Platform Competition with “Must-Have” Components

Christiaan Hogendorn and Ka Yat Yuen*

July 10, 2007

Abstract

In platform-component systems with indirect network effects, some components are so popular with consumers that they create large, discrete indirect network effects when they become available on a platform. They can be regarded as “must-have” from the point of view of the platform. For example, ESPN is a must-have component of cable TV platforms. This paper presents a theoretical model to assess how platform market structures affect the likelihood of exclusive versus non-exclusive contracts between platforms and components. The model evaluates the combined impacts of (i) the popularity of the component, (ii) the platform market share difference and (iii) the strength of cross-platform indirect network effects on the platform-component contractual arrangements. It shows that a component provider is more likely to sign exclusive access contracts with a single platform if its popularity is high, the platform market share difference is large, and cross-platform indirect network effects are low.

JEL classification: L14, L22, L82

Keywords: network effects, bargaining, platforms

*Economics Department, Wesleyan University. E-mail: chogendorn@wesleyan.edu.
1 Introduction

Many products operate on the platform-component model. Consumers derive more utility from platforms with a broad choice of components. This creates indirect network effects and a two-sided market. Due to superior technologies and well-known brand names, the availability of certain component providers causes a large, discrete indirect network effect. Examples of such “must-have” component providers include ESPN in the US pay-TV market, Squaresoft in the Japanese video game market and short messaging services (SMS) in the Chinese cell phone market.¹ These component providers typically try to internalize some of this network effect by bargaining with the platforms. Research interest in this type of industry has heightened recently, but we believe this is the first model to combine strategic competition between platforms with differentiated components that bargain with platforms over exclusivity and access fees.

Theoretical research on indirect network effects can be divided into two broad categories, namely the traditional platform-component literature and the emerging two-sided markets literature. Chou and Shy (1990, 1993 and 1996) and Church and Gandal (1992, 1993 and 2000) made significant contributions to the platform-component literature. They analyzed how indirect network effects influence the number of components on each platform. Typically there

¹The expression “must-have” is used to mean “very important,” but does not imply perfect complementarity. For perfect complements, Matutes and Regibeau (1988) show different results from those presented here.
are asymmetric market equilibria in which competing platforms do not have equal market shares and do not have the same number of components available.

The two-sided markets literature (Rochet and Tirole 2003, Armstrong 2004) emphasizes that indirect network effects present a chicken-and-egg problem. On the one hand, it is the number of components rather than the size of the installed customer base that attracts a given consumer to choose a platform. On the other hand, the size of the installed customer base determines how many component providers there are to join a given platform. Platforms try to get the two types of end-users on board by appropriately charging each side of the market. In order to coordinate the demand between components and consumers, the platform often chooses one side of the market (e.g., video game developers) as the profit center and the other side (e.g., gamers) as the loss leader.

The focus of the present paper is on platform-component contractual arrangements when some components create large indirect network effects and therefore have substantial bargaining power. Katz and Shapiro (1994) discuss the importance of quality differentiation among components. Harbord and Ottaviani (2002) model premium programming in the UK pay-TV market, and Rochet and Tirole (2003) model bargaining between end-users and component providers. In general most network models focus on homogeneous components and arms-length transactions without bargaining.

We define a must-have component as one that provides sufficient utility to consumers to create a large, discrete indirect network effect when it becomes
available on a platform. Thus, its contract with the platform will reflect not only its own attractiveness to consumers but the indirect network effect that it generates as well. A must-have component stands in contrast to basic components, which create positive but small indirect network effects. We model a must-have component provider’s incentive to offer exclusive or non-exclusive access contracts to platforms under different technological and market regimes.

A striking feature of platform-component settings with must-have components is that sometimes the must-have component is available exclusively on one platform, while other times it is available non-exclusively on all platforms. For example, the dominant video game console (platform) in the mid 1990s was Nintendo’s Family Computer (FC) until 1993. Game developer Squaresoft created an extraordinarily popular style of Role Playing Games (in which players traverse virtual worlds, learn fighting skills, and complete a quest) exclusively for the FC. But in 1996, Squaresoft signed a new exclusive agreement with Sony’s new Playstation (PS). Nintendo lost its decade-long market leadership, and Squaresoft’s defection was widely considered a key factor in the ultimate success of the PS.

An example with both exclusive and non-exclusive contracts is the US pay-TV market. The pay-TV industry consists of two types of businesses, satellite or cable operators and content providers (channels). The most popular channel is Disney’s sport-oriented ESPN, which in 2003 received an average fee of $1.76

\footnotetext[2]{The US version of FC was called Nintendo Entertainment System (NES).}

per subscriber per month from pay-TV operators, 50% higher than its nearest rival.\footnote{Kagan World Media, 2003.} Relations between pay-TV operators and Disney have been strained for years because of fights over how much Disney charges to carry ESPN.\footnote{Peter Grant, “Cox to Blame Cable Sports for Rate Surge,” Wall Street Journal, Oct. 6, 2003.} But ESPN offers non-exclusive access contracts to pay-TV operators and is carried on all pay-TV networks. In contrast, another sports channel, NFL Sunday Ticket, provides access to all U.S. National Football League games. It has an exclusive arrangement with satellite operator DirecTV.

In section 2, we describe the model. In section 3 we add bargaining between the platforms and the components, and we evaluate whether a must-have component should offer an exclusive or non-exclusive contract. Section 4 concludes.

## 2 The Model

We base our model on Crémer, Rey and Tirole (2000) (hereafter CRT) and a later extension of CRT by Malueg and Schwartz (2006). CRT model two Internet backbone providers competing to provide connections to many Internet service providers (ISPs). If the backbones are not interconnected themselves, there is a direct network effect between the various ISPs all connected to one backbone, and the number of ISPs determines the number of customers of each backbone. If the backbones are interconnected (at varying quality levels), the direct network effect is expanded to the ISPs connected to the other backbone.
CRT show that the larger backbone may not want to interconnect with the smaller one.

The CRT model is a good basis for our work because it includes strategic behavior by the platforms (the backbones) and partial compatibility between them (the quality of interconnection). We reinterpret the direct network effect in the CRT model as a reduced form version of an indirect network effect. Clements (2004) shows that this kind of interpretation affects the results of a network model only insofar as tipping to a single platform is possible. But we follow CRT and rule out tipping, so the reinterpretation does not affect our results. As in Rohlfs (2001), we translate the degree of interconnection into the strength of indirect network effects between platforms. We then introduce the must-have component and analyze how it affects the equilibrium sales, prices and profitability of competing platforms.

In this section we describe the CRT model. We preserve their notation and our only addition at this point is the pre-determined presence of a must-have component on one or both platforms. There are two platforms, $i = 1, 2$ with installed customer bases $\beta_1$ and $\beta_2$ respectively, where $\beta_1 \geq \beta_2 \geq 0$. The platforms’ initial market share difference is thus $\Delta = \beta_1 - \beta_2 \geq 0$.  

Platforms compete for new consumers to add to their installed bases. Consumers have an intrinsic value for each platform given by their type $\tau$. They also value the number of basic components available on the platform, given

\footnote{Most of our results hold for symmetric starting market shares, which is equivalent to \textit{ex ante} identical platforms. A positive $\Delta$ gives one platform a vertical product differentiation advantage, making it “higher quality.”}
by $N_i$. Consumers derive a marginal utility $\mu$ (a constant) from the must-have component if it is present on a platform.\footnote{Note that all consumers derive the same marginal utility from the must-have component.}

### 2.1 Exclusive on Platform 1

For now, assume platform 1 has exclusive access to the must-have component. Each consumer pays price $p_i$ for access to platform $i$. A type-\(\tau\) consumer’s utility from each platform is

\[
\begin{align*}
    u_1 &= \tau + N_1 + \mu - p_1 \\
    u_2 &= \tau + N_2 - p_2
\end{align*}
\]

Note that the platforms are not horizontally differentiated, since $\tau$ is not dependent on which platform is chosen. Therefore, in an equilibrium where both platforms attract new customers, their quality-adjusted prices must be equal:

\[
p_1 - N_1 - \mu = p_2 - N_2 = \hat{p}
\]

The marginal customer has type $\tau = \hat{p}$. Following Malueg and Schwartz (2006), let $\tau$ be distributed over $(-\infty, 1]$ with density equal to 1 everywhere; this means that the pool of potential new customers is never exhausted. Let each firm choose a quantity $q_i$ of new customers to recruit; then the total number of new customers must solve $q_1 + q_2 = 1 - \hat{p}$. Substituting this equation into (1) gives the inverse demand curves:

\[
\begin{align*}
    p_1 &= 1 + N_1 + \mu - (q_1 + q_2) \\
    p_2 &= 1 + N_2 - (q_1 + q_2)
\end{align*}
\]
We model the number of basic components on platform $i$, $N_i$, based on indirect network effects relating to both the number of customers of platform $i$ and the number of customers of the other platform. Let us consider why:

More customers mean more opportunities to sell the product – a larger market makes it easier to cover fixed costs of product development. The standard intra-platform indirect network effect occurs when more customers join platform $i$. A cross-platform indirect network effect occurs when customers join platform $j$, and some basic components developed for platform $j$ are ported over to platform $i$. There are extra costs to porting, so we expect that only a portion of components initially developed for one platform are ported to the other. Porting costs depend on the technologies of the platforms. For example, if two video game consoles adopt the same software development system (e.g., Windows), then game developers will incur very low costs when they convert games from one console to another.\footnote{For simplicity, we do not model any such porting costs for the must-have component. If we did, they would tend to make non-exclusive contracts less desirable simply because of the higher costs of porting to a second platform.}

To model the cross-platform indirect network effect, we reinterpret CRT’s measure of interconnection between networks. CRT parameterize interconnection by $\theta \in [0,1]$. If $\theta = 0$, users on different networks cannot communicate, if $\theta = 1$ all users of both networks can communicate with perfect quality, and if $\theta$ is intermediate then communications across networks is less than perfect quality. We reinterpret this $\theta$ parameter as the extent of the cross-platform
indirect network effect between platform $j$ and $i$.\textsuperscript{9} We also introduce a scaling parameter $s$ that gives the strength of both types of indirect network effects. The total number of basic components on platform $i$ is

\[ N_i = s[(\beta_i + q_i) + \theta(\beta_j + q_j)] \]

$N_i$ is proportional to both the user base of network $i$ and, to a lesser degree given by $\theta$, the user base of platform $j$. When there is a high $\theta$, many of the basic components will be ported over from one platform to another. With low $\theta$, this is less true. Since consumers treat all basic components as equal in their utility function, it makes no difference which basic components are the ones ported.\textsuperscript{10}

Using our linear specification for $N_i$, we restrict $0 < s < 1/2$ to avoid tipping in the platform market. If utility exhibited increasing returns to $N_i$, tipping would be much more likely and the conditions to prevent it would be very restrictive. In the case of decreasing returns to $N_i$, the network effect would “run out,” reducing both the impact of access to the must-have components and the impact of a larger initial market share.

Following CRT, we assume the installed bases are locked into prior contracts

\textsuperscript{9}Farell and Saloner (1986) and Clements (2004) among others also use a fraction to represent the use on one network of components developed for another.

\textsuperscript{10}We take $\theta$ as exogenous, but it is possible that a platform could reduce $\theta$ by placing barriers in the way of porting components from one platform to another. We know a lot about this situation since the noncooperative choice of $\theta$ was the subject of CRT’s paper. They find that the larger platform prefers a lower $\theta$ than the smaller one and prefers $\theta = 0$ for $\Delta$ sufficiently large.
and that both platforms have the same marginal cost of production \( c \). Malueg and Schwartz (2006) pointed out that it makes sense to restrict \( c < 1 \) to ensure that there will be at least some new customer enrollment, no matter how small the value of \( s \) is. The operating profits from new customers are

\[
\pi_1^E = [1 + s(\beta_1 + \theta \beta_2) - (1 - s)q_1 - (1 - \theta s)q_2 + \mu - c]q_1
\]

\[
\pi_2^{E'} = [1 + s(\beta_2 + \theta \beta_1) - (1 - s)q_2 - (1 - \theta s)q_1 - c]q_2
\]

Superscript \( E \) denotes platform 1’s exclusive access to the must-have component, while superscript \( E' \) denotes that platform 2 is excluded. These are operating profit functions because they do not include the costs of negotiating with the must-have component – we will describe these in the next section.

As in CRT, the two platforms compete à la Cournot; given \( \beta_1, \beta_2 \) and \( \theta \), they maximize profits by choice of \( q_i \). Taking first order conditions and solving simultaneously gives a Cournot equilibrium quantity for platform 1:

\[
q_1^E = q_1^B + m
\]

The first term is the “basic component effect.”

\[
q_1^B = \frac{1}{2} \left[ \frac{2(1-c) + s(1+\theta)\beta}{2(1-s) + (1-\theta s)} + \frac{(1-\theta)s\Delta}{2(1-s) - (1-\theta s)} \right]
\]

It is identical to the solution of the CRT model. It represents the underlying effect of basic components excluding the must-have component. The effect of the must-have component is contained in the term

\[
m = \frac{2\mu(1-s)}{4(1-s)^2 - (1-\theta s)^2} \quad (2)
\]
which is positive indicating that platform 1 gains from its exclusive access.

Note that the must-have component effect is independent of $\beta_i$; hence it is not subscripted and depends only on whether the platform has access to the must-have component, not the identity of the platform.

Platform 2’s equilibrium quantity will be lower as a result of being excluded:

$$q_{2E} = q_{2}^B + m'$$

Platform 2’s basic quantity is

$$q_{2}^B = \frac{1}{2} \left[ \frac{2(1-c) + s(1 + \theta)\beta}{2(1-s) + (1-\theta s)} - \frac{(1-\theta)s\Delta}{2(1-s) - (1-\theta s)} \right]$$

and its (negative) must-have effect is

$$m' = -\frac{\mu(1-\theta s)}{4(1-s)^2 - (1-\theta s)^2}$$ (3)

Despite the negative effect of platform 2’s demand, the must-have component increases total demand of both platforms: $m + m' > 0$.

The equilibrium prices of the two platforms are

$$p_1^E = p_1^B + (1-s)m \quad p_2^E = p_2^B + (1-s)m'$$

where $p_i^B = 1 + s(\beta_i + \theta\beta_{-i}) - (1-s)q_i^B - (1-\theta s)q_{-i}^B$.

We now introduce an assumption that the must-have component does not exert a powerful-enough effect to tip the market:

**No-Tipping Assumption:** Even when platform 2 is excluded from the must-have component, it still has positive demand and positive price: $m' > -\frac{p_2^B}{1-s}$.$^{11}$

$^{11}$The no-tipping assumption essentially restricts $\mu$ from being too large, given the other
Let the basic operating profits (identical to CRT) be \( \pi^B_i = (p^B_i - c)q^B_i \).

Then the two platforms’ operating profit functions are

\[
\pi^E_1 = \pi^B_1 + (p^B_1 + (1-s)(q^B_1 + m) - c) m \\
\pi^E'_2 = \pi^B_2 + (p^B_2 + (1-s)(q^B_2 + m') - c) m'
\]

We can extend the must-have component model to two other cases where the must-have component provider grants (i) exclusive access to platform 2 and (ii) non-exclusive access to both platforms.

### 2.2 Exclusive on Platform 2

If the must-have component exclusively supports platform 2, then

\[
q^{E'}_1 = q^B_1 + m' \\
p^{E'}_1 = p^B_1 + (1-s)m' \\
q^{E'}_2 = q^B_2 + m \\
p^{E'}_2 = p^B_2 + (1-s)m
\]

The operating profits functions are simply reversed from the previous case:

\[
\pi^{E'}_1 = \pi^B_1 + (p^B_1 + (1-s)(q^B_1 + m') - c) m' \\
\pi^{E'}_2 = \pi^B_2 + (p^B_2 + (1-s)(q^B_2 + m) - c) m
\]

parameters. The inequality can be expanded to \( \mu < \frac{p^B_2}{1-s} \frac{4(1-s)^3 - (1-\theta s)^2}{(1-\theta s)} \). Note that \( p^B_2 \) is not a function of \( \mu \). For the case of \( \theta = 1 \) or \( s \to 0 \), the right hand side simplifies to \( 3p^B_2 \), so in a sense, the must-have component cannot be three times “better” than the basic value of the smaller platform to the marginal consumer. The right hand side goes to 0 for \( \theta = 0 \) (no cross-platform indirect network effect) and \( s = 1/2 \) (very strong indirect network effect), so there are parameter values for which the assumption cannot be satisfied.
2.3 Nonexclusive

In the non-exclusive access case, both platforms enjoy increases in sales and operating profits. If the must-have component is available non-exclusively on both platforms, then

\[ q_{11}^{NE} = q_{1}^{B} + m + m' \]
\[ q_{22}^{NE} = q_{2}^{B} + m + m' \]
\[ p_{11}^{NE} = p_{1}^{B} + (1 - s)(m + m') \]
\[ p_{22}^{NE} = p_{2}^{B} + (1 - s)(m + m') \]

Recall that the must-have effects \( m \) and \( m' \) have opposite signs, so the nonexclusive quantities and prices are less than an exclusive platform’s but more than an excluded platform’s.

The operating profits in the nonexclusive case are

\[ \pi_{i}^{NE} = \pi_{i}^{B} + \left[ p_{i}^{B} + (1 - s)(q_{i}^{B} + m + m') - c \right] (m + m') \]

2.4 Comparisons

The must-have component’s net utility \( \mu \) is similar to a demand or cost shifter in a standard Cournot model. An increase in \( \mu \) increases \( m \) and decreases the (negative) value of \( m' \), and more important, it is market-expanding overall:

\[ \frac{\partial (m + m')}{\partial \mu} = \frac{1 - 2s + \theta s}{4(1 - s)^2 - (1 - \theta s)^2} > 0 \]  (4)

Inequality (4) follows from \( s \in (0, 1/2) \) and \( \theta \in [0, 1] \), making both numerator and denominator positive. And as a result of (4), an increase in \( \mu \) increases \( \pi_{i}^{E} \), decreases \( \pi_{i}^{E'} \), and increases their sum. It also increases both platforms’ profits \( \pi_{i}^{NE} \) under non-exclusive access.
Changes in cross-platform indirect network effects, such as platform standardization (equivalent to an increase in $\theta$) or platform differentiation (equivalent to a decrease in $\theta$), influence the market equilibria. From CRT, $\frac{\partial(q_1^B + q_2^B)}{\partial \theta} > 0$. More porting of basic components increases consumer utility on both platforms. Another CRT result is that $\frac{\partial(q_1^B - q_2^B)}{\partial \theta} < 0$. This implies that platform 1’s initial market share advantage (as reflected by $\beta_1 \geq \beta_2$) fades away as more software is ported. Cross-platform indirect network effects equalize the number of basic components on the two platforms because an increase in $\theta$ reduces $m$ but increases the (negative) value of $m'$. Thus, the net utility of the must-have component works to widen the market share difference while more porting serves to narrow it. As with $\mu$, increases in $\theta$ are market-expanding: $m + m'$ increases in $\theta$.

We can rank profits in the different contracting cases:

**Lemma 1:** For either platform, operating profits are highest with exclusive access to the must-have component, intermediate with nonexclusive access, and lowest when the platform is excluded:

$$\pi^E_i \geq \pi^{NE}_i \geq \pi^{E'}_i$$

### 2.5 Must-Have Component Profits

Let the must-have component provider’s operating profit be a function of the total customer base on its chosen platform:

$$\pi^{1E}_\mu = \gamma(\beta_1 + q_1^E) \quad \pi^{2E}_\mu = \gamma(\beta_2 + q_2^E)$$
The constant $\gamma \geq 0$ represents per-subscriber income that the must-have component provider receives from the customer base; this could be either a direct payment from the customer or it could come from advertisers. We can think of the must-have component as creating gross utility per consumer of $\bar{\mu} = \mu + \gamma$. Some of the gross utility is the per-subscriber revenue $\gamma$, and the remainder is the consumer’s net utility $\mu$ which creates a network effect on the platform(s).

We model $\gamma$ as independent from $\mu$.\(^{12}\) This simplifying assumption is justified because in most platform-component markets, the component products and their pricing are established outside the negotiations about which platform(s) the components will appear on. In some cases, the per-subscriber income of a component is constrained by the existing state of technology and/or the industrial business model. For example, the TV broadcasting technology limits content providers’ ability to receive direct payment from the viewers; thus the case $\gamma = 0$ is a particularly important one.\(^{13}\) The single game pricing scheme in the video game industry allows game developers to charge customers directly, but even there the prices of games typically do not vary much with their popularity. Another example is anchor stores in shopping malls, which usually adopt regional or even national pricing of their products, rather than varying their pricing depending on which malls (platforms) they appear in.

\(^{12}\)This independence is important, because we assume consumers have identical marginal values for the must-have component. This means that with free choice of $\gamma$, the must-have component might set $\gamma = \bar{\mu}$ to extract all surplus (and would no longer be “must-have” since it would have $\mu = 0$).

\(^{13}\)A movie studio receives a royalty when its movie is played on TV, but it cannot directly sell advertising or charge a viewer fee for the movie.
sum, our view is that must-have components typically generate network effects primarily based on their presence on or absence from a platform, rather than their marginal pricing decisions.

If, nevertheless, we did allow dependence of $\gamma$ on $\mu$, the effect of $\mu$ in the following analysis would be reduced, since an increase in $\mu$ would increase per-subscriber revenue as well as the number of subscribers.

The must-have component provider always receives a higher operating profit under non-exclusive access because it can sell to a larger customer base:

$$\pi^\mu_{NE} > \pi^\mu_{iE} \quad i = 1, 2$$

(5)

3 Bargaining Scenarios

In this section we investigate the contractual arrangements between the platforms and the must-have component provider. In particular, when are exclusive access contracts between a single platform and the must-have component provider more likely to exist?

There are two platforms and one component provider, so the order in which negotiations take place is crucial to the outcome.\textsuperscript{14} This order could be pre-arranged by the institutional environment, but since the must-have compo-

\textsuperscript{14}Our model is arguably capable of dealing with multiple must-have components in a sequential game where must-have components join the platforms one by one. Each component will translate previous decisions into different values of $\beta_1$ and $\beta_2$. The bargaining process between the individual must-have component provider and the platforms is thus the same as the single must-have component case. Simultaneous jockeying for position on multiple platforms would require a much more complex multi-agent bargaining model.
ponent provides a unique, irreproducible product, it is a natural extension of this monopoly power to let the must-have component choose the order of negotiation. Thus, we model a bargaining game in which (i) the must-have component provider proposes an exclusive or non-exclusive contract with either or both platforms, (ii) bargaining takes place over lump-sum transfer payment(s) $T_i$ from the must-have component provider to platform $i$ (these can be positive or negative), and (iii) if this bargaining fails, the must-have component provider proposes a different type of contract and the process begins again.\footnote{This lump-sum transfer reflects the \textit{expected} change in subscribers that will result from the presence of the must-have component on the platform. In negotiations it might be quoted on a per-existing-subscriber basis or a per-expected-future-subscriber basis, but however it might be discussed, it is a lump-sum fee and therefore does not affect the marginal decisions of the platforms in the subgame that follows the bargaining. If, instead, the transfer payments were negotiated \textit{ex ante} but paid based on the \textit{ex post} number of subscribers, they would create inefficient marginal incentives, so this type of payment would be outside the realm of efficient bargaining.} We use the Nash bargaining solution, so the initial proposal (i) determines the total surplus available, the bargaining (ii) involves a 50-50 split of the surplus, and the fallback position (iii) determines the outside opportunity.\footnote{Our primary results concern the \textit{relative} gains from non-exclusive versus exclusive bargaining, and they are quite robust to the form of bargaining used. The key element is that the outside option of each firm affects the payoff to bargaining in the standard way, i.e. a higher outside option raises the payoff. This is true by definition in Nash bargaining, and it can be true in certain types of alternating-offer bargaining (Binmore, Rubinstein and Wolinsky 1986). Bowles (2004) shows that an “inside option” – a payoff that occurs within the \textit{ongoing} alternating-offer bargaining game – also has a Nash-like effect on the bargaining outcome. However, in a simple alternating-offer bargaining game, an outside option that is...}
Given this setup, there are four possible combinations of initial and fallback contractual offers. First there are two pure cases. Exclusive (E): Simultaneously offer exclusive access to both platforms and choose the better option, fallback with another proposal of exclusive access. Non-exclusive (NE): Simultaneously offer non-exclusive contracts to both platforms, fallback with the same non-exclusive offer again. And then there are two hybrid cases. Hybrid non-exclusive (HNE): First offer non-exclusive contracts to both platforms, fallback with exclusive case E. Hybrid exclusive (HE): Simultaneously offer exclusive access to both platforms and choose the better option, fallback with non-exclusive case NE. Note that the must-have component can control the initial and fallback contract choice, but it must always bargain with the platforms and split the resulting surplus.\footnote{If we assigned the must-have component more market power, it could make one-time, take-it-or-leave-it offers to the platforms. This would allow it to extract all the surplus, just paying the platforms their outside options. The choice of which type of contract to offer would still be important, and the comparative statics results would be essentially the same since Nash bargaining already depends on outside options. The key difference would be that the platforms would have no bargaining power, so the outside options of the must-have component would no longer matter. This means that the direct revenue, $\gamma$, of the must-have component would no longer have any effect on the contractual decision, nor would the size less valuable than the result of a successful bargain is never exercised (Binmore, Osborne, and Rubinstein 1988). If we employed this type of result in our model, then most of our comparative statics would collapse since they depend on outside options. We would be left with a comparison of the rates of time preference of the two platforms and the must-have component, and the must-have component would choose which type of contract based on these rates.}

17
To illustrate our method, we discuss the exclusive (E) case in detail, and then discuss the remaining cases and their relative payoffs more briefly.

3.1 Exclusive Access Only

Let $T_i^E$ be the transfer payment that the must-have component provider pays when it signs an exclusive contract with platform $i$. Platform $i$’s payoff is $\pi_i^E + T_i^E$, the sum of its operating profits and the transfer payment, and the other, excluded platform $j$ suffers from lower sales and lower prices receiving payoff $\pi_j^{E'}$. The payoff to the must-have component provider is $\pi_{\mu}^E - T_i^E$. Since platform 1 has a larger starting market share, the must-have component would choose an exclusive contract with platform 1 if the transfer fees were equal.

Bargaining is simultaneous, so the two transfer payments are decided in the same period. There is a pair of constraints that for each platform, the net payoff has to be positive: $\pi_i^E + T_i^E - \pi_i^{E'} \geq 0$. Otherwise, it is not worthwhile for the platforms to contract with the must-have component provider.

Under simultaneous bargaining, platform 1 and the must-have component provider take $T_2^E$ as given when they bargain. The same applies to the negotiation between platform 2 and the must-have component provider. The equilibrium fees solve

\[
(\pi_1^E + T_1^E) - \pi_1^{E'} = (\pi_{\mu}^1 - T_1^E) - (\pi_{\mu}^2 - T_2^E)
\]

\[
(\pi_2^E + T_2^E) - \pi_2^{E'} = (\pi_{\mu}^2 - T_2^E) - (\pi_{\mu}^1 - T_1^E)
\]

It turns out that the simultaneous solution violates the net payoff constraint of off-equilibrium-path payments.
for platform 2. Thus, platform 2 is at a corner solution where its net payoff is zero: $\pi_2^E - \pi_2^{E'} + T_2^E = 0$. It would always need to pay to get an exclusive contract with the must-have component provider. The equilibrium fees are

$$T_1^E = \frac{1}{2} \left[ \pi_1^{1E} - \pi_2^{2E} - \left( \pi_1^{1E} - \pi_1^{E'} \right) - \left( \pi_2^{E} - \pi_2^{E'} \right) \right]$$

$$T_2^E = - \left( \pi_2^{E} - \pi_2^{E'} \right)$$

It is worthwhile to point out that if $\gamma = 0$, then platform 1’s payment $T_1^E$ is negative. That is, if the must-have component does not receive any per-customer revenue, it will always get a subsidy from the platform. This is typically the case in the pay-TV industry, where content networks are entitled to a fee from the pay-TV operators.

Given $T_1^E$ and $T_2^E$, the must-have component decides which platform to contract with. We can calculate $(\pi_1^{1E} - T_1^E) - (\pi_2^{2E} - T_2^E) > 0$, so the must-have component provider will always choose to contract with platform 1. Its payoff is:

$$\pi_1^{1E} - T_1^E = \frac{1}{2} \left[ \pi_1^{1E} + \pi_2^{2E} + \pi_1^{E} - \pi_1^{E'} + \pi_2^{E} - \pi_2^{E'} \right]$$

(6)

We can now evaluate the effect of changes in the parameters on the transfer payment. An increase in $\mu$ enhances the must-have component quantity and price effects, which in turn raises the must-have component provider’s outside payoff. Hence, the must-have component provider is in a position to make a lower transfer payment to platform 1.

**Proposition 1:** Under bargaining for exclusive access only, an increase in the
the net utility \( \mu \) of the must-have component decreases the transfer payment to platform 1.

Note that the result of Proposition 1 is sensitive to the independence of must-have component per-customer revenue \( \gamma \) from net utility \( \mu \). If a higher-net-utility must-have component can also get more advertising or other direct revenue, this would increase the relative gain of a successful bargain with platform 1 versus the outside payoff of a bargain with the smaller platform 2. If this effect were strong enough, it could reverse the result of Proposition 1. An example of the disconnect between \( \gamma \) and \( \mu \) is the NFL Sunday Ticket package. It is directed at a small group of very avid football fans, generating a high net utility. It also commands a high fee, but the terms of the deal allow the platform DirecTV to keep these revenues,\(^ {18} \) so this is actually a case of low \( \gamma \) in terms of our model. (See Stennek (2006) for more analysis of this type of exclusive arrangement).

If the two platforms are more similar in starting size (lower \( \Delta \)), platform 1 has less to gain from the bargaining process, and the must-have component provider has a larger outside opportunity. The must-have component provider thus makes a smaller transfer payment.

**Proposition 2:** Under bargaining for exclusive access only, an increase in the starting market share difference \( \Delta \) (for fixed total starting market size \( \beta \)) in-

\(^{18} \)“DirecTV hangs onto NFL,” CNN Money, December 11, 2002
creases the transfer payment to platform 1.

The limiting case of proposition 2 is when $\beta_1 = \beta_2$. When the two platforms are equal sized, they are essentially undifferentiated, and they engage in Bertrand competition for the must-have component. Thus with equal-sized platforms, the must-have component can capture all the rents, and the winning platform gets a net payoff of zero. The smaller $\Delta$, the more closely platform competition resembles Bertrand competition, allowing the must-have component provider to play off one platform against the other.

Cross-platform indirect network effects have ambiguous effects on the transfer payment. Porting basic components expands the overall platform market (as shown by CRT), increasing the must-have component provider’s opportunity cost of going exclusive on platform 1. Also, more porting weakens platform 1’s initial market advantage (also shown by CRT). But porting also weakens the must-have component price and quantity effects (Lemma 3), negatively affecting the must-have component provider’s outside payoff.

**Proposition 3:** Under bargaining for exclusive access only, higher cross-platform indirect network effects $\theta$ reduce the outside payoffs of both the platform and the must-have component provider.

For example, in a mature platform market where both platforms have accumulated substantial subscriber bases, the basic component expansion effect
and the platform differentiation effect associated with porting would be limited. Thus, in a mature market we expect that more porting would reduce the must-have component provider’s outside payoff relative to the platforms. In a growing market, the basic component effect and platform differentiation effect would probably be strong, so we expect increased porting would increase the must-have component’s outside payoff. Therefore, the must-have component provider would gain more from porting in a growing market than in a mature one.

3.2 Comparison with Non-Exclusive Contracts

While we observe exclusive contracts in certain industries, such as the video game industry, non-exclusive access contracts are also prevalent in indirect network markets. Here we compare the exclusive payoffs discussed above with the non-exclusive options. In the simplest non-exclusive option, the must-have component (i) offers non-exclusive contract to both platforms, (ii) bargains simultaneously, and (iii) if bargaining fails simply restarts the process. This process is dominated by the exclusive arrangement mentioned above, since non-exclusive access only essentially gives away some of the market power of the must-have component by ignoring the possibility of withholding access from one platform.

Proposition 4: For the must-have component provider, bargaining for exclusive access only (case E) is always more profitable than bargaining for non-
exclusive access only (case \(NE\)).

The preferred non-exclusive option, from the must-have component’s point of view, is what we have called hybrid non-exclusive. In this type of contract negotiation, the must-have component provider (i) offers non-exclusive contracts with both platforms, (ii) bargains simultaneously on these contracts and only concludes the bargaining if it can come to an agreement with both platforms, and (iii) in the even that this process fails, the must-have component provider restarts negotiations using the exclusive procedure discussed above.

From either platform’s perspective, the payoff to this hybrid non-exclusive bargain is \(\pi^i_{NE} + T^H_{NE}\). Platform 1’s outside opportunity is the payoff function under the exclusive scenario, \(\pi^1_E + T^E_1\). For platform 2 the outside opportunity is the loss associated with no access to the must-have component, \(\pi^2_{E'}\). If the non-exclusive negotiation is successful, the must-have component’s payoff is \(\pi^\mu_{NE} - T^H_{NE} - T^H_{2NE}\), where \(\pi^\mu_{NE} = \gamma(\beta + q^NE_1 + q^NE_2)\). If it fails, the must-have component provider’s outside opportunity is \(\pi^1_{E'} - T^E_1\).

The simultaneous equations for this bargaining problem are:

\[
(p^1_{NE} + T^H_{1NE}) - (p^1_E + T^E_1) = (p^\mu_{NE} - T^H_{1NE} - T^H_{2NE}) - (p^1_{E'} - T^E_1)
\]
\[
(p^2_{NE} + T^H_{2NE}) - p^E_2 = (p^\mu_{NE} - T^H_{1NE} - T^H_{2NE}) - (p^1_{E'} - T^E_1)
\]

These are subject to the bargaining constraints \((p^1_{NE} + T^H_{1NE}) - (p^1_E + T^E_1) \geq 0\) and \((p^2_{NE} + T^H_{2NE}) - p^E_2 \geq 0\).

Substituting \(T^E_1\) into the above equations and simplifying gives the fol-
lowing expressions. It can be verified that both $T_{1}^{HNE}$ and $T_{2}^{HNE}$ pass their respective bargaining constraint tests.

$$T_{1}^{HNE} = \frac{1}{3} \left[ \left( \frac{\pi_{\mu}^{NE}}{2\mu} + \frac{\pi_{1}^{1E}}{2\mu} - \frac{3}{2} \pi_{2}^{2E} \right) - \left( -\frac{1}{2} \pi_{1}^{1E} + 2\pi_{1}^{NE} - \frac{3}{2} \pi_{1}^{E'} \right) - \left( \frac{3}{2} \pi_{2}^{2E} - \pi_{2}^{NE} - \frac{1}{2} \pi_{2}^{E'} \right) \right]$$

$$T_{2}^{HNE} = \frac{1}{3} \left[ \left( \pi_{\mu}^{NE} - \pi_{\mu}^{1E} \right) - \left( \pi_{1}^{E} - \pi_{1}^{NE} \right) - \left( \frac{2}{2} \pi_{2}^{NE} - \frac{2}{2} \pi_{2}^{E'} \right) \right]$$

It follows that the must-have component provider’s net profit is

$$\pi_{\mu}^{NE} - T_{1}^{HNE} - T_{2}^{HNE} = \frac{1}{6} \left[ (2\pi_{\mu}^{NE} + \pi_{\mu}^{1E} + 3\pi_{\mu}^{2E}) + \left( \pi_{1}^{E} + 2\pi_{1}^{NE} - 3\pi_{1}^{E'} \right) + \left( 3\pi_{2}^{E} + 2\pi_{2}^{NE} - 5\pi_{2}^{E'} \right) \right]$$

We now compare exclusive only with platform 1 versus hybrid non-exclusive. (We show that the remaining option, Hybrid Exclusive, is also dominated in a section at the end of the appendix.) The provider’s contractual decision will be based on the net payoff difference between the two bargaining scenarios:

$$D = (\pi_{\mu}^{NE} - T_{1}^{HNE} - T_{2}^{HNE}) - (\pi_{\mu}^{1E} - T_{1}^{E})$$

$$= \frac{1}{3} \left[ (\pi_{\mu}^{NE} - \pi_{\mu}^{1E}) + (\pi_{1}^{NE} - \pi_{1}^{E}) + (\pi_{2}^{NE} - \pi_{2}^{E'}) \right]$$

If this is positive, then the must-have component provider will sign non-exclusive contracts with both platforms. Otherwise, the must-have component provider will go exclusive on platform 1.

The sign of $D$ is indeterminate. Let us call the first term in $D$ the *market share effect*; it is positive because the must-have component has a larger market when it is available on both platforms. The second term is the *loss of exclusivity*. It is negative, since platform 1 would do better in the exclusive
regime and would partially share those gains with the must-have component via the transfer fee. The third term in $D$ is the *non-exclusivity gain*; it is positive since platform 2 gains from the non-exclusive scenario and partially shares those gains with the must-have component. So the final decision on contract type depends on the strength of these three effects.

The effect of the direct customer revenue $\gamma$ is to make it more attractive for the must-have component to expand its customer base by being available on both platforms. An increase in $\gamma$ raises the *market share effect* and leaves the remaining components of $D$ unchanged. Thus,

**Proposition 5:** *An higher $\gamma$ makes the hybrid non-exclusive contract more attractive to the must-have component.*

An increase in the net utility of the must-have component has different effects on each component of $D$. It increases the market share effect because the higher net utility increases demand on both platforms more than on one exclusive platform. It makes the loss of exclusivity worse because platform 1 has more to lose when it does not get an exclusive contract with a more popular must-have component. Finally, it makes the non-exclusivity gain larger for the opposite reason: platform 2 gains more when it is not excluded from a more popular must-have component. The overall effect on $D$ has no definite sign:

**Proposition 6:** *A higher net utility ($\mu$) has the following effects on the at-
tractiveness of the hybrid non-exclusive contract to the must-have component:

(i) increases the positive market share effect $\pi_{NE}^\mu - \pi_0^E$

(ii) decreases the negative loss of exclusivity $\pi_1^{NE} - \pi_1^E$

(iii) increases the positive non-exclusivity gain $\pi_2^{NE} - \pi_2^{E'}$

Note an important corollary to Propositions 5 and 6. If a higher net utility $\mu$ allows the must-have component to receive a higher customer revenue $\gamma$ (say, through advertising), then it will amplify the market share effect. This gives an additional reason that more popular must-have components may favor nonexclusive contracts.

Cross-platform indirect network effects have different effects on each component of $D$. They increase the market share effect because porting increases demand on both platforms more than on one exclusive platform. They increase the (negative) loss of exclusivity because platform 1 has less to lose when it does not get an exclusive contract if there is more porting.19 Finally, the effect

---

19We can reinterpret the indirect network effect in our model as a specific asset (see Williamson 1985 or Hart 1995). Relationship-specific investments can be protected from opportunistic behavior by exclusive contracts. When the must-have component becomes available on platform $i$, it produces a network effect and tries to appropriate the resulting surplus. Reduced porting of basic components confines the network effect more to one platform, making the network effect more relationship-specific. As a result, it is easier to appropriate the surplus under an exclusive contract. (When platforms introduce a product upgrade, they often partner with must-have components. To some degree this is what happened with Sony and Squaresoft. If the must-have component provider must make complementary investments to fit its product to a particular platform, these investment could
on the non-exclusivity gain is ambiguous. This is because an increase in $\theta$ has a demand expansion effect shown by CRT which amplifies the must-have component effect, but it also directly reduces the must-have effect. Overall, the effect on $D$ again has no definite sign. The following lemma collects the above results:

**Proposition 7**: Higher cross-platform indirect network effects $\theta$ have the following effects on the attractiveness of the hybrid non-exclusive contract to the must-have component:

(i) increase the positive market share effect $\pi_\mu^{NE} - \pi_\mu^{1E}$

(ii) increase the (negative) loss of exclusivity $\pi_1^{NE} - \pi_1^{E}$

(iii) ambiguously change the positive non-exclusivity gain $\pi_2^{NE} - \pi_2^{E'}$

Because $D$ is indeterminate, we will show a numerical example. We parameterize $\gamma = 0.5$, $s = 0.25$ and $c = 0.2$. We limit consideration to values of $\mu$ that do not induce tipping, i.e. $\mu \in [0, \bar{\mu}]$ where $\bar{\mu}$ satisfies the condition that $\min\{q_2^{E'}, p_2^{E'}\} = 0$. We investigate changes in the parameters $\mu$ (the net utility of the must-have component), $\theta$ (the extent of porting), and $\Delta$ (the starting platform market share difference).

Figure 1 plots the regions in which exclusive and non-exclusive contracts are preferred for different values of $\mu$ and $\theta$. The curves represent the locus of points where $D = 0$, i.e. where must-have component is indifferent between the two different types of contracts. A movement up and to the left represents an
increase in $D$, i.e. an increase in the advantage of the nonexclusive contract. The two curves represent two levels of $\Delta$, holding constant the total starting market size at $\beta_1 + \beta_2 = 1$.

Given $\Delta$, it is more likely for the must-have component provider to go exclusive if $\mu$ increases. A high $\mu$ enables the must-have component provider to leverage its popularity and to demand a higher transfer payment.

![Figure 1: Payoff Difference: Hybrid Non-Exclusive vs. Exclusive-Only](image)

A larger range of parameter values support exclusive contracts when $\Delta$ is larger. When $\Delta$ is large, the must-have component provider has a less good outside payoff (Proposition 2). Offering exclusive contracts gives the must-have component an additional bargaining chip since it can push the platforms into differentiated Bertrand competition. Thus, offering exclusive contracts to a high $\Delta$ platform is actually a sign of weakness. When $\Delta$ goes to zero, the must-have component provider will go non-exclusive for any $\mu$ and $\theta$.  

29
An example of a high-$\theta$, high-$\Delta$ platform is the U.S. pay-TV market. There are about 80 million cable subscribers in the USA. Philadelphia-based Comcast is the largest cable operator in the USA, with over 22 million subscribers at the end of 2003. All cable companies are facing increasing competition from satellite TV. NewsCorp’s satellite network DirectTV and Echostar’s Dish Network Satellite TV have been competing nationally against every cable company. Each had approximately 10 million subscribers at the end of 2003.\footnote{“Cable Vision,” \textit{Wall Street Journal}, Feb. 12, 2004.} Thus, of the 100 million pay-TV subscribers, cable has an 80% market share and satellite a 20% share. Roughly speaking, this is consistent with $\Delta = 0.8 - 0.2 = 0.6$.

Based on the results illustrated in Figure 1, ESPN’s offering of non-exclusive contracts is predicted by the model. Since their debuts, DirecTV and Dish Network Satellite TV experienced explosive expansion. This increasingly competitive situation allowed ESPN to extract better deals from Comcast. The reason is that the smaller is $\Delta$, the easier it is for the must-have component provider to induce the platforms to enter Bertrand competition. This may have been a motivation for Comcast’s February 2004 hostile takeover bid for Disney – a merger would have stopped ESPN from playing Comcast off against the satellite-TV operators in search of higher fees.

Given $\mu$ and $\Delta$, the must-have component provider is more likely to choose the non-exclusive contract when the cross-platform indirect network effects, $\theta$, increases. This carries an interesting policy implication. In many cases, government antitrust and regulatory authorities mandate open engineering stan-
Our model shows that there is an additional impact on the contractual arrangement between the platforms and the must-have component provider. The likelihood that the must-have component provider signs an exclusive contract will decrease, even though the government policy may just make porting basic components easier. In other words, a mandated open-technology regime may achieve the same purpose as regulating the must-have component provider’s contractual choice.

Video game consoles give an example of an increase in $\theta$. In the 32-bit era, there were two game console storage media: Sony’s PS, Sega’s Saturn and Panasonic’s 3DO all took advantage of the latest technology and adopted CD-ROM as the medium of storage. Nintendo, on the other hand, stuck to the traditional cartridge as the medium of storage. Due to limited storage space on the cartridge, full motion video and some special sound effects could not be produced on the Nintendo system. Hence, it was almost technically impossible for game developers to convert games between CD-ROM-based consoles and Nintendo’s console. This storage space issue, if interpreted in the theoretical framework, implies that the video game industry would have low cross-platform indirect network effects if the cartridge format survived. Otherwise, higher cross-platform indirect network effects would exist in video game industry.

The model showed that the must-have component provider makes a higher transfer payment when porting is lower. That is to say, Squaresoft would end

\footnote{This was the focus of the antitrust case against Microsoft in the USA.}
up paying more royalty fees if it adopted the cartridge over the CD-ROM format. Thus, it was logical for Squaresoft to abandon Nintendo. Although there is no way to know the exact royalty fee arrangements between consoles and game developers, some industry sources revealed that Nintendo charged about $10 to $20-per-unit royalties on the sale of third-party games. This was compared with $5 to $10-per-unit royalties for the PS.\textsuperscript{22}

It is important to note that all of the above discussion describes the contractual structure that is preferred by the must-have component, and therefore not preferred by the platforms. If the entire process is embedded in a larger game involving industry negotiating conventions or repeated interactions between the parties, the platforms might be able to use their own market power influence the process.

4 Conclusion

This paper has combined strategic platforms, “must-have” component providers, and bargaining in the platform-component paradigm. The major theoretical findings can be summarized into three areas of inquiry.

In the area of platform competition, the model predicts: (i) In the exclusive access case, the platform that has access to the must-have component experiences higher sales, price and profitability, whereas the excluded platform suffers from lower sales, price and profitability. (ii) In the non-exclusive access case, both platforms enjoy higher sales, prices and profitability as a result of

\textsuperscript{22}These estimates are mentioned on gaming websites IGN.com and the-magicbox.com.
a new must-have component.

Regardless of the access mode, the predictions for the transfer payment are: (iii) If the must-have component provider gains in popularity, then it will make a smaller transfer payment to the platform(s). (iv) For any given platform market, the larger the initial market share difference, the higher the transfer payment from the must-have component provider to the platform(s). (v) Cross-platform indirect network effects have an ambiguous effect on the transfer payment. We conjecture that in a growing platform market, more porting is associated with a lower transfer payment, while in a mature platform market it is associated with a higher transfer payment.

As for exclusivity, (vi) A must-have component provider is more likely to sign an exclusive contract if cross-platform indirect network effects are weak and the initial market share difference between the platforms is high. This suggests a key policy implication in indirect network industries – a mandated reduction in the costs of porting components from one platform to another can induce the must-have component provider to sign non-exclusive contracts with platforms. It has been common knowledge, as CRT’s model implies, that an increase in platform interconnection is often favorable for consumer welfare because it expands the number of components available. According to this traditional policy perspective, improvements in interconnection have a direct, market-oriented impact.

The must-have component model adds a new result: technological costs of porting components cause a contractual impact as well. The must-have com-
ponent is more likely to sign non-exclusive contracts when more components are ported between platforms. This means that policies requiring greater technological connectivity between platforms will encourage a contractual change towards non-exclusivity between the platforms and the must-have component provider. In other words, while the government may implement policies with the intent of opening technological standards, its effect can spill over to the contractual arena. Therefore, the must-have component model shows a “hidden” policy tool in addition to standard disclosure requirements.

Appendix

Proof of Lemma 1: We can rewrite the non-exclusive profits

$$\pi_{i}^{NE} = \pi_{i}^{E} + (p_{i}^{B} + (1 - s)(q_{i}^{B} + 2m + m') - c)m'$$

Since $m + m' > 0$ and $m'$ is negative, the last term of this equation is negative. We can also write

$$\pi_{i}^{NE} = \pi_{i}^{E'} + (p_{i}^{B} + (1 - s)(q_{i}^{B} + 2m + m') - c)m$$

Since $m + m' > 0$ and $m$ is positive, the last term is positive. ■

Proof of Proposition 1: $\frac{\partial T_{i}^{E}}{\partial \mu} = -\frac{1}{2} \left[ \frac{\partial (\pi_{i}^{E} - \pi_{i}^{E'})}{\partial \mu} + \frac{\partial (\pi_{2}^{E} - \pi_{2}^{E'})}{\partial \mu} \right]$ (note that the $\pi_{\mu}$ terms drop out because changes in $\mu$ have the same effect on must-have component profits on either platform). Both $\frac{\partial (\pi_{i}^{E} - \pi_{i}^{E'})}{\partial \mu}$ and $\frac{\partial (\pi_{2}^{E} - \pi_{2}^{E'})}{\partial \mu}$ are positive. ■
Proof of Proposition 2

\[
\frac{\partial T^E}{\partial \Delta} \bigg|_{\beta} = \frac{1}{2} \left[ \gamma + \gamma \left( \frac{\partial q_B^1}{\partial \Delta} \bigg|_{\beta} - \frac{\partial q_B^2}{\partial \Delta} \bigg|_{\beta} \right) \right. \\
- \left. [(1 + (1 - s))(m - m')] \cdot \left( \frac{\partial q_B^1}{\partial \Delta} \bigg|_{\beta} + \frac{\partial q_B^2}{\partial \Delta} \bigg|_{\beta} \right) \right]
\]

Since \( \frac{\partial q_B^1}{\partial \Delta} \bigg|_{\beta} = - \frac{\partial q_B^2}{\partial \Delta} \bigg|_{\beta} \) the final term is zero. And since \( \frac{\partial q_B^1}{\partial \Delta} \bigg|_{\beta} - \frac{\partial q_B^2}{\partial \Delta} \bigg|_{\beta} > 0 \), the first two terms must be positive. ■

Proof of Proposition 3

\[
\frac{\partial T^E}{\partial \theta} = \frac{1}{2} \left[ \frac{\partial (q_B^1 - q_B^2)}{\partial \theta} \right. \\
- (1 - s)(m - m') \left( \frac{\partial q_B^1}{\partial \theta} + \frac{\partial q_B^2}{\partial \theta} \right) \\
- (m - m') \left( \frac{\partial p_B^1}{\partial \theta} + \frac{\partial p_B^2}{\partial \theta} \right) \\
- (1 - s) \frac{\partial m}{\partial \theta} (q_B^1 + q_B^2 + 2m) + (1 - s) \frac{\partial m'}{\partial \theta} (q_B^1 + q_B^2 + 2m') \\
- \frac{\partial m}{\partial \theta} (p_B^1 + p_B^2 - 2c + 2(1 - s)m) \\
+ \frac{\partial m'}{\partial \theta} (p_B^1 + p_B^2 - 2c + 2(1 - s)m') \left. \right]
\]

We need to decompose the terms in \( \frac{\partial T^E}{\partial \theta} \) to delineate the three effects \( \theta \) has on the platform-component contractual arrangement. The first term is negative and captures the fact that a higher \( \theta \) reduces the initial market share difference between the two platforms, thus reducing platform1’s outside payoff. The second and third terms are negative and capture the fact that a higher \( \theta \) expands the overall platform market and increases the must-have component provider’s opportunity cost of going exclusive. The last four terms are positive and show the inverse relationship between the ease of porting and the must-have component quantity and price effects. A higher \( \theta \) reduces the must-have
component provider’s outside payoff. Thus, the first two effects are negative, but the last is positive. ■

**Proof of Proposition 4:** Platform $i$’s payoff is $\pi_i^{NE} + T_i^{NE}$, while its outside opportunity is $\pi_i^{E'}$. The must-have component’s payoff is $\pi_{\mu}^{NE} - T_i^{NE} - T_i^{NE}$, where $\pi_{\mu}^{NE} = \gamma(\beta + q_1^{NE} + q_2^{NE})$. If it fails with platform $i$ but succeeds with platform $j$, the must-have component provider’s outside opportunity is $\pi_j^{E'} - T_j^{E'}$. The simultaneous equations for this bargaining problem are:

\[
\begin{align*}
(\pi_1^{NE} + T_1^{NE}) - \pi_1^{E'} &= (\pi_{\mu}^{NE} - T_1^{NE} - T_2^{NE}) - (\pi_{\mu}^{2E} - T_2^{NE}) \\
(\pi_2^{NE} + T_2^{NE}) - \pi_2^{E'} &= (\pi_{\mu}^{NE} - T_1^{NE} - T_2^{NE}) - (\pi_{\mu}^{1E} - T_1^{NE})
\end{align*}
\]

These are subject to the bargaining constraints $(\pi_i^{NE} + T_i^{NE}) - \pi_i^{E'} \geq 0$.

Solving simultaneously gives the following expressions.

\[
\begin{align*}
T_1^{NE} &= \frac{1}{2} \left[ \pi_{\mu}^{NE} - \pi_{\mu}^{2E} - \pi_1^{NE} + \pi_1^{E'} \right] \\
T_2^{NE} &= \frac{1}{2} \left[ \pi_{\mu}^{NE} - \pi_{\mu}^{1E} - \pi_2^{NE} + \pi_2^{E'} \right]
\end{align*}
\]

It can be verified that both $T_1^{NE}$ and $T_2^{NE}$ pass their respective bargaining constraint tests. The payoff to the must-have component provider is

\[
\pi_{\mu}^{NE} - T_1^{NE} - T_2^{NE} = \frac{1}{2} \left[ \pi_{\mu}^{1E} + \pi_{\mu}^{2E} - \pi_1^{NE} - \pi_2^{NE} - \pi_1^{E'} + \pi_2^{E'} \right] \quad (7)
\]

Comparing (6) and (7), the only differences are the terms $\pi_i^{E} - \pi_i^{NE}$, $i = 1, 2$, which were shown to be positive in Lemma 1. ■

**Proof of Proposition 6:**

(i) $\pi_{\mu}^{NE} - \pi_{\mu}^{1E} = \gamma(\beta_2 + q_2^B + m + 2m')$. Taking the derivative,

\[
\frac{\partial(m + 2m')}{\partial \mu} = \frac{2(1 - s) - 2(1 - \theta s)}{4(1 - s)^2 - (1 - \theta s)^2}
\]

36
The denominator is positive. The numerator is (weakly) positive since \( \theta \in [0, 1] \).

(ii) From the proof of Lemma 1, \( \pi^N_1 - \pi^E_1 = (p^B_1 + (1-s)(q^B_1 + 2m + m') - c)m' \). The term in brackets is positive and increases in \( \mu \) from (4). The \( m' \) term is negative and decreases in \( \mu \). Thus, the difference decreases in \( \mu \).

(iii) Also from the proof of Lemma 1, \( \pi^N_2 - \pi^E'_{2} = (p^B_2 + (1-s)(q^B_2 + 2m + m') - c)m' \). The term in brackets is positive and increases in \( \mu \) from (4). The \( m \) term is positive increases in \( \mu \). Thus, the difference increases in \( \mu \). ■

Proof of Proposition 7:

(i) \( \pi^N_{\mu} - \pi^E_{\mu} = \gamma(\beta_2 + q^B_2 + m + 2m') \). From CRT, \( \frac{\partial q^B_2}{\partial \theta} > 0 \). From (2) and (3), \( m + 2m' = \frac{(\theta-1)s}{1-s}m \). Then the derivative is

\[
\frac{\partial (m + 2m')}{\partial \theta} = \frac{(\theta - 1)s}{1 - s} m + \frac{s}{1 - s} m
\]

Since \( \frac{\partial m}{\partial \theta} < 0 \) and \( \theta < 1 \), the first term is the product of two negatives. The second term is also positive.

(ii) From the proof of Lemma 1, \( \pi^N_1 - \pi^E_1 = (p^B_1 + (1-s)(q^B_1 + 2m + m') - c)m' \), where the term in brackets is positive. From CRT, we know that \( p^B_1 \) and \( q^B_1 \) are decreasing in \( \theta \). We can shows that

\[
\frac{\partial (2m + m')}{\partial \theta} = \frac{2s(\theta - 1)sm}{4(1-s)^2 - (1 - \theta s)^2}
\]

This is negative since \( \theta < 1 \). Thus, the term in square brackets is positive and decreasing in \( \theta \). The derivative we want to evaluate is \( \frac{\partial (\pi^N_1 - \pi^E_1)}{\partial \theta} \) which equals

\[
(p^B_1 + (1-s)(q^B_1 + 2m + m') - c) \frac{\partial m'}{\partial \theta} + \left[ \frac{\partial p^B_1}{\partial \theta} + (1-s) \frac{\partial (q^B_1 + 2m + m')}{\partial \theta} \right] m'
\]

Since \( m' \) increases in \( \theta \), the first term is positive. Since \( m' \) is negative, the second term is the product of two negatives, hence also positive.

37
(iii) Also from the proof of Lemma 1, \( \pi_2^{NE} - \pi_2^{E'} = (p_2^B + (1 - s)(q_2^B + 2m + m') - c) m \)

where the term in brackets is positive. The derivative \( \frac{\partial (\pi_2^{NE} - \pi_2^{E'})}{\partial \theta} \) is

\[
(p_2^B + (1 - s)(q_2^B + 2m + m') - c) \frac{\partial m}{\partial \theta} + \left[ \frac{\partial p_2^B}{\partial \theta} + (1 - s) \frac{\partial (q_2^B + 2m + m')}{\partial \theta} \right] m
\]

Since \( \frac{\partial m}{\partial \theta} < 0 \), the first term is negative. From CRT we know that \( q_2^B \) is increasing in \( \theta \), \( p_2^B \) is decreasing in \( \theta \), but by less than \( (1 - s) \) times the increase in \( q_2^B \), so the sum of the derivatives of the basic effects is positive. Since \( 2m + m' \) is decreasing in \( \theta \), the term in brackets is cannot be signed. The \( m \) term is also positive.

**Hybrid Exclusive Access**

Consider the following bargaining order: (i) the must-have component provider offers an exclusive contract to platform 1 or 2. (ii) In the event of breakdown, the must-have component provider offers non-exclusive contracts to both platforms as in case 2 above. Note that it is not possible for the must-have component provider to use hybrid non-exclusive access (case 3) as a disagreement point because that in turn uses exclusive access as its disagreement point. An endless loops results. If platform \( i \) were offered the initial contract, the transfer fee \( T_i^{HE} \) would solve:

\[
(\pi_i^E + T_i^{HE}) - (\pi_i^{NE} + T_i^{NE}) = (\pi_i^{NE} - T_i^{HE}) - (\pi_i^{NE} - T_j^{NE})
\]

This is subject to the bargaining constraints \( (\pi_i^E + T_i^{HE}) - (\pi_i^{NE} + T_i^{NE}) \geq 0 \).

Substituting \( T_i^{NE} \) from case 2 into the above equation and simplifying gives the following payoff. (For some parameter values, \( T_i^{HE} \) and \( T_j^{NE} \) do not pass
their respective bargaining constraint tests, in which case this contract could not be offered successfully. But we show below that this contract is always dominated by the exclusive access only (case 1.).

\[
\pi_i^{1E} - T_i^{HE} = \frac{1}{2} \left( -\frac{1}{2} \pi_i^{NE} + \frac{3}{2} \pi_i^{1E} + \pi_i^E \right) + \left( \pi_i^E - \pi_i^{1E} \right) + \left( \pi_j^{NE} - \pi_j^{E'} \right)
\]

The must have component prefers HE to 1E if \( \pi_i^{1E} - T_i^{HE} > \pi_i^{1E} - T_i^{E} \). If the initial contract goes to platform 1, this is equivalent to \( 2T_i^{E} > 2T_i^{HE} \), which can be written:

\[
\pi_2^{NE} - \pi_2^{E} + > \frac{1}{2} \pi_2^{NE} - \frac{1}{2} \pi_1^{1E}
\]

From Lemma 1, the left hand side is negative. From (5), the right hand side is positive. Thus, the inequality can never hold.

For the case of platform 2, the condition is \( 2T_i^{E} > 2T_2^{HE} + 2\pi_1^{1E} - 2\pi_2^{2E} \), which can be written:

\[
\pi_1^{NE} - \pi_1^{E} > \frac{1}{2} \pi_1^{NE} - \frac{1}{2} \pi_2^{2E}
\]

From Lemma 1, the left hand side is negative. From (5), the right hand side is positive. Thus, the inequality can never hold.

References


