau)}$.

Proof. Please see the Appendix.

Lemma 2 describes the developer's optimal price and the platform's optimal price in the simultaneous pricing case and hence reveals their respective maximum profits. We next explore their maximum profits in two types of sequential pricing cases and evaluate the respective preferences of the platform and the developer among the three pricing cases.

Case 2: Developer or Platform A Moves One After Another

Case 2.1. Developer moves first

When the developer leads the sequential pricing cases, the digital service developer makes pricing decision first and Platform A then sets its pricing of the digital service based on its knowledge of the price set by the developer. Mathematically, we first solve the profit maximization problem of the developer by substituting the developer's price (p_D) for the platform's price (p_A), which is a function of p_D, from the profit maximization problem of the platform because $p_D$is known. Accordingly, the maximum profit for developer in Case 2.1 is ${\pi_{D2.1}}^* = \frac{(\mu+\delta\tau-\mu\gamma-\delta\tau\gamma-\frac{1}{2}\tau\mu-\frac{1}{2}\delta\tau^2-\frac{1}{2}\tau c+\tau\mu\gamma+\delta\tau^2\gamma)^2}{2\tau(1-\gamma)(\mu+\delta\tau)}$ and, hence, the maximum profit for Platform A in Case 2.1 is ${\pi_{A2.1}}^* = \frac{1}{4}\frac{(-\frac{\mu}{\tau}-\delta+\frac{\mu\gamma}{\tau}+\delta\gamma+\frac{3}{2}\mu+\frac{3}{2}\delta\tau-\frac{1}{2}c-\mu\gamma-\delta\tau\gamma)^2}{(1-\gamma)(\mu+\delta\tau)}$.

After examining the maximum profits in Case 1 and Case 2.1, we obtain the following proposition.

Proposition 3. As compared to the simultaneous pricing case, when the developer leads the sequential pricing case, the developer gains more profit and Platform A gains less profit.

Proof. Please see the Appendix.

Proposition 3 reveals the relative preferences of the developer and platform in the simultaneous pricing case versus the developer-led sequential pricing case. Based on Proposition 3 and the rationality assumption—i.e., both the digital service developer and the platform prefer more profit—one can intuitively conclude that the developer prefers the developer-led sequential pricing case to simultaneous pricing, while the platform prefers simultaneous pricing to the developer-led sequential pricing case. Proposition 3 is based on the simultaneous pricing model and the developer-led sequential pricing model. Next, we explore another sequential pricing model in which the platform leads the sequential pricing of the game and determines its price. We then compare the results of these three models.

Case 2.2. Platform A moves first

In this case scenario, Platform A determines its price before the developer determines his price. Similarly, we substitute the platform's price (p_A) for the developer's price (p_D), which is a function of p_A based on the developer's profit maximization function with p_A known, to deal with the profit maximization problem of the platform. Therefore, the maximum profit for the developer is ${\pi_{D2.2}}^* = \frac{1}{4}\frac{(\frac{3}{2}(\mu+\delta\tau-\mu\gamma-\delta\tau\gamma-\tau c+\tau\mu\gamma+\delta\tau^2\gamma)-\mu\tau-\delta\tau^2+\tau c)^2}{\tau(1-\gamma)(\mu+\delta\tau)}$ and, accordingly, the maximum profit for platform A is ${\pi_{A2.2}}^* = \frac{1}{2}\frac{(\mu+\delta\tau-\frac{1}{2}(\frac{\mu}{\tau}+\delta-\frac{\mu\gamma}{\tau}-\delta\gamma-c+\mu\gamma+\delta\tau\gamma)-c)^2}{(1-\gamma)(\mu+\delta\tau)}$. Based on the comparison between the maximum profits in this case with maximum profits in Case 1, we propose the following:

Proposition 4. As compared to the simultaneous pricing case, when Platform A leads the sequential pricing, Platform A gains more profit and the developer gains less profit.

Proof. Please see the Appendix.

In Proposition 4, the digital service developer prefers simultaneous pricing to the platform-led sequential pricing, while the platform prefers the platform-led sequential pricing to the simultaneous pricing case. As compared to the simultaneous pricing case, in the platform-led pricing case, the developer stands to gain less profit, while the platform can realize higher profits. Proposition 4, taken together with Proposition 3, reveal the preferences of the developer and the platform when the developer sets the price for the digital service first, when the platform sets the price for the digital service first, and when the developer and the platform simultaneously set the prices. Accordingly, Proposition 5 posits:

Proposition 5. Among the three release case scenarios, the developer gains maximum profits in the developer-led pricing case and gains minimum profits in the platform-led pricing case. Similarly, Platform A realizes maximum profits in the platform-led pricing case and minimum profits in the developer-led pricing case.

Proof. Please see the Appendix.

Proposition 5 shows a relationship between the sequence of acting (price determination) and the corresponding profit. For both the digital service developer and the platform, naming their respective price first always yields higher profits. Accordingly, determining prices first is a strategy that can be used by both the digital service developer and the platform. Proposition 3, Proposition 4, and Proposition 5 explore the three cases involving an interaction between the developer and platform regarding the market pricing of a digital service. We now discuss the exclusivity of the digital service at a given price based on the models of the simultaneous and sequential pricing.

4. Platform A Pays the Developer a Leasing Fee

Our previous results show that platforms prefer making an exclusive deal with a developer while developers prefer offering their digital service across different platforms. We find that platforms and developers have radically different exclusivity preferences. However, a game can only begin to make profits after platforms and developers make an agreement regarding the exclusivity (or nonexclusivity) of a service and establish the duration of a potential exclusivity deal. We also sought to investigate the effect of exclusivity on profit for platforms and developers. To do so, we defined the leasing fee as a payment made from a platform to a developer for a period of exclusivity. In other words, the platform agrees to transfer part of its profit to the developer in exchange for a period of platform exclusivity. With the presence of the leasing fee, the decision-making process may be changed. The leasing fee is a common feature of the digital service market. For example, Apple purchased an exclusive deal for *Plants vs. Zombies 2* by means of a leasing fee. In the words of the president of Electronic Arts: "Apple gave us a truckload of money to delay the Android version." We also did some survey with developers - the leasing fee is not only in cash format, while it can be in the form of marketing resources, such as recommended position or Featured First.

More specifically, because both the developer and the platform are unwilling to accept profit losses caused by a leasing fee based on the rationality assumption, we further define the leasing fee to be equal to the profit lost by a developer by switching from an initial period of exclusivity on one platform (τ) to a new period of exclusivity on another platform (τ'), which is the fee that is optimal for the platform as the payer. Similarly, a feasible leasing fee should ensure that, at a minimum, the platform does not lose profit after paying a leasing fee for a new period of exclusivity. Therefore, we have:

$$\begin{cases} l = \pi_D{}^*(\tau) - \pi_D{}^*(\tau') \\ \pi_A{}^*(\tau') - l \geq \pi_A{}^*(\tau) \end{cases}$$

In other words, a feasible leasing fee is a leasing fee that is equal to the developer's lost profit ($\pi_D{}^*(\tau) - \pi_D{}^*(\tau')$) encountered from switching from an initial period of exclusivity (τ) to a new period of exclusivity (τ') and is no larger than the increased profits realized by the platform ($\pi_A{}^*(\tau') - \pi_A{}^*(\tau)$) generated by the period of exclusivity.

$$l = \pi_D{}^*(\tau) - \pi_D{}^*(\tau') \leq \pi_A{}^*(\tau') - \pi_A{}^*(\tau)$$

therefore, in this case scenario, the developer would be indifferent to entering into the exclusivity deal and the leasing fee would be affordable for the platform.

In this section, we aim to explore the condition of a feasible leasing fee in the simultaneous and sequential pricing cases. Here, we assume that the initial period of exclusivity is optimal for the digital service developer and assume that new period of exclusivity will be a totally exclusive deal, $\tau' = 1$, the so-called final period of exclusivity. The totally exclusive deal is a special case of the new period of exclusivity. In this special case, the platform becomes the exclusive home of the digital service throughout its expected lifespan. This special case is common in the digital service market—for example, *Netflix* has hundreds of exclusive videos, including series, films, etc.; iMessage is exclusive to the iPhone; etc. While the digital service developer may potentially gain higher profits by being multihoming, there may be some important constraints involved in arrangements that are not multihoming. Since these constraints are focused, in this section, we address the minimum available period of exclusivity as the initial period according to the associated constraints. In the cases of leasing fee, this will involve situations that are optimal to the digital service developer, noting that those developers who deserve leasing fee are large developers and they gain higher profit by multi-homing or nearly multi-homing.

Case 1: Developer and Platform A make decisions simultaneously

Noting that in the simultaneous pricing case (Case 1), the digital service developer and the platform decide on the prices for the digital service at the same time, we use the platform's nonnegative optimal price for the digital service from the previous section. Since the initial period of exclusivity in the simultaneous pricing case (τ_1) is subject to the nonnegative price constraint and since the new period of exclusivity is the final period of exclusivity ($\tau' = 1$), we determine the developer's lost profit to be $\pi_{D1}{}^*(\tau_1) - \pi_{D1}{}^*(\tau') = \frac{1}{9}\frac{9\tau_1(-c+\mu+\delta\tau_1)^2}{(1-\gamma)(\mu+\delta\tau_1)} - \frac{1}{9}\frac{(\mu+\delta-c)^2}{(1-\gamma)(\mu+\delta)}$ and the increased profit of platform as $\pi_{A1}{}^*(\tau') - \pi_{A1}{}^*(\tau_1) = \frac{1}{9}\frac{(\mu+\delta-c)^2}{(1-\gamma)(\mu+\delta)}$. Accordingly, the feasible leasing fee in the simultaneous pricing case is $l_1 = \pi_{D1}{}^*(\tau_1) - \pi_{D1}{}^*(\tau') \leq \pi_{A1}{}^*(\tau') - \pi_{A1}{}^*(\tau_1)$ and we present the following proposition:

Proposition 6 If the final profit of platform is larger than half of the initial profit of the digital service developer, then a leasing fee is affordable for the platform.

Proof. Please see the Appendix.

Proposition 6 shows that the leasing fee for the platform in the simultaneous pricing case is feasible if the threshold value of the platform's final profit is half of the developer's initial profit, defined as the aggregate profit of a digital service divided equally between the developer and the platform in the simultaneous pricing case when the digital service is totally exclusive to the platform. When the platform's final profit is less than half of the developer's initial profit, the platform's increased profit, $\pi_{A1}{}^{*}(\tau') - \pi_{A1}{}^{*}(\tau)$, is less than the developer's lost profit, $\pi_{D}{}^{*}(\tau) - \pi_{D}{}^{*}(\tau')$, so that the first platform's increased profit does not cover the developer's lost profit and, hence, the platform does not realize enough profit to offset the leasing fee. However, when the platform's final profit is equal to at least half of the developer's initial profit, the platform's increased profit is also at least equal to the developer's lost profit, and therefore the leasing fee is affordable for the platform.

Case 2: Developer or Platform A Moves One After Another

Case 2.1. Developer moves first

In Case 2.1, the developer determines his price before the platform makes pricing decision. In this scenario, we also consider the nonnegative price constraint to conclude the initial period of exclusivity in the developer-led pricing case ($\tau_{2.1}$). Again, let the new period of exclusivity be the final period of exclusivity ($\tau' = 1$), which is optimal for the platform as the payer. In this case, the developer's lost profit is $\pi_{D2.1}{}^{*}(\tau_{2.1}) - \pi_{D2.1}{}^{*}(\tau') = \frac{1}{2}\frac{\tau_{2.1}(\mu+\delta\tau_{2.1}-c)^2}{(1-\gamma)(\mu+\delta\tau_{2.1})} - \frac{1}{8}\frac{(\mu+\delta-c)^2}{(1-\gamma)(\mu+\delta)}$ and the platform's increased profit is $\pi_{A2.1}(\tau') - \pi_{A2.1}{}^{*}(\tau_{2.1}) = \frac{1}{16}\frac{(\mu+\delta-c)^2}{(1-\gamma)(\mu+\delta)}$. Thus, the feasible leasing fee would be $l_{2.1} = \pi_{D2.1}{}^{*}(\tau_{2.1}) - \pi_{D2.1}{}^{*}(\tau') \leq \pi_{A2.1}{}^{*}(\tau') - \pi_{A2.1}{}^{*}(\tau_{2.1})$, and we can thus propose the following:

Proposition 7 If the final profit of the platform is larger than one third of the initial profit of the digital service developer, the leasing is affordable for the platform.

Proof. Please see the Appendix.

Proposition 7, again, determines the feasibility of the leasing fee paid by the platform in the developer-led pricing case. The threshold value of the platform's final profit is one third of the developer's initial profit, i.e. the platform's final profit is one third of the aggregate final profit of the digital service in the developer-led release scenario. When the platform's final profit is less than this threshold value, the platform's increased profit generated by the period of exclusivity is less than the losses incurred by developer through the exclusivity deal; hence, the platform's profit gains do not offset the developer's profit losses and a feasible leasing fee would thus not be affordable for the platform. However, when the platform's final profit is equal to or exceeds this threshold value, the platform's increased profit yielded by the period of exclusivity is enough to at least offset the developer's lost profit incurred by the exclusivity deal. Accordingly, the platform can afford a feasible leasing fee equal to the developer's lost profit.

Case 2.2. Platform A moves first

In Case 2.2, the platform determines its price before the digital service developer names a price. Similar to the previous cases, the nonnegative price constraint determines the duration of the initial period of exclusivity. Again, the new period of exclusivity in this sequential pricing case is still the final period of exclusivity, $\tau' = 1$. Therefore, the lost profit of developer is $\pi_{D2.2}{}^{*}(\tau_{2.2}) - \pi_{D2.2}{}^{*}(\tau') = \frac{1}{4}\frac{4\tau_{2.2}(-c+\mu+\delta\tau_{2.2})^2}{(1-\gamma)(\mu+\delta\tau_{2.2})} - \frac{1}{16}\frac{(\mu+\delta-c)^2}{(1-\gamma)(\mu+\delta)}$ and the increased profit of the platform is $\pi_{A2.2}{}^{*}(\tau') - \pi_{A2.2}{}^{*}(\tau_{2.2}) = \frac{1}{8}\frac{(\mu+\delta-c)^2}{(1-\gamma)(\mu+\delta)}$. Finally, the feasible leasing fee in the pricing case led by the platform is $l_{2.2} = \pi_{D2.2}{}^{*}(\tau_{2.2}) - \pi_{D2.2}{}^{*}(\tau') \leq \pi_{A2.2}{}^{*}(\tau') - \pi_{A2.2}{}^{*}(\tau_{2.2})$, and we propose the following:

Proposition 8 If the final profit of platform is larger than two-thirds of the initial profit of the digital service developer, the leasing is affordable for this platform.

Proof. Please see the Appendix.

Proposition 8 reveals the conditions for a feasible platform leasing fee in the platform-led pricing case. In the platform-led pricing case, because the platform's final profit is equal to at least two thirds of the aggregate final profit of a digital service, two-thirds of developer's initial profit represents the threshold value of the platform's final profit in this pricing case. Similarly, when the platform's final profit is less than the threshold value, two thirds of the developer's initial profit, the platform's increased profit generated by the period of exclusivity is less than the developer's losses caused by this period of exclusivity. Therefore, in this case scenario, the platform would not gain enough profit to afford the leasing fee, which is equal to the developer's lost profit. However, when the platform's final profit is equal to or larger than the threshold value, the platform's increased profit would be no less than the leasing fee, and hence the platform's increased profit would offset the leasing fee.

Since the leasing fee is equal to the developer's lost profit, there is no change in the developer's profit if the feasible leasing fee is executed. Accordingly, if the feasible leasing fee is executed, the profit of the platform would be mathematically derived from difference between the aggregate final profit and the developer's initial profit. Based on Proposition 6, Proposition 7, and Proposition 8, we thus propose the following:

Proposition 9 When the feasible leasing fee is executed, the digital service platform can gain more profit in the simultaneous pricing case than in the platform-led pricing case, but this result is not true for the developer-led pricing case.

Proof. Please see the Appendix.

Proposition 9 offers insight into the sequencing of a digital service pricing for the platform across three different pricing cases, with a feasible leasing fee executed in all three pricing cases. Proposition 9 suggests that in the context of a leasing fee, the platform stands to gain more profits when the platform and developer sets their prices for a digital service simultaneously, versus when the platform sets the price before the developer does, while the developer would realize the same amount of profit in both scenarios. However, uncertainty remains in the developer-led pricing context, as the initial period of exclusivity and the initial developer profit values are more defined in the simultaneous pricing and platform-led pricing contexts.

5. Conclusion

Exclusivity deals are very common in the growing digital service market because platforms can use such agreements to attract more users to their platforms and developers can compensate for losses related to such agreements through leasing fees paid by the platforms. In this study, we established an analytical model to investigate the tradeoffs involved with exclusivity deals in the digital services industry. Our model examines the exclusivity preferences of digital service developers and platforms, explores the interaction between developers and platforms regarding the orders of pricing of digital services in three different scenarios, and analyses the conditions that justify leasing fee payments in exchange for exclusivity. As such, our study can assist digital service developers and platforms in developing business strategies.

Our research yielded several interesting findings. First, we address the different preferences of digital service developers vis-à-vis platforms—to yield maximum profits, digital service developers prefer multi-homing strategies while platforms prefer exclusivity agreements. In addition, we further find that platforms prefer to set prices for the digital service prior to developers doing so, while developers prefer to set prices for their digital service before platforms do so.

Next, we define the leasing fee as payment made by a platform to a developer to compensate for platform exclusivity. Our findings show that in all our case scenarios, threshold values for platforms exists—when the final profit of the platform exceeds the certain threshold value based on the benchmark of the developers' initial profit, platforms can afford to pay a feasible leasing fee for exclusivity rights. Our findings surprisingly show that when the feasible leasing fee is executed, platforms prefer a simultaneous pricing case to even a platform-led pricing case. One implication of this result is that platforms are able to take better advantage the utility yielded by providing exclusive access to a new digital service in the simultaneous pricing case.

We have several suggestions for future research avenues: First, it would be interested to investigate the effects of relaxing the special case of the leasing fee in the model, but we are optimistic with the special case since the industry standard is for digital services to be released in exclusivity deals. There is also a need for additional research on developer-led pricing of digital services to address the uncertainty we identified in this scenario. This would allow developer-led pricing case to be more easily compared to the results in platform-led and simultaneous pricing cases. In conclusion, this study offers a first look at the phenomenon of exclusivity in the digital service market and sheds light on the implications of exclusivity deals among digital service developers and platforms in contexts that do and do not feature leasing fees to compensate developers for granting exclusivity rights.

References

Adner, R., Chen, J., & Zhu, F. (2020). Frenemies in platform markets: Heterogeneous profit foci as drivers of compatibility decisions. *Management Science*, 66(6), 2432-2451.

Amazon Web Services, Inc. (2018). “AWS and Coursera Offer New Course, AWS Fundamentals: Going Cloud-Native.” Retrieved from https://aws.amazon.com/about-aws/whats-new/2018/11/aws-coursera-new-course-aws-fundamentals-going-cloud-native/

Armstrong, M. (2006). Competition in two‐sided markets. *The RAND Journal of Economics*, *37*(3), 668-691.

Armstrong, M., & Wright, J. (2007). Two-sided markets, competitive bottlenecks and exclusive contracts. *Economic Theory*, 32(2), 353-380.

Anderson Jr, E. G., Parker, G. G., & Tan, B. (2014). Platform performance investment in the presence of network externalities. *Information Systems Research*, 25(1), 152–172

Annie, A. (2015). IDC. 2014. Mobile App Advertising and Monetization Trends 2012-2017: The Economics of Free.

Bhattacharjee, S., Gopal, R. D., Marsden, J. R., & Sankaranarayanan, R. (2011). Digital goods and markets: Emerging issues and challenges. *ACM Transactions on Management Information Systems (TMIS)*, 2(2), 1-14.

Cai, G., Dai, Y., & Zhou, S. X. (2012). Exclusive channels and revenue sharing in a complementary goods market. *Marketing Science*, *31*(1), 172-187.

Chakravorti, S., & Roson, R. (2006). Platform competition in two-sided markets: The case of payment networks. *Review of Network Economics*, *5*(1).

Chandra, A., & Collard‐Wexler, A. (2009). Mergers in two‐sided markets: An application to the Canadian newspaper industry. *Journal of Economics & Management Strategy*, *18*(4), 1045-1070.

Cheng, H. K., & Liu, Y. (2012). Optimal software free trial strategy: The impact of network externalities and consumer uncertainty. *Information Systems Research*, *23*(2), 488-504.

Cheng, H. K., & Tang, Q. C. (2010). Free trial or no free trial: Optimal software product design with network effects. *European Journal of Operational Research*, *205*(2), 437-447.

Chiang, I. R., & Jhang-Li, J. H. (2020). Competition through Exclusivity in Digital Content Distribution. *Production and Operations Management*, 29(5), 1270-1286.

Choi, J. P. (2010). Tying in two‐sided markets with multi‐homing. *The Journal of Industrial Economics*, *58*(3), 607-626.

Demange, G., & Gale, D. (1985). The strategy structure of two-sided matching markets. *Econometrica: Journal of the Econometric Society*, 873-888.

Evans, D. S. (2003). Some empirical aspects of multi-sided platform industries. *Review of Network Economics*, *2*(3).

Evans, D. S., & Schmalensee, R. (2005). *The industrial organization of markets with two-sided platforms* (No. w11603). National Bureau of Economic Research.

Gale, D., & Shapley, L. S. (1962). College admissions and the stability of marriage. *The American Mathematical Monthly, 69*(1), 9-15.

Gaudiosi, J. (2015). "Mobile game revenues set to overtake console games in 2015." Retrieved from http://fortune.com/2015/01/15/mobile-console-game-revenues-2015/

Hagiu, A. (2009). Two‐sided platforms: Product variety and pricing structures. *Journal of Economics & Management Strategy, 18*(4), 1011-1043.

Jhang-Li, J. H., & Chiang, I. R. (2015). Resource allocation and revenue optimization for cloud service providers. *Decision Support Systems*, 77, 55-66.

Kaiser, U., & Wright, J. (2006). Price structure in two-sided markets: Evidence from the magazine industry. *International Journal of Industrial Organization*, *24*(1), 1-28.

Li, S., Liu, Y., & Bandyopadhyay, S. (2010). Network effects in online two-sided market platforms: A research note. *Decision Support Systems*, 49(2), 245-249.

Lin, M., Pan, X. A., & Zheng, Q. (2020). Platform Pricing with Strategic Buyers: The Impact of Future Production Cost. *Production and Operations Management*, 29(5), 1122-1144.

Mantena, R., Sankaranarayanan, R., & Viswanathan, S. (2010). Platform-based information goods: The economics of exclusivity. *Decision Support Systems*, 50(1), 79-92.

Netflix, Inc. (2015). "Netflix To Be The Exclusive Global Streaming Home For Season One Episodes Of ABC's "How To Get Away With Murder"." Retrieved from https://www.prnewswire.com/news-releases/netflix-to-be-the-exclusive-global-streaming-home-for-season-one-episodes-of-abcs-how-to-get-away-with-murder-300145844.html

Newman, J. (2014). "If There's an Apple vs Google 'Arms Race' for Mobile Game Exclusives, Android's Losing." Time. Retrieved from http://time.com/70201/if-theres-an-apple-vs-google-arms-racefor-mobilegame-exclusives-androids-losing/

Pynadath, D. V., & Marsella, S. C. (2004). Fitting and compilation of multiagent models through piecewise linear functions. *International Conference on Autonomous Agents: Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems*, Vol. 3, 1197-1204.

Rochet, J. C., & Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, *1*(4), 990-1029.

Rochet, J. C., & Tirole, J. (2004a). Defining two-sided markets. *Toulouse, France: IDEI, mimeo, January*.

Rochet, J. C., & Tirole, J. (2004b). Two-sided markets: an overview. *Institut d'Economie Industrielle working paper*.

Rochet, J. C., & Tirole, J. (2006). Two-sided markets: a progress report. *The RAND journal of Economics*, *37*(3), 645-667.

Roson, R. (2005a). Auctions in a two-sided network: The market for meal voucher services. *Networks and Spatial Economics*, *5*(4), 339-350.

Roson, R. (2005b). Two-sided markets: A tentative survey. *Review of Network Economics, 4*(2).

Shields, B. (2014). "Are Mobile Games The Next Great Ad Medium?" Retrieved from http://blogs.wsj.com/cmo/2014/08/18/are-mobile-games-the-next-great-ad-medium/

Wu, C. H., & Chamnisampan, N. (2020). Platform entry and homing as competitive strategies under cross-sided network effects. *Decision Support Systems*, 113428.

Yu, A., Hu, Y., & Fan, M. (2011). Pricing strategies for tied digital contents and devices. *Decision Support Systems*, 51(3), 405-412.