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Abstract

This paper develops and analyzes a model of competition between platforms in an industry with indirect network effects, with a specific focus on complementary product exclusivity. The objective is to understand the determinants of exclusivity and explore its effects on competition. We find that the stage of platform market maturity and the asymmetry between the installed bases of platforms are critical determinants of exclusivity. Exclusivity is the dominant outcome in the nascent stage of the platform market and is sometimes the outcome in mature stages as well, while non-exclusivity is the usual outcome in the intermediate stages. In the nascent stages, the bigger platform secures exclusivity, while in the mature stages it is the smaller platform.

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1 Introduction and Motivation

Several high technology markets are structured as systems comprising of platforms and complementary products where the value of the platform to customers increases with the availability of complements. The benefit to consumers of joining a particular platform then, depends on the variety and quality of compatible complementary products available, which in turn depends on the size of the platform's membership. Most computer and communication technologies exhibit such a structure, with a set of 'hardware' platforms on one side and complementary 'software' on the other, leading to the creation of indirect network effects (Church and Gandal, 1993; Clements, 2004). Video games consoles and video games, operating systems and software applications, PDAs and applications, cellular phone services and mobile phones and applications that run on them, media networks and content, media and advertising, are good examples of such platforms-complements systems. An interesting and important characteristic of these industries is that some complementary components are available only for specific platforms, while other competing complements are made available for multiple platforms. For instance, AT&T Cingular recently signed a multi-year exclusive deal to provide cellular phone services to users of Apple's iPhone scheduled for release in June 2007, while users of other cellular phones and mobile devices have a choice of several competing service providers. Similarly, certain television programming is available only for satellite or cable, while other content is available for both systems. MLB, for instance, signed an exclusive deal with DirecTV forgoing non-exclusive deals with cable and other satellite services. The hi-tech manufacturing sector is also filled with examples of exclusive as well as non-exclusive licensing alliances between component manufacturers and platform providers. For example, Cornice, a manufacturer of tiny hard drives for digital music preferred non-exclusive deals with Thomson/RCA and Rio - manufacturers of MP3 players - over an exclusive deal with Apple for its iPod Mini. These exclusive contracts/licenses are a crucial factor in the competitive landscape of systems with platforms and complementary components, as they can distort the competition in the market for both the platform and the components of the system. The complementary component manufacturers (for e.g., video-game publishers, TV program

producers, application providers, etc.) typically sign a licensing contract with the platform provider(s), which specifies the terms of the contract and the licensing fee to be paid to the platform provider(s). Given the relatively high fixed costs of designing and developing complements, a complementary component manufacturer would typically prefer to make the complement available for as many platforms as possible. However, the platform provider would prefer that the complements be exclusive to its platform as such exclusivity not only make the platform more attractive to potential customers, but also enables the platform to differentiate itself from its rivals. These diverging incentives lead to very interesting dynamics that take on added significance in the presence of network externalities.

Despite the ubiquity of such practices in many hi-tech industries, there has been very little systematic research addressing this phenomenon. The objective of this paper is to understand the drivers and consequences of such exclusive contracting in network industries. The dynamics of such exclusive practices are most prominent in the market for console-based video games. Titles such as “Harry Potter” and “Madden NFL 06” are available on all major video game consoles-PlayStation, Xbox, and GameCube, others such as “Grand Theft Auto” were initially made exclusively available only on Sony’s PlayStation. Consequently, we use the video-game industry as our primary context to model exclusive contracting in network industries. While our specific focus in this paper is on the video game industry, most of our analysis is conceptually relevant for any set of products fitting the platforms-complements paradigm. Our focus on the video game industry sacrifices some generality in terms of the applicability of our findings to other network products. However, it helps us to build a richer description of consumer behavior into our model, and at the same time permits us to make some reasonable analytical assumptions which help tractability. The focus will also enable us to calibrate our model and find some empirical support for our findings.

Most existing research on competition in complementary product markets has focused on issues such as the impact of network effects and switching costs (Farrell and Klemperer, 2004), technology adoption in the presence of externalities (Katz and Shapiro, 1986), issues of compatibility (Katz and Shapiro, 1985), and two-sided platforms (Rochet and Tirole,

2003). While there is no research on exclusivity in complementary network industries, there is a sizeable body of research in economics that studies exclusivity arrangements primarily in the manufacturer-retailer context (e.g. Aghion & Bolton, 1987; Bernheim & Whinston, 1998). The primary focus of this literature is to understand whether an incumbent can strategically foreclose an entrant through the use of vertical restraints and to highlight the accompanying efficiency distortions. Exclusivity has also been studied in the context of R&D investments, where it is used to minimize spillovers (e.g., Masten and Snyder, 1993). Finally, a few papers discuss the effect of exclusivity in the context of the Microsoft antitrust litigation (e.g., Klein, 2001; Whinston, 2001). Our research in this paper extends this body of research by studying exclusivity in network industries as well as going beyond the typical monopoly focus in this literature.

In this paper we focus on exclusive/non-exclusive contracts between consoles and game developers. We derive conditions that lead to regimes of exclusivity and non-exclusivity. We then examine the implications of these regimes for the competitive outcomes for both the console manufacturers and the game developers/manufacturers. More specifically, we seek to answer the following questions:

- Under what conditions do console manufacturers and game developers engage in exclusive contracting?
- Can the dominant console lock out a weaker rival through the use of such exclusive contracts?
- How do these contracts affect the division of surplus between the console and the games?

Our results show that the stage of console market maturity and the asymmetry between the installed bases of consoles are critical determinants of exclusivity. Exclusivity is much more likely both in the nascent and mature stages of the console market, but non-exclusivity is usually the outcome in the intermediate stages. In the nascent stages, the bigger console secures exclusivity. In the mature stages, somewhat surprisingly there exist conditions under which the smaller console is able to secure exclusivity. Asymmetry

in the console market also has a critical impact on division of surplus between consoles and game developers.

The rest of the paper is structured as follows. We start with a brief description of the industry and some related research in this section. Section 2 presents our basic model of consumer utility and derives the demand curves for games. Section 3 describes customers' preferences for consoles and derives the equilibrium console prices, following which we derive the equilibrium exclusivity regimes in section 4 of the paper. Finally, section 5 discusses some of the implications of our findings and concludes.

1.1 The Video Game Industry

The video gaming industry in the US, with sales of over \$10 billion, is bigger than the movie industry. It is among the fastest growing, most profitable segments in the entertainment world and has enjoyed an average growth rate of 12% over the last six years. Analysts expect it to grow at over 40% in 2006. In the 1980s while the customer base was largely in the 12-18 year range, by 2002 the core age demographic of video game players was 10-45 years (Burgelman, 2002).

The video game system comprises of two primary components – the game console, and the game software. A game console requires an operating system that provides the interface between the console and the games, and the most popular consoles (Sony's PS2, Microsoft's Xbox and Nintendo's GameCube) use different and incompatible operating systems. Thus games designed for one console are typically incompatible with other consoles and the cost of "porting" a game developed for one console to a competing console can be substantial. However, the game in itself forms the core of the system as most of the utility to a customer derives from being able to play her favorite games. According to the Yankee Group, most customers had just one console with a small minority owning more than one. The key factor driving console purchases is the quality and variety of game available for the console. Thus while customers really care a lot more about the games rather than the consoles, the cost of purchasing additional consoles generally restricts customers to the games available for their console.

Game publishers sign a licensing contract with the console manufacturer, which specifies the licensing fee to be paid to the console manufacturer for each copy of the game sold. Given the relatively high fixed costs of designing and developing games, third-party publishers would typically prefer to market the game for as many consoles as possible. However, surprisingly there are several game titles that are made available exclusively for just one console. These include both successful and unsuccessful games. Thus one of the key decisions for a game publisher is to select the consoles on which to publish the game and more importantly, whether to make the game exclusive to one console or make it available on multiple competing consoles. Correspondingly, an important question for the console manufacturer is which games to license and whether to sign an exclusive or non-exclusive licence contract with the game publisher.

As noted by Schilling (2003) firms introducing a new technology standard can use strategic alliances and licensing agreements with manufacturers of complementary goods to gain competitive advantage. However manufacturers of complementary goods may seek to extract a larger portion of the combined value of the bundle under such situations. The ultimate outcome though, would depend on a number of factors, the characterization and analysis of which is the primary objective of this paper.

2 Model

We model duopoly competition in the hardware segment between two firms each selling a single video game console. The firms as well as the consoles are labeled A and B . Consoles A and B have installed bases¹ n_A and n_B respectively. While we do not specifically explain how the current installed bases have been attained, this does not cause any loss of generality as n_A and n_B can take any positive values. We further assume, again without loss of generality, that $n_A \geq n_B$ and therefore we'll call A the bigger or dominant console. Each console has a number of games available for it. Each game is different. Therefore the higher the number of games, the larger the variety that customers of a particular console

¹meaning, the number of customers who currently own the consoles.

can choose from. The games are incompatible in the sense that games developed for one console cannot be played on the other console. However, the game publisher can choose to port the game onto the second console at an additional cost. We assume that the number of games available for a console is proportional to the size of its installed base. This reflects the presence of indirect network effects in this market.

To sharpen focus on the exclusivity choices of a single game publisher, we assume that all games with the exception of a single one are supplied by non-strategic players. Thus while each console has several games available for it, only a single game publisher strategically decides which of the two consoles to publish for. The strategic publisher takes into consideration each console's installed base, the number of non-strategic games available for each console and the contractual terms offered by the console manufacturers in deciding whether to release its game exclusively for a single console or non-exclusively for both consoles.

This assumption of a single strategic game publisher is not as restrictive as it may first appear. It simply means that each game publisher makes her exclusivity choice given the competitive landscape defined by the other games available for a console. One way to think about this is to assume that the games move sequentially and each game myopically decides which console to publish for given the consoles' installed bases and the number of games currently available for each.

2.1 Consumer utility and demand

There are three distinct segments of customers in the market – customers who already own console A , customers who already own console B and new customers who do not currently own either console². The numbers of customers in each of these three segments are given by n_A , n_B and n_N respectively. The aggregate preferences of customers in each of the three segments are represented by a representative customer.

²We ignore the possibility that some customers might own both consoles as these customers are typically a very small fraction of the total. Further, the presence of multihomers among current customers does not qualitatively affect the results so long as new customers purchase only a single console.

The consumption preferences of the representative consumer for each segment are as given by the following utility function.

$$U(x_0, u) = x_0 u \tag{1}$$

where x_0 is the quantity of numeraire good and u is a function that represents the utility the representative consumer receives from using one of the two consoles and some of the compatible games. If customers in a segment do not own/purchase either console, then u simply takes a value of 1. Going forward we will assume that all customers participate in the market and use the following Cobb-Douglas specification for u .

$$\begin{aligned} u &= u_i = x_g^\gamma x_h^{\eta_i} & i = A, B \\ x_g, x_h &> 0, \quad \gamma, \eta_i \in (0, 1) \end{aligned} \tag{2}$$

where x_g and x_h represent normalized *quantities* of the strategic and non-strategic games demanded by the representative consumer. The actual quantities of each of these games demanded by each segment can be obtained by multiplying the normalized quantities by their respective market sizes (n_A, n_B and n_N). While there may be several non-strategic games available for each console, the above specification effectively treats the set of non-strategic games as a single composite good. This enables us to abstract away from the details of how consumption might be split among the different non-strategic games and focus attention on the interaction between the strategic game and the set of non-strategic games available for each console.

The parameters γ and η_i affect the marginal utilities of consumption for the strategic and non-strategic games respectively. The higher these parameters, the higher the marginal consumption utility of the corresponding game(s). γ can be interpreted as a *quality* parameter of the strategic game and we assume that its value is endowed exogenously on the game publisher. We also assume that η_i is a monotonically increasing, but concave function of n_i . This relationship between η_i and n_i reflects the indirect network effects in this market. As the installed base for a console (n_i) increases, the number (variety) of

games available for it also goes up, thereby increasing the marginal utility of consumption for these set of games.

The representative consumer for each segment chooses a consumption bundle (x_0, x_g, x_h) subject to a budget constraint. The budget constraint for the representative consumer of the new customer segment is given by:

$$x_0 + x_g p + x_h p = Y \tag{3}$$

where $Y = y - p_i$ gives the disposable income available to customers in this segment. y is the common endowment of the numeraire among customers, p_i is the price of console i and p is the common exogenous price charged by publishers for each copy of a video game. This assumption of a common fixed price is somewhat unusual, but is justified in the context of the video game industry where most games are sold at a fixed introductory price of \$49.99. Older games are sometimes discounted, but that does not create a problem as we can assume that this effect is captured indirectly through η_i , rather than directly through price. This assumption of a common price p therefore simplifies the problem and also makes it possible to treat the set of non-strategic games as a single composite product.

New customers do not have specific preferences for the consoles themselves. Therefore, the representative consumer for the new segment buys the console i that maximizes (1) subject to (3). Customers in the other two segments (n_A and n_B) already own one of the two consoles and therefore buy only the games compatible with that console, but not the other console. Therefore, the budget constraint for these customers is slightly different – essentially $Y = y$ rather than $y - p_i$ for these customers.

Table 1 summarizes the notation used in the paper, some of which will be introduced later. Maximizing the utility (1) of the representative consumer in each segment subject to the budget constraint (3) gives the following set of normalized³ demands per customer.

³The actual demand for each segment can be obtained by multiplying these normalized demands by the number of customers in that segment.

Notation	Description
n_i	number of customers in segment i . ($i = A, B, N$)
$U(.)$	utility function of the representative consumer
x_0, x_g, x_h	quantities of the numeraire, strategic game and non-strategic games respectively consumed per each consumer in the segment
$\gamma \in (0, 1)$	quality parameter for the strategic game, specifies the marginal utility from its consumption
η_i	specifies the marginal utility from consumption of the non-strategic games available for console i
y	common endowment of the numeraire good among customers
p_i	price of console i
p	price of a game – assumed exogenous and equal for all games
L, l	percentage of game price charged as license fee from non-strategic and strategic game respectively
F_1, F_2	fixed costs of game development for exclusive and non-exclusive game respectively
c	constant marginal cost of consoles

Table 1: Summary of notation used in the paper

$$\begin{aligned}
\bar{x}_0 &= \frac{Y}{1 + \gamma + \eta_i} \\
\bar{x}_g &= \frac{\gamma}{p} \left(\frac{Y}{1 + \gamma + \eta_i} \right) \\
\bar{x}_h &= \frac{\eta_i}{p} \left(\frac{Y}{1 + \gamma + \eta_i} \right)
\end{aligned} \tag{4}$$

The normalized demands reveal the well-known constant budget shares property of the Cobb-Douglas utility specification. As the disposable income goes up, the demands for all games go up, but the ratio of their demands remains the same. A similar effect accompanies a reduction in price. Further, an increase in the "quality" of the games or a reduction in their price result in a substitution from the numeraire good to the games sector.

Equation (4) specifies normalized demands for a console which has both the strategic and non-strategic games available for it. However, if the strategic game is not available for a console, then normalized demand for games on that console are given by:

$$\begin{aligned}
x_0 &= \frac{Y}{1 + \eta_i} \\
x_h &= \frac{\eta_i}{p} \left(\frac{Y}{1 + \eta_i} \right)
\end{aligned} \tag{5}$$

Comparing the demand for games in (4) and (5), it is clear that although demand for non-strategic game suffers somewhat with the introduction of the strategic game, the overall demand for games ($x_g + x_h$) goes up. Thus the publication of the strategic game expands the game sector at the cost of expenditure allocated to other sectors. The higher the quality parameter γ for the game, the higher is this expansion.

In addition to specifying the normalized demands when the strategic game is not available for a console, (5) also specifies the optimal budget allocations of a representative consumer when a corner solution – one at which zero quantity of the strategic game is purchased – is optimal. The following proposition identifies the condition under which this corner solution arises.

Proposition 1 *For $Y > p(2 + \eta_i) \left(\frac{2 + \eta_i}{1 + \eta_i} \right)^{1 + \eta_i}$, there exists a critical value γ_c for the quality*

parameter γ of the strategic game, below which it has no demand. Demand is positive for $\gamma > \gamma_c$.

Proof. Equations (4) and (5) provide the optimal consumption bundles in the case when positive quantities of the strategic game are purchased and not purchased respectively. Substituting these into (1) and (2), we get the corresponding utilities.

$$U_h = \text{utility without strategic game} = \left(\frac{\eta_i}{p}\right)^{\eta_i} \left(\frac{Y}{1+\eta_i}\right)^{1+\eta_i} \quad (6)$$

$$U_{gh} = \text{utility with strategic game} = \left(\frac{\eta_i}{p}\right)^{\eta_i} \left(\frac{\gamma}{p}\right)^{\gamma} \left(\frac{Y}{1+\gamma+\eta_i}\right)^{1+\gamma+\eta_i} \quad (7)$$

The representative consumer chooses a consumption bundle that maximizes her utility. From (6) and (7), it is clear that $U_{gh} = U_h$ for $\gamma = 0$ and $U_{gh} > U_h$ for $\gamma = 1$ as long as $Y > p(2 + \eta_i) \left(\frac{2+\eta_i}{1+\eta_i}\right)^{1+\eta_i}$. From (7), U_{gh} is a continuous function of γ . Differentiating it twice with respect to γ , we have:

$$\frac{\partial U_{gh}}{\partial \gamma} = \left(\frac{\eta_i}{p}\right)^{\eta_i} \left(\frac{\gamma}{p}\right)^{\gamma} \left(\frac{Y}{1+\gamma+\eta_i}\right)^{1+\gamma+\eta_i} \text{Ln} \left(\frac{\gamma Y}{p(1+\gamma+\eta_i)}\right) \quad (8)$$

$$\frac{\partial^2 U_{gh}}{\partial \gamma^2} = \left(\frac{\eta_i}{p}\right)^{\eta_i} \left(\frac{\gamma}{p}\right)^{\gamma} \left(\frac{Y}{1+\gamma+\eta_i}\right)^{1+\gamma+\eta_i} \left[\frac{1+\eta_i}{\gamma(1+\gamma+\eta_i)} + \left(\text{Ln} \left(\frac{\gamma Y}{p(1+\gamma+\eta_i)}\right)\right)^2 \right] \quad (9)$$

From (8), we have $\frac{\partial U_{gh}}{\partial \gamma} < 0$ at $\gamma = 0_+$, and $\frac{\partial^2 U_{gh}}{\partial \gamma^2} > 0$ for $\gamma \in (0, 1)$. Since U_h is independent of γ , this implies that $U_{gh} - U_h$ is also a continuous, convex function of γ and that $U_{gh} - U_h < 0$ at $\gamma = 0_+$. The intermediate value theorem along with the facts that $U_{gh} - U_h < 0$ at $\gamma = 0_+$ and $U_{gh} - U_h > 0$ for $\gamma = 1$ then implies that there must be a unique value of $\gamma \in (0, 1)$ below which $U_{gh} - U_h < 0$ and above which $U_{gh} - U_h > 0$. The result follows. ■

Proposition 1 shows that only games whose endowed level of quality meets a threshold can be introduced into the market place. Figure 1 illustrates the intuition behind this result. For low levels of quality parameter γ for the strategic game, customers prefer to buy only the non-strategic game. But for higher levels of quality, the strategic game will be purchased.

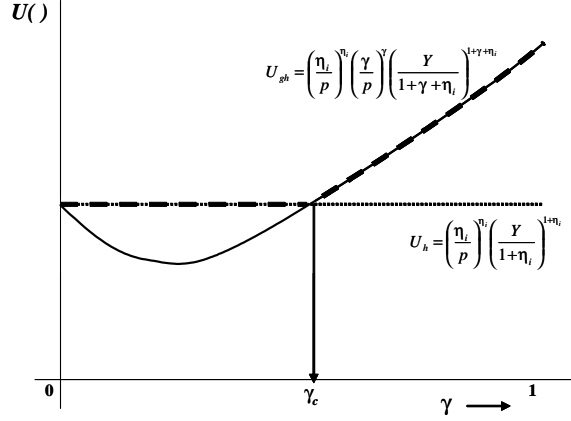


Figure 1: Representative consumer utility with and without strategic game

$\frac{Y}{p}, \eta_i$	0.1	0.2	0.25	0.5	0.75	0.9
5	0.81	0.88	0.92	> 1	> 1	> 1
10	0.35	0.38	0.39	0.47	0.55	0.6
25	0.13	0.14	0.14	0.17	0.2	0.22
50	0.06	0.07	0.07	0.08	0.09	0.10
100	0.03	0.03	0.03	0.04	0.05	0.05
1000	0.003	0.003	0.003	0.004	0.005	0.005

Table 2: Critical values of gamma

Table 2 provides the critical values of γ under different assumptions for the other parameters. The numerical analysis reveals that γ_c is an increasing function of η_i . This is intuitive because the impact of an increase in the "quality" of non-strategic games is likely to be higher if only non-strategic games are consumed as compared to a situation where consumption is distributed between non-strategic and strategic games. More interestingly, this implies that the critical quality level for the strategic game increases with the size of the installed base for a console. Therefore, *for some intermediate levels of endowed quality, it may only be viable to publish the game for a smaller console but not for a larger console.* Going forward, we will assume that the exogenously endowed quality level of the strategic game is high enough for it to be viably published for either console and revisit the case of very low quality in the discussion section.

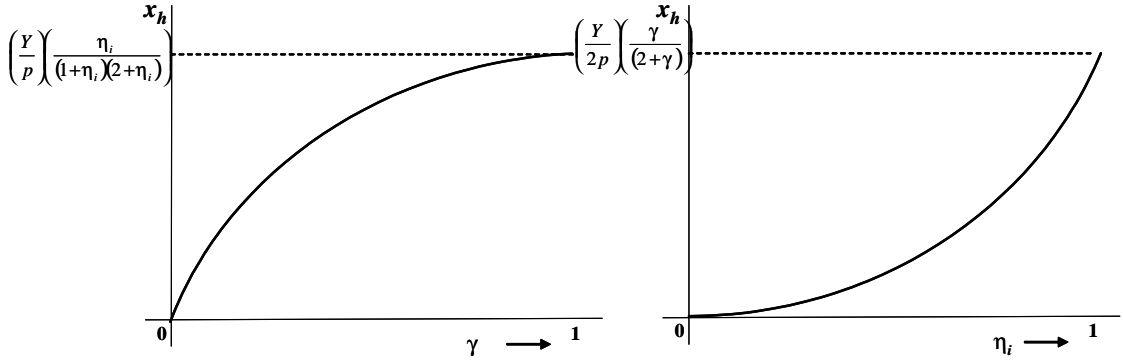


Figure 2: Cannibalization as a function of γ and η_i

2.2 The effect of the strategic game on overall game sales

As pointed out in the previous section, the publication of the strategic game has two effects on the game sector. First, it cannibalizes sales of the existing non-strategic games. Second, it expands the sector by increasing the overall expenditure on games. In this subsection, we will quantify these two effects a little more precisely. The magnitude of these two effects will be important drivers of the consoles' and strategic game's exclusivity choices.

Towards quantifying the cannibalization effect, let x_{hg} and $x_{h\bar{g}}$ respectively represent the normalized demand for the non-strategic games in the presence and absence of the strategic game. The cannibalization by the strategic game is therefore the difference between these two i.e. $x_{h\bar{g}} - x_{hg}$. From (4) and (5), this is:

$$Cannibalization = \left(\frac{Y}{p}\right) \left(\frac{\eta_i}{1 + \eta_i}\right) \left(\frac{\gamma}{1 + \gamma + \eta_i}\right) \quad (10)$$

Figure 2 shows changes in the extent of cannibalization as the quality parameters of the strategic and non-strategic games vary. In general, holding one of the quality parameters constant, an increase in the other parameter causes the extent of cannibalization to go up. Thus a strategic game of a given exogenous quality, cannibalizes the non-strategic games for a larger console more than it does for a smaller console. At the same time, a strategic game of higher quality results in a higher cannibalization for each console.

Now turning to the expansion effect, we once again use the same notation introduced

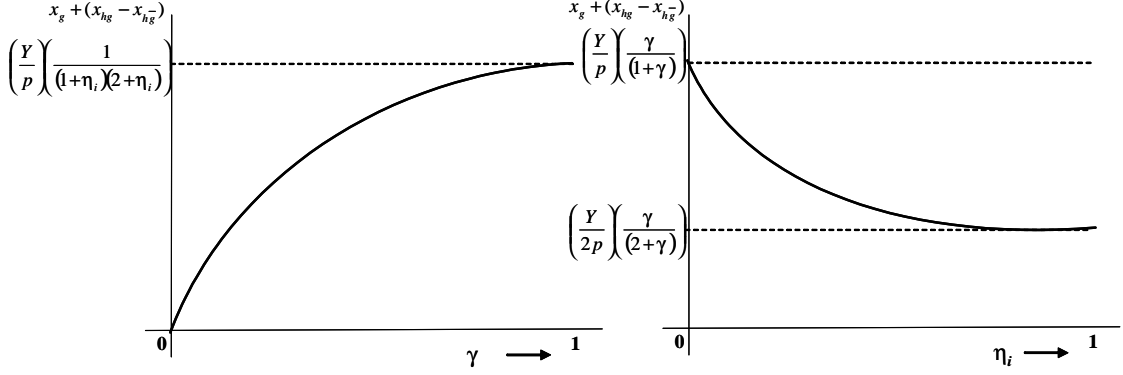


Figure 3: Net expansion as a function of γ and η_i

above. Market expansion (net of the cannibalization) equals $(x_{hg} + x_g) - x_{h\bar{g}} = x_g + (x_{hg} - x_{h\bar{g}})$. From (4) and (5), this simplifies to:

$$Expansion = \left(\frac{Y}{p}\right) \left(\frac{1}{1 + \eta_i}\right) \left(\frac{\gamma}{1 + \gamma + \eta_i}\right) \quad (11)$$

Figure 3 illustrates changes in the net game sector expansion as a function of the quality parameters. Once again we see that for a given η_i the gain is an increasing function of γ . However, it is also clear that given a quality level of the game, the expansion is lower for higher values of η_i i.e. the larger the installed base of the console, the smaller the net expansion in the per customer game spending caused by the strategic game. This is summarized in the following proposition.

Proposition 2 *The incremental game spending per customer arising from the publication of the strategic game is higher for the smaller console.*

Proposition 2 highlights one of the dilemmas faced by the strategic game publisher. While the bigger console has a larger installed base, the value added by the game to the smaller console is higher per customer. Therefore while the game might be valued more highly by the smaller console, the total revenue potential for the game might still be higher from the bigger console.

3 Customers' console choices and firm payoffs

Having specified the demand for games, we now turn to customers' choice of consoles. This section starts by laying out the structure of the game. We then describe customers console choices as well as firms pricing decisions under each of the possible exclusivity regimes.

3.1 Game structure

The interaction between the consoles and the strategic game publisher is modeled as a two stage game of complete information (see Figure 4). In the first stage, each console manufacturer simultaneously offers a licensing contract to the strategic game. The contracts specify the license fees that the strategic game will have to pay to the console manufacturers for each unit of game sold under both the exclusive and non-exclusive regimes. These license fees – l_{ei} in the exclusive case and l_{ni} in the non-exclusive case, are specified as a fraction of the selling price p of the game. Although the non-strategic game publishers do not actively make any decisions, it is assumed that the non-strategic games make a license payment of L (as a fraction of game price) per unit of game sold. At the end of stage one, the game publisher decides which license(s) to accept and invests accordingly to produce either one or two versions of the game.

Given the set of games (strategic and non-strategic) available for each console, the console manufacturers simultaneously choose console prices p_i in the second stage. The prices for the games are exogenously fixed as discussed earlier. Given the set of games and prices, new customers then purchase one of the two consoles, and all customers (old and new) buy a set of games for their console.

3.2 Costs

We assume that both consoles are produced at a symmetric constant marginal cost $c > 0$. In general, there will be a fixed design and set up cost associated with the production of consoles. Often these design costs are quite high. However, we ignore these costs in our model because these fixed costs can be considered sunk under the current set-up and

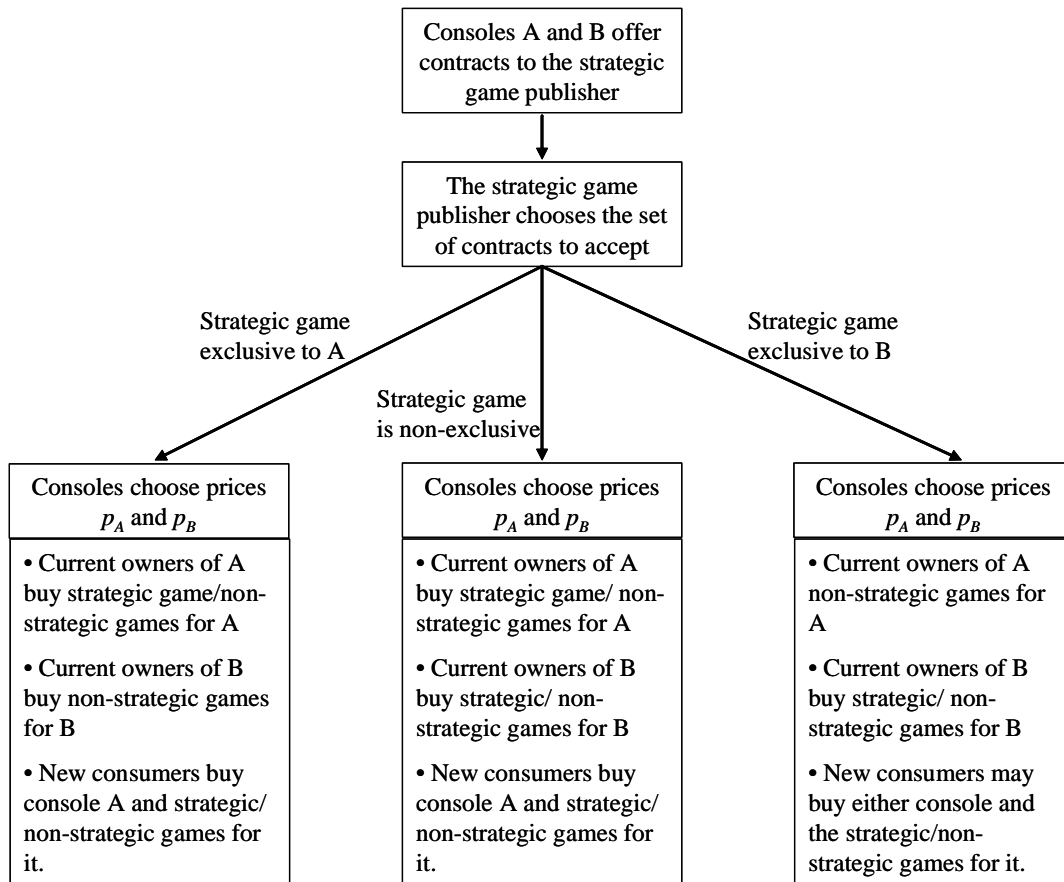


Figure 4: Structure of the game

therefore do not affect the results. In addition to the fixed costs, there may be significant economies of scale associated with the manufacture of the consoles, as indeed with most semiconductor components. If that is the case, then the marginal costs may be asymmetric, with the larger console having a lower marginal cost than the smaller one. We will briefly discuss the impact of asymmetric marginal costs in the final concluding section. The costs for the strategic game depend on the exclusivity regime chosen by the publisher. We assume that the publisher has to incur an initial fixed investment of F_1 for designing and developing the game for one of the consoles as well as its marketing. If the publisher wishes to sell the game on both consoles, then she will have to incur an additional fixed porting and marketing cost, bringing the total fixed cost to F_2 ($F_2 > F_1$). Typically $F_2 < 2F_1$ as the porting of the game to a second console generally involves only re-coding, but not new concept development. Industry figures indicate that porting costs are typically in the range of 15 - 25% of the initial development costs. The marginal costs of production/sale for the game will be assumed to be 0. Finally, we will ignore the costs associated with non-strategic games as these do not affect the results.

3.3 Customers console preferences under different exclusivity regimes

In addition to laying out the structure of the game, Figure 4 also describes the choices made by customers under different exclusivity regimes. While customers in segments A and B makes choices only about which games to purchase, the new customers make console choices as well. This subsection describes the console choices of the new customer segment. To do this, we have to compare the utility that these new customers receive from the two consoles under different exclusivity regimes.

In comparing the utility from the two consoles, we will assume that the quality endowment γ of the strategic game is higher than the critical value γ_c so that it is viable to supply it for either console. We can now specify the following orderings of utilities for customers in the new segment.

Property1 $U_h^A \geq U_h^B$ where U_h is as defined in (6) and the superscripts A, B stand for the respective consoles. This follows directly from the form of utility in (6) and the inequality is strict as long as the solution to the consumption bundle is an interior one i.e. at least some games are purchased. Thus, in the absence of the strategic game (for both consoles), the larger console provides a larger gross utility (before accounting for the cost of the console) than the smaller one.

Property2 $U_{gh}^A \geq U_{gh}^B$ where U_{gh} is as defined in (7). The inequality which follows from the definition in (7) is once again strict as long as customers purchase positive quantities of both the strategic and non-strategic games. This implies that if the strategic game is non-exclusive, then the larger console once again provides a larger gross utility (before accounting for the cost of the console) than the smaller one.

Property3 $U_{gh}^i \geq U_h^i$. This follows from the proof of proposition 1 and the fact that $\gamma > \gamma_c$. Therefore gross utility for customers is higher with the strategic game than without it.

Property4 $U_{gh}^A \geq U_h^B$. This follows from 2 and 3 and implies that the gross utility from larger console is higher if it has the strategic game, but the smaller console does not.

Property5 The ordering is not unique in a situation where the smaller console has the strategic game and the larger one does not. This ordering is given by the following lemma.

Lemma 1 $U_{gh}^B > U_h^A$ if and only if $\frac{Y_A^{1+\eta_A}}{Y_B^{1+\gamma+\eta_B}} < \gamma^\gamma p^{\eta_A - \eta_B - \gamma} \frac{\eta_B^{\eta_B}}{\eta_A^{\eta_A}} \left(\frac{(1+\eta_A)^{1+\eta_A}}{(1+\gamma+\eta_B)^{1+\gamma+\eta_B}} \right)$, where $Y_A = y - p_A$ and $Y_B = y - p_B$.

Proof. Substituting U_{gh}^B and U_h^A from (6) and (7) and simplifying yields the condition. ■

3.4 Console prices and purchases by the new customer segment

In this section, we specify the second stage prices set by the two consoles under different exclusivity regimes. We will then use intuition developed from these prices to identify the console which sells to the new customer segment under different conditions. The crucial insights required to understand the pricing choices of the consoles in the second stage of the game are provided in the following remarks.

Remark 1 *Given the exclusivity choice made by the strategic game in the first period, the second stage pricing choices of the consoles do not affect their revenues (or profits) from their existing customers.*

Remark 2 *The minimum price a console will be willing to charge will exactly equate its total profits on the new customer segment to zero. At any price above this minimum, the console will be willing to undercut its competitors price (in a Bertrand fashion) in order to sell to the new customers. Note that this minimum price is not the console's marginal cost, as the console also gets license revenue from the games.*

It is easy to understand why the first remark should hold. The prices of the consoles in the second period only affect the console and game choices of the new customers, but do not affect the game choices of customers in the consoles' existing customer segments. The only factors which affect game purchases by the existing customers are the selection of games as well as game prices. The former is fixed in the first stage and the latter are exogenous. Further, since the license fee paid by the strategic game to the consoles (if any) is also fixed in the first stage, consoles' profits from their existing customers are completely independent of their second stage pricing decisions.

The second remark follows from the first. If the console's actions on the new customer segment do not affect its profits from its existing customers, then any price that yields some net revenue to the console will be preferred to not selling to the customers in the new segment (which would yield a net profit of zero). At the same time, losses made on the new customer segment cannot be recovered through incremental profits on its existing customers. Therefore the minimum price will exactly equate the profits on the new segment to zero. What is however interesting is that this minimum price will be below the marginal cost of the console as a consequence of the fact that the consoles receive licensing revenue from the strategic/non-strategic games sold for the console. This licensing revenue will only be realized if the console is sold in the first place and as a consequence, the console will be willing to price well below marginal cost – even sell it them for a "negative"

price under some circumstances⁴.

Given remarks 1 and 2, in this section, we'll focus only on the new customer segment and ignore the existing customers. We now examine each of the possible regimes (in terms of game availability) from the stage to gain some intuition about the corresponding second stage console prices and customers' console choices.

3.4.1 Case1: Strategic game not available for either console

In this case, Property 1 in section 3.3 implies that new customers have a higher gross utility for the larger console. Therefore they will buy the larger console as long as the price p_A is not much higher than the price of the smaller console p_B . Console B realizes this, and will be willing to lower its price to $\underline{p_{B\bar{g}}}$. This price can be calculated by equating console B 's profits $(= (p_B - c) + Lp \left(\frac{\eta_B}{p}\right) \left(\frac{y-p_B}{1+\eta_B}\right))$ on the new segment to zero and is given by

$$\underline{p_{B\bar{g}}} = \frac{c + (c - Ly)\eta_B}{1 + (1 - L)\eta_B} \quad (12)$$

Console A 's best response to this price by console B , would be to choose a price p_A that would leave the new customers just indifferent between buying either console. This price p_A will be higher than $\underline{p_{BO}}$ given in (12) and can be obtained by solving the customer indifference condition given below.

$$\left(\frac{\eta_A}{p}\right)^{\eta_A} \left(\frac{y - p_A}{1 + \eta_A}\right)^{1+\eta_A} = \left(\frac{\eta_B}{p}\right)^{\eta_B} \left(\frac{y - \underline{p_{B\bar{g}}}}{1 + \eta_B}\right)^{1+\eta_B} \quad (13)$$

3.4.2 Case2: Strategic game exclusive to larger console

Property 4 in section 3.3 implies in this case that the new customers would still purchase console A . The price for console B will still be as given in (12), but p_A will higher than the corresponding value in (13) due to property 3.

⁴While in reality, we never observe negative prices for consoles in the market, it is nevertheless a theoretical possibility. Further, consoles often come bundled with games and other equipment and if you subtract the market value of these bundled add-ons from the console price, the net price might indeed work out to be negative in some cases.

3.4.3 Case3: Strategic game non-exclusively supplied for both consoles

When the strategic game is available for both consoles, property 2 in section 3.3 states that the gross utility to customers from console A is still higher than the gross utility from console B . Therefore new customers still end up buying the larger console A . However, the equilibrium prices set up the consoles will be slightly different in this case. The equilibrium price set by console B , labeled \underline{p}_{Bg} , can once again be obtained by setting the total profit (which includes margin on the consoles, license revenue from non-strategic games as well as license revenue from strategic games) to zero.

$$\underline{p}_{Bg} = \frac{c(1 + \gamma + \eta_B) - y(l_{nB}\gamma + L\eta_B)}{1 + (1 - L)\eta_B + (1 - l_{nB})\gamma} \quad (14)$$

The corresponding equilibrium price for console A can be obtained by solving $U_{gh}^A = U_{gh}^B$, or equivalently

$$\left(\frac{\eta_A}{p}\right)^{\eta_A} \left(\frac{\gamma}{p}\right)^\gamma \left(\frac{y - p_A}{1 + \gamma + \eta_A}\right)^{1+\gamma+\eta_A} = \left(\frac{\eta_B}{p}\right)^{\eta_B} \left(\frac{\gamma}{p}\right)^\gamma \left(\frac{y - \underline{p}_{Bg}}{1 + \gamma + \eta_B}\right)^{1+\gamma+\eta_B} \quad (15)$$

The only interesting thing about the price of console A is that p_A in this case is potentially lower than the corresponding values in both cases 1 and 2 above. The reasons for this is two fold. First, the availability of the strategic game increases the total games revenue for the smaller console B as compared to cases 1 and 2 where it does not have the strategic game. Therefore, as long as l_{nB} is not significantly smaller than L , console B receives higher license revenue from the new customer segment if it manages to sell them the console. Therefore it is quite likely that $\underline{p}_{Bg} \leq \underline{p}_{B\bar{g}}$. Further, since the incremental increase in utility (from the strategic game) is smaller for customers of the larger console as compared to customers of the smaller console, the difference $U_{gh}^A - U_{gh}^B$ is smaller than $U_h^A - U_h^B$ or $U_{gh}^A - U_h^B$. As a consequence, the premium that console A can charge over the price of console B and still sell to the new customer segment comes down. Therefore, if we represent the price of console A in cases 1, 2 and 3 respectively as p_{A1} , p_{A2} and p_{A3} , then we have:

$$p_{A2} > p_{A1} > p_{A3} \tag{16}$$

3.4.4 case4: Strategic game exclusive to smaller console B

As per property 5 in section 3.3, the outcome in this case depends on whether or not the condition in Lemma1 is satisfied. If the condition is satisfied, then console B serves the new customer segment, otherwise console A serves this segment. First considering the case when console A sells to the new customers, the equilibrium price of console B is still given by (14) with the only difference being, l_{nB} in the expression is now replaced by l_{eB} . The corresponding equilibrium price for A is obtained by solving $U_h^A = U_{gh}^B$.

The only case in which console B sells to the new customer segment is in the current case in which the condition in Lemma1 holds. In this case, the utility of the smaller console with the strategic game leapfrogs the utility of the larger console without the strategic game i.e. $U_{gh}^B > U_h^A$ assuming equal prices for both consoles. Therefore in this case, console B will be able to charge a premium over the larger console A and still sell to the new customers. Console A 's equilibrium price in this case will be given by an expression similar to the one in (12), but with the index B replaced by A . We can call this price $\underline{p_{A\bar{g}}}$. The corresponding equilibrium price for console B (labeled p_{B4}) is obtained by equating $U_{gh}^B = U_h^A$, with $p_A = \underline{p_{A\bar{g}}}$ and solving for p_B . Note that $\underline{p_{A\bar{g}}} < \underline{p_{B\bar{g}}}$ as $\eta_A > \eta_B$. Therefore the price of console B here will be lower than the price at which console A sells to the new customer when it has the strategic game exclusive.

4 First-stage exclusivity choices

Having specified the second stage equilibria for console prices and customers' console choices in the last section, we now turn our attention to the primary question in the paper – that of the first stage exclusivity choices. Towards identifying the conditions under which different exclusivity regimes arise as equilibria, we first quantify the effect of the strategic game on the consoles' profits. Then we list the set of conditions that need to be satisfied

for a given exclusivity regime to be an equilibrium and finally identify the parameter values for which these conditions are satisfied.

4.1 The strategic game's impact on console profits

The strategic game affects the consoles' revenues in three ways. First, it provides additional license revenue through the sale of units of the strategic game. Second, it decreases the license revenue from non-strategic games through cannibalization. Finally, it may affect the new customers' decisions about which console to buy. Note that while the third effect is limited to only the new customer segment, the first two effects have an impact on a console's current customers as well.

In order to quantify the first two effects, Let l_i be the license fee (as a fraction of the price p) that the strategic game pays to the console i . l could either be l_{ei} or l_{ni} depending on which of the two contracts the strategic game has accepted. The change in license revenue per customer in a given segment that accompanies the introduction of the strategic game is therefore given by:

$$\begin{aligned}
 \text{Change in license revenue} &= \left(Lp \left(\frac{Y}{p} \right) \left(\frac{\eta_i}{1 + \gamma + \eta_i} \right) + lp \left(\frac{Y}{p} \right) \left(\frac{\gamma}{1 + \gamma + \eta_i} \right) \right) \\
 &\quad - \left(Lp \left(\frac{Y}{p} \right) \left(\frac{\eta_i}{1 + \eta_i} \right) \right) \\
 &= Y \left(\frac{1}{1 + \eta_i} \right) \left(\frac{\gamma}{1 + \gamma + \eta_i} \right) (l(1 + \eta_i) - \eta_i L)
 \end{aligned} \tag{17}$$

The incremental license revenue from the strategic game defined in (17) will be positive only if

$$\frac{l}{L} > \frac{\eta_i}{1 + \eta_i} \tag{18}$$

The condition in (18) raises a few interesting issues. First of all, even though the strategic game always expands the games market for a console, the console might not be able to capture the benefit of this expansion if it has to give a significant discount on the license fee (compared to L) in order to incentivize the strategic publisher to create the game for its

platform. Further, since the R.H.S is increasing in η_i , the smaller console will be able to give a larger discount per unit of game sold than the larger console, and still come out ahead. What this implies is that, the smaller console will be willing to provide a larger incentive per customer than the larger console to persuade the strategic game to go exclusive with it. This of course is consistent with the result we had in proposition 2 earlier. While the incremental license revenue generated by the strategic game is important for the consoles, what is likely to be much more important is the third effect of a change in the console purchased by the new customers. As discussed in section 3.4, new customers always buy the bigger console in the absence of the strategic game. or when the strategic game is available on the bigger console either exclusively or non-exclusively. However, when the strategic game is available exclusively on the smaller console, but not the larger one, then the new customers may buy the smaller console if the condition specified in Lemma 1 is satisfied.

4.2 The players' incentives towards exclusivity

In this section we analyze the incentives of the consoles as well as the strategic publisher in order to identify the conditions under which they would prefer exclusivity to non-exclusivity and vice-versa. First off, the incentives of the strategic publisher are straightforward to characterize. The strategic publisher maximizes its revenues if it develops the game for both consoles, as in this case, it will be able to sell to all three customer segments. Producing exclusively for one console will shut out at least one segment of the market from the strategic game. However, the publisher also potentially faces higher costs under the non-exclusive regime for two reasons. First, it has to pay a higher fixed cost to produce two versions of the game rather than one (F_2 rather than F_1). Second, it potentially has to pay higher license fees to the consoles in the non-exclusive regime rather than the exclusive regime. Therefore the publisher will develop versions for both consoles only as long as the incremental revenue from doing so exceeds these incremental fixed and licensing costs. Otherwise the publisher prefers to limit development to a single console. In examining the preferences of the consoles to make the game exclusive, it will be useful to

examine the incentives of the consoles on the current customer segment and the new customer segment separately.

4.2.1 Incentives for exclusivity on the current customer segment

We know from (11) that the strategic game increases the game revenues on each console's current customer segment. As long as condition (18) is satisfied, this expansion also results in higher license revenue for the console, and therefore the console prefers having the game to not having it. Given this, does having the game exclusive (rather than non-exclusive) add to the console's profitability on its own customer segment? The answer is no as long as $l_{ni} \geq l_{ei}$. The reason for this is obvious. The total sales of games in a console's own customer segment (or the mix between strategic and non-strategic game purchases) is in no way affected by whether or not the other console also has the strategic game available for it. Therefore the only effect of exclusivity is through the license fees that the console charges to the strategic game. If the console has to give a larger discount on the license fee to persuade the strategic publisher to become exclusive, then this decrease in license fee only lowers the console's profits on its current customer segment. Therefore in the absence of other considerations, neither console would incentivize the strategic publisher to go exclusively with them. However, there is of course a very important other consideration – the console choice of the new customers. We therefore analyze the incentives for exclusivity on the new customer segment next.

4.2.2 Incentives for exclusivity on the new customer segment

To begin with, we know from section 3.4 that new customers will buy the smaller console only when the strategic game is exclusive to it and the condition in Lemma 1 is satisfied. Under all other conditions, they purchase the bigger console. Second, conditioned on the event that the new customers buy a console i , the quantities and mix of games sold for that console on the new customer segment, is not affected by the set of games available for the other console. These two facts imply that the bigger console has no direct incentive to make the game exclusive if $l_{nA} \geq l_{eA}$.

However, console A has an indirect incentive to make the strategic game exclusive under some conditions. Recollect from (16) that the console price p_A charged by the bigger console is higher when the strategic game is exclusive to it, as compared to the case when the game is non-exclusive. Therefore, although the license revenue that console A can obtain from the strategic game may be lower in the exclusive case, the increase in p_A might be sufficiently large for the console to offset this decrease in license revenue.

Two things need to be noted about this indirect effect. First, the loss in license revenue from a reduction in the license fee will affect console A 's profits both from the new customers as well as the existing customers. Therefore the gain in console price has to compensate for both these losses. As a consequence, console A is more likely to seek exclusivity when the number of new customers is much larger than the number of existing customers. The second thing to note is that, from console A 's perspective, an increase in the console price is preferable to an equivalent increase in the license revenue. To understand the reason for this, refer back to (4). A reduction in the console price p_A increases Y (since $Y = y - p_i$). From (4), an increase in Y increases the spending on video games, thereby leading to an increase in the revenue for the strategic game. If we were to assume that the console then adjusts the license fee (lowers it) so that the total license revenue for the console remains constant, then the strategic game will be worse off than before. This is because the increase in Y caused by the lowering of p_A is only partially allocated to the purchase of the strategic game, with the rest being going to the non-strategic games and the numeraire sector. Therefore, while an increase in spending on games accompanies a reduction in the console price, the total revenue of the strategic game plus the console will still be lower.

From the discussion in section 3.4, it is clear that having the strategic game exclusive is a necessary (but not sufficient) condition for the smaller console B to sell to the new customers. Therefore B has a strong incentive to try and make the strategic game exclusive. In the next section, we will identify the conditions under which B can successfully do this. However, before that, it will be useful to establish the following result.

Lemma 2 *The smaller console B will seek exclusivity of the strategic game only if the new*

customers purchase B in the ensuing equilibrium.

Proof. Assume to the contrary that new customers purchase console A even when the strategic game is exclusive to B . Then the only revenue B obtains is from license fees from its own customers – both from the strategic as well as the non-strategic game. Further, this license revenue does not depend on whether or not A also has the strategic game.

Therefore console B will at least weakly prefer non-exclusivity, unless $l_{eB} < l_{nB}$. However, $l_{eB} < l_{nB}$ cannot be true because the strategic game more than doubles the number of customers served, and significantly increases its profits if it goes non-exclusive. Further, if F_2 is much larger than F_1 and the game is forced to go exclusive, then it will prefer exclusivity to A rather than B , as A will be able and willing to give it at least as much profit as B . Therefore if the new customers purchase A , then exclusivity of the strategic game for B cannot be part of a sub-game perfect equilibrium. ■

4.2.3 Conditions for Exclusivity

Based on the discussion in the previous section, we can conclude that in any subgame perfect equilibrium of the two-stage game, only a console which ultimately sells to the new customer segment is likely to have the strategic game exclusive. Further, sometimes, the equilibrium might involve non-exclusivity for the strategic game, in which case the bigger console A serves the new customer segment.

In this section we identify the regions in the parameter space for which different exclusivity regimes arise as equilibria. But before doing so, it will be useful to specify the conditions that need to be satisfied for these to be equilibria. These conditions are given by Lemmas 3 and 4 below. To state these lemmas, we need some additional notation, which is first defined.

Let R_{ii} denote the total revenue accruing to the console i plus the strategic game when the strategic game is exclusive to console i . R_{ii} includes the revenue from the sale of consoles, the total revenue from the sale of strategic game on console i (not just the license fee paid to the console by the game), and the license revenue to console i from the non-strategic games sold for the console. Note that at this stage we are not concerned about what license

fees the strategic game pays to the console i.e. we are not currently interested in how R_{ii} is shared between the console and the strategic game. Let R_{ij} denote the total revenue accruing to the console i when the strategic game is exclusive to the other console j . Naturally, R_{ij} includes revenues from console sales and the license revenue to the console from non-strategic games, but no revenue from the strategic game since the game is exclusive to the other console.

Define $\Delta R_i = R_{ii} - R_{ij}$. Therefore, ΔR_i denotes the incremental total revenue created on a console by the strategic game as compared to a situation when the game is exclusive to the other console. R_{ii} , R_{ij} and ΔR_i are absolutely critical in specifying the conditions under which different equilibria arise and also the license fees charged by the consoles to the strategic game.

Lemma 3 *If $\Delta R_i > \Delta R_j$ $i = A, B$, $j \neq i$, then console i cannot be excluded from the strategic game in any subgame perfect equilibrium.*

Proof. Let $\Delta R_i > \Delta R_j$ but assume that the subgame perfect equilibrium involves the strategic game being exclusive on console j . Also assume without loss of generality that the revenues from the sale of games directly accrue to the consoles, who then transfer the revenues less any license fees to the game publishers⁵. Now, let console i make the following offer to the strategic game: Console i will pay the strategic game an amount equal to ΔR_i if the game switches loyalties and goes exclusive with console i instead of console j . If the strategic game accepts the offer and switches, then console i will be no worse off than before because the difference between the total revenues in the two cases for console i is exactly ΔR_i . Now, can console j make an acceptable counter offer to retain the strategic game? The answer is no – because the maximum total amount that console j would be willing to give up to retain the strategic game would be ΔR_j (including any amount it was paying the game in the first place) which is less than ΔR_i . Therefore the strategic game will accept console i 's offer and switch. Therefore, any equilibrium of this game cannot exclude console i . ■

⁵This assumption is purely for clarity of exposition and the arguments presented are not affected by whether the console collects the revenues and transfers a part of them to the game or the other way around.

There are two things of interest to be noted about Lemma 3 and the argument presented in its proof. First, when $\Delta R_i > \Delta R_j$, although console j cannot exclude console i from the strategic game, it is possible the other way around. That is, console i can unilaterally exclude console j if it so wishes. However, this does not imply that console i will always do that. Second, console i need not offer the strategic game ΔR_i to be able to make it exclusive. Any offer $\geq \Delta R_j$ is sufficient for this purpose, because console j will not be able to make an acceptable counter offer in this case. The following lemma formalizes this assertion.

Lemma 4 *If $\Delta R_i > \Delta R_j$, and $\Delta R_j > F_1$, then console i will leave the strategic game with a gross surplus of ΔR_j and appropriate the rest of the game revenues as license payments.*

Proof. First of all note that since the gross payoff of the strategic game ΔR_j is greater than its fixed costs F_1 , the strategic publisher prefers producing a version of the game for console i to staying out. Further, since console j will be unable to offer the game a gross surplus larger than ΔR_j , the game has no choice but to accept console i 's offer. ■

An interesting thing to note about Lemma 4 is that it does not specify the nature of the equilibrium. The equilibrium could involve the strategic game being exclusive to the console i or being non-exclusively available for both consoles. In either case, the gross payoff to the game is capped at ΔR_j . In fact the gross payoff to the strategic game will exactly equal ΔR_j as the console i will not offer any larger amount, and for any smaller amount, the game can profitably switch to console j .

Going forward, we will generally assume $\Delta R_j > F_1$. This will make the exposition easier by not having to explicitly mention the condition every time.

4.3 Exclusive and non-exclusive equilibria

In this section, we will use Lemmas 3 and 4 along with some results from sections 3.3 and 3.4 to identify the regions of the parameter space where different exclusivity regimes obtain as equilibria. In doing so, we will analytically specify the ΔR_A and ΔR_B values. This requires consideration of two different cases – First, when the smaller console has an

opportunity to make the game exclusive and second, when the smaller console cannot make the game exclusive.

Case 1 *Console B can make the strategic game exclusive.*

For the smaller console B to be able to make the strategic game exclusive, we need two conditions to be simultaneously satisfied.

1. $\Delta R_B > \Delta R_A$
2. The condition in Lemma1 is satisfied.

We will now derive the analytical expressions for these two conditions and identify the region of the parameter space where they are satisfied. This involves specifying the final payoffs of the two consoles when each of them has the game exclusive and identifying a set of parameters which are consistent with the two conditions. Based on the discussion in section 3.4, we do know that in this case, whichever console has the strategic game will sell to the new customers. Therefore we have the following:

$$\begin{aligned}
 R_{BB} &= n_{By} \left(\frac{\gamma + L\eta_B}{1 + \gamma + \eta_B} \right) + n_N \left((y - p_{B4}) \left(\frac{\gamma + L\eta_B}{1 + \gamma + \eta_B} \right) + (p_{B4} - c) \right) \\
 R_{BA} &= n_{By} \left(\frac{L\eta_B}{1 + \eta_B} \right) \quad \text{and therefore} \\
 \Delta R_B &= n_{By} \left(\frac{\gamma(1 + \eta_B(1 - L))}{(1 + \eta_B)(1 + \gamma + \eta_B)} \right) \\
 &\quad + n_N \left((y - p_{B4}) \left(\frac{\gamma + L\eta_B}{1 + \gamma + \eta_B} \right) + (p_{B4} - c) \right)
 \end{aligned} \tag{19}$$

where p_{B4} is the price of console B when it has the strategic game exclusive as defined in Case 4 in section 3.4. Note that deriving the console price for B in this fashion automatically subsumes the second condition (Lemma1) specified above. We now specify

the corresponding values for console A .

$$\begin{aligned}
R_{AA} &= n_{Ay} \left(\frac{\gamma + L\eta_A}{1 + \gamma + \eta_A} \right) + n_N \left((y - p_{A2}) \left(\frac{\gamma + L\eta_A}{1 + \gamma + \eta_A} \right) + (p_{A2} - c) \right) \\
R_{AB} &= n_{Ay} \left(\frac{L\eta_A}{1 + \eta_A} \right) \quad \text{and therefore} \\
\Delta R_A &= n_{Ay} \left(\frac{\gamma(1 + \eta_A(1 - L))}{(1 + \eta_A)(1 + \gamma + \eta_A)} \right) \\
&\quad + n_N \left((y - p_{A2}) \left(\frac{\gamma + L\eta_A}{1 + \gamma + \eta_A} \right) + (p_{A2} - c) \right)
\end{aligned} \tag{20}$$

where p_{A2} is the price of console A when it has the strategic game exclusively. This price was also defined and characterized in section 3.4 (Cases 2 and 3). We can now specify the conditions under which the smaller console B can make the strategic game exclusive.

Proposition 3 *The strategic game will be exclusive to the smaller console B , when $\Delta R_B > \Delta R_A$ where ΔR_B and ΔR_A are as defined in (19) and (20) respectively. The set of licenses offered by console B to the strategic game will involve*

$$\begin{aligned}
l_{eB} &= 1 - \frac{\Delta R_A}{n_{By} \left(\frac{\gamma}{1 + \gamma + \eta_B} \right) + n_N (y - p_{B4}) \left(\frac{\gamma}{1 + \gamma + \eta_B} \right)} \\
l_{nB} &= 1
\end{aligned} \tag{21}$$

Proof. The two conditions stated at the beginning of this case need to be satisfied for console B to be able to successfully make the strategic game exclusive. The first condition is assumed in the statement of the proposition and the second condition is subsumed in the way p_{B4} is defined in the specification of ΔR_B . Therefore console B will be able to offer the strategic game a suitable contract to make it exclusive if so wishes. But will console B prefer exclusivity to non-exclusivity in this case?

The maximum profit that console B can make when the game is non-exclusive is R_{BA} since the new customers buy console A in that case. On the other hand, if console B makes the game exclusive through an offer of license fee in (21) above, then its net profit in this case will be $R_{BB} - \Delta R_A$. We know that $R_{BB} - \Delta R_A > R_{BA}$ since $\Delta R_B > \Delta R_A$. Therefore console B prefers exclusivity to non-exclusivity.

As per Lemma 4 and the discussion following that Lemma, console B has to offer the strategic publisher a gross payoff equal to ΔR_A to make it exclusive. The exclusive license

fee in (21) does exactly that as the denominator in the RHS of this expression is the strategic games total sales under exclusivity. The non-exclusive license fee takes away all the surplus from the strategic game and its primary role is to make the exclusive contract incentive compatible for the strategic publisher (therefore this non-exclusive fee is not unique). ■

Case 2 *When the smaller console B cannot make the game exclusive*

Based on the discussion in section 3.4, we know that in this case the new customers always purchase console A (irrespective of the availability of the strategic game for either console). Therefore $\Delta R_A > \Delta R_B$ will always be satisfied and console A can impose exclusivity on the strategic game if it so wishes. However given the arguments in sections 4.1 and 4.2, console A may not always wish to impose exclusivity.

To see why console A might prefer non-exclusivity, recollect the following facts. (i) Console A has to ensure the strategic game a gross surplus of at least ΔR_B to avoid the strategic game accepting an exclusive contract from console B. (ii) The revenues for any console are higher with the strategic game than without it. Therefore both consoles weakly prefer having the strategic game to not having it. Let R_{BN} be the total revenue generated for console B, in the sense of R_{ii} etc., when the game is non-exclusive. We know that the total revenue generated for console B when the game is exclusive to console A is given by R_{BA} . Now $R_{BN} > R_{BA}$ as a consequence of (ii) above. Therefore console B will be willing to allow the strategic game a gross surplus of upto $R_{BN} - R_{BA}$, to have the game available on B. Therefore console A can reduce the gross surplus that it provides to the strategic game by the same amount so that the total gross surplus to the strategic game is still ΔR_B . This is formalized in the next proposition.

Proposition 4 *With $\Delta R_A > \Delta R_B$, the outcome sometimes involves non-exclusive provision of the strategic game. In this case, the equilibrium license fee contracts are given*

by:

$$\begin{aligned}
l_{eB} &= 1 - \frac{\Delta R_B}{n_{By} \left(\frac{\gamma}{1+\gamma+\eta_B} \right)} \tag{22} \\
l_{nB} &= \frac{L\eta_B}{1+\eta_B} \\
l_{nA} &= 1 - \frac{\Delta R_B - n_{By} \left(\frac{\gamma(1+\eta_B(1-L))}{(1+\eta_B)(1+\gamma+\eta_B)} \right)}{n_{Ay} \left(\frac{\gamma}{1+\gamma+\eta_A} \right) + n_N (y - p_{A3}) \left(\frac{\gamma}{1+\gamma+\eta_A} \right)} \\
l_{eA} &= 1 - \frac{\Delta R_B}{n_{Ay} \left(\frac{\gamma}{1+\gamma+\eta_A} \right) + n_N (y - p_{A2}) \left(\frac{\gamma}{1+\gamma+\eta_A} \right)}
\end{aligned}$$

Proof. Console B will be willing to give up its entire surplus from the strategic game in order to get it exclusive as it will not receive a positive surplus from sales on the strategic game anyway. This gives us the expression for l_{eB} in (22), where the denominator on the RHS is the total sales of the strategic game on console B . Further, $R_{BN} = n_{By} \left(\frac{\gamma+L\eta_B}{1+\gamma+\eta_B} \right)$ and $R_{BA} = n_{By} \left(\frac{L\eta_B}{1+\eta_B} \right)$. Therefore, $R_{BN} - R_{BA} = n_{By} \left(\frac{\gamma(1+\eta_B(1-L))}{(1+\eta_B)(1+\gamma+\eta_B)} \right)$. This is the total gross surplus that console B will be willing to give the strategic game to persuade it to be non-exclusive. Therefore, $l_{nB} = 1 - \frac{n_{By} \left(\frac{\gamma(1+\eta_B(1-L))}{(1+\eta_B)(1+\gamma+\eta_B)} \right)}{n_{By} \left(\frac{\gamma}{1+\gamma+\eta_B} \right)} = 1 - \frac{(1+\eta_B(1-L))}{(1+\eta_B)} = \frac{L\eta_B}{1+\eta_B}$.

The total gross surplus that console A needs to allow the strategic game is ΔR_B . Therefore given the surplus of $n_{By} \left(\frac{\gamma}{1+\gamma+\eta_B} \right) (1 - l_{nB}) = n_{By} \left(\frac{\gamma(1+\eta_B(1-L))}{(1+\eta_B)(1+\gamma+\eta_B)} \right)$, console A only needs to allow for a gross surplus of $\Delta R_B - n_{By} \left(\frac{\gamma(1+\eta_B(1-L))}{(1+\eta_B)(1+\gamma+\eta_B)} \right)$. Since the total revenues from the sale of strategic game on console A equal $n_{Ay} \left(\frac{\gamma}{1+\gamma+\eta_A} \right) + n_N (y - p_{A3}) \left(\frac{\gamma}{1+\gamma+\eta_A} \right)$, we

have $l_{nA} = 1 - \frac{\Delta R_B - n_{By} \left(\frac{\gamma(1+\eta_B(1-L))}{(1+\eta_B)(1+\gamma+\eta_B)} \right)}{n_{Ay} \left(\frac{\gamma}{1+\gamma+\eta_A} \right) + n_N (y - p_{A3}) \left(\frac{\gamma}{1+\gamma+\eta_A} \right)}$ where p_{A3} is as defined in section 3.4 (case 3).

When the game is exclusive to console A , the strategic game once again gets a total gross surplus of ΔR_B , but this time entirely from console A . Therefore

$l_{eA} = 1 - \frac{\Delta R_B}{n_{Ay} \left(\frac{\gamma}{1+\gamma+\eta_A} \right) + n_N (y - p_{A2}) \left(\frac{\gamma}{1+\gamma+\eta_A} \right)}$ where the denominator provides the total strategic game revenues under exclusivity and p_{A2} is as defined under case 2 of section 3.4. ■

Having specified the outcomes in the case of the non-exclusive regime, we now turn our attention to identifying the conditions under which console A would and would not want to impose exclusivity. Based on the discussion preceding Proposition 4, it is clear that console A gains in the case of non-exclusivity by using the strategic game to create additional

surplus on console B and then forcing console B to give up this surplus to the strategic game using a threat of exclusivity. This lowers console A 's transfer to the strategic game and therefore increases its profits.

Given that this threat is credible, what incentive does console A have to make the strategic game exclusive? The answer lies in our discussion in section 4.2.2. Making the strategic game non-exclusive decreases the premium that console A can charge over the price of console B in the new customer segment. Therefore there is a tradeoff for console A between higher license revenue from the strategic game, and higher console price on the new customer segment. Further as discussed in section 4.2.2, console A will only be able to capture back only a part of the surplus given up in terms of reduced console price from increased license revenue as part of the reduction in price is used towards additional consumption of the numeraire good rather than games.

When the new customer segment is much larger in size than console A 's current customer segment, the loss from a reduction in console price is likely to be much larger than the gain through increased license revenue. The opposite will be true when console A 's current customer segment is much larger than the new customer segment. Proposition 5 captures this intuition and lays out the conditions under which console A will choose each of these two equilibrium exclusivity regimes. In order to derive that result, we need to compute console A 's payoffs under both exclusive and non-exclusive regimes.

Let Π_{nA} and Π_{eA} represent console A 's profits respectively under non-exclusivity and exclusivity. These are given by:

$$\begin{aligned}\Pi_{nA} &= n_A y \left(\frac{l_{nA} \gamma + L \eta_A}{1 + \gamma + \eta_A} \right) + n_N \left((y - p_{A3}) \left(\frac{l_{nA} \gamma + L \eta_A}{1 + \gamma + \eta_A} \right) + (p_{A3} - c) \right) \\ \Pi_{eA} &= n_A y \left(\frac{l_{eA} \gamma + L \eta_A}{1 + \gamma + \eta_A} \right) + n_N \left((y - p_{A2}) \left(\frac{l_{eA} \gamma + L \eta_A}{1 + \gamma + \eta_A} \right) + (p_{A2} - c) \right)\end{aligned}\quad (23)$$

where l_{nA} and l_{eA} are as defined in (22) and p_{A2} and p_{A3} are as defined in section 3.4. We can now state the following proposition.

Proposition 5 *The subgame perfect equilibrium of the two stage game will involve a non-exclusive supply of the strategic game if and only if $\Pi_{nA} \geq \Pi_{eA}$ where Π_{nA} and Π_{eA} are as defined in (23).*

Figure 5 provides an illustration of the parameter space where each of the exclusivity regimes described in propositions 3 to 5 obtain as subgame perfect equilibria of the two-stage game. In figure 5, the x -axis represents the ratio between the installed bases of consoles B and A and the y -axis represents the proportion of the total customers ($n_A + n_B + n_N$) that currently own a console (A or B). The x -axis represents a measure of the degree of asymmetry in the console market. Points on the extreme left imply a great deal of asymmetry with the larger console being much larger than the smaller one, while points on the extreme right represent relatively symmetric installed bases for the console. The y -axis provides a measure of the stage in the consoles' lifecycle. Points in the graph close to the x -axis represent a situation where both consoles have very low penetrations as compared to the total potential market size. We can think of these points as being in the nascent stages of the consoles' lifecycle i.e. soon after their launch.

Figure 5 illustrates a number of important results. We find that the stage in the console lifecycle and the symmetry of the installed bases for the two consoles are important determinants of content exclusivity. In the early stages of console lifecycles, the larger console is much more likely to find exclusivity deals compared to the smaller console. However, in the later stages of the console lifecycle, the smaller console is able to get exclusive access to the strategic game. Moreover, this ability to ink exclusivity deals with games increases as the degree of asymmetry between the consoles decreases. When the larger console grows to a reasonable fraction of the total market, then it has much more leverage in terms of dictating terms to the game publishers.

Somewhat surprisingly, the dominant console often does not shut out the smaller console from the content market, even if is capable of doing so. The reason for this is that, once the console gains an unsurmountable lead, it feels quite secure about attracting new customers on its own steam and hence has less incentive to seek game exclusivity. Further, allowing the game publishers to create content non-exclusively for both consoles not only maximizes the surplus created by the game, but also allows the bigger console to appropriate away much of this surplus through a threat of exclusivity. Thus from a social perspective, the loss from exclusivity contracts is quite minimal in the later stages of the

consoles' lifecycle. As the size of the smaller console's installed base grows in proportion to the size of the new customer segment, the game exclusivity with the smaller console turns out to be the equilibrium outcome. While as the bigger console's installed base increases, the bigger console provides the strategic game with a larger potential market. However, the strategic game is also faced with more intense competition for this larger market. Beyond a point, this competitive effect outweighs the benefit from a larger market and tilts the balance in favor of the smaller console.

The game publisher's profits are determined by the profit opportunity it provides to the less valuable (in terms of the surplus the game creates) console. Therefore the game has the biggest clout and hence receives the highest profits in a situation where the two consoles are relatively symmetric in size. When one of the consoles has a significant lead, then the negotiation power of the game is considerably weakened and it receives relatively small payoffs even if it creates a great deal of surplus.

5 Discussion and Conclusions

In this paper, we developed and analyzed a model of competition between platforms in a market with indirect network effects, using the video games industry as an underlying context. The model captured a number of salient factors that affect competitive outcomes in this industry including, customers' desire for a variety of games, the ensuing indirect network effects, the structuring of contracts between console manufacturers and game publishers and the cost structures for consoles and games. We applied this model to study exclusive contracting between strategic game publishers and consoles and derived some interesting results.

Exclusivity in the early stage of console lifecycle. In the introduction, we highlighted the natural reluctance of a game publisher to enter into an exclusivity agreement with a console manufacturer. This reluctance stemmed from the fact that exclusivity shuts out the game from a subset of the market that purchased the other console. However, our results indicate that the outcomes in the early stages of consoles' lifecycle are often

exclusive. This comports well with the empirical observation that consoles often seek exclusive games in the early stages and according to our analysis, apparently readily find them. This is understandable because in the early stages, each console has a relatively small installed base, and as a consequence, the number of potential customers that the game cannot serve because of its exclusivity to a single console is quite small.

Exclusivity is often necessary to capture new customers. Our analysis indicates that game exclusivity is often necessary for consoles to attract new customers. This is especially true when the consoles are relatively symmetric in terms of installed bases and each of them is relatively small. A single high quality game under these circumstances can tilt the new untethered customers' preferences from one console to the other. Therefore, the consoles will be willing to forego most of their profits in return for the game's exclusivity.

A hurdle level for game quality. Our analysis indicates that there is a critical level of game quality for each console below which it will not be viable to publish a game. Further, this threshold level for quality is higher for the larger console. Therefore games which do not meet the higher threshold for the dominant console in the market, might end up getting published exclusively for the smaller console by default.

Leads in this industry tend to be self-reinforcing and exclusivity further strengthens this tendency. This is especially true if there is a great deal of asymmetry between the established bases of the consoles, with the bigger console capturing exclusive control of valuable content and using it to forge further ahead. This kind of situation can arise, for instance, when the next generation console for a company is launched much before the corresponding console of a competitor and builds up a lead by the time competition arrives. Under these circumstances, it will be extremely difficult for the latecomer to compete with and catch the early leader. This may explain why video console marketers seem to place a great deal of importance on beating the competition and getting first to the market.

Non-exclusivity in the mature phase. Our analysis indicates that non-exclusivity is most likely to be the outcome in the intermediate to later stages of consoles' lifecycle. The reason for this non-exclusivity is not an inability on the part of the consoles to force exclusivity. Rather it is a consequence of the fact that exclusivity may not be very valuable

to a console at that stage and therefore it prefers to leave a game non-exclusive in return for higher rents. One important concern in markets where exclusive contracting is possible is whether the incumbent (or the larger console in our case) can use exclusivity to shut out an entrant (or a smaller console). Our non-exclusivity result indicates that the dominant consoles often do not find it worthwhile to do so.

Exclusivity creates limited efficiency distortions. From a social perspective, exclusivity always results in a loss of surplus because some of the customers who derive value from the content are excluded from it because of their platform ownership. However, given the nature of outcomes in the video game industry, where exclusivity most often results in the early stages while non-exclusivity is more common in the later stages, the losses arising from permitting exclusive contracting are relatively mild.

Exclusivity softens competition in the hardware sector. While the most important reason for pursuing exclusivity is a desire on the part of the hardware manufacturers to grow their installed base, this is not the only reason. Exclusivity might sometimes instead be pursued even if it does not add substantially to a console's network growth. This is because the presence of exclusive games serves to differentiate the consoles thereby decreasing the Bertrand nature of competition between them.

The model in the current paper can also be extended in a number of ways to incorporate other interesting aspects of the video game industry. For instance, the model we have analyzed in the current paper is a single period model, albeit you could interpret it as a single period of a state dependent dynamic model without uncertainty. But uncertainty about the success of a game and therefore its effect on customers' console choices, is a significant issue for players in this industry. To incorporate uncertainty into this model, we have to extend it to a two period setting, which will also allow us to study the length rather than just the presence, of exclusivity. We could also build in more richness into the description of consumer behavior in this industry. For instance, customers in the industry can be divided into extensive and intensive types. The extensive type of customers are those that have less specific preferences about different types of games, while at the same time, their reservation value for any game is also relatively low. On the other hand,

intensive customers are passionate about the games they play. So they have a much higher reservation value for these games, but also a higher degree of specificity with respect to the types of games they play. Integrating this extension into the current model is challenging through, given the relatively high complexity of our current demand specification.

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