Vertical Integration and Two-Sided Market Pricing: Evidence from the Video Game Industry*

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Abstract

This paper evaluates the effects of vertical integration on two-sided market prices using data from the 128 bit video game industry which consists of Nintendo Gamecube, Sony Playstation 2 and Microsoft Xbox. Estimation of video game console demand deviates from previous research on network externalities by incorporating video game heterogeneity and software competition into the indirect network effect–consumers differentiate between a "hit" and a "bust" game rather than assuming video games are homogeneous. After the construction of an empirical model I investigate the outcome of vertical integration on console prices. There are two important trade-offs to vertical integration. The first is a demand effect which further differentiates consoles and forces prices higher. The second, a market structure effect, drives prices lower. A counterfactual exercise determines the market structure effect dominates the demand effect for all consoles which leads to lower prices or an increase in console competition when vertical integration is permitted. However, the increase price competition is found to benefit console manufacturers. Lower prices lead to a rise in the number of consoles sold which generates greater demand for video games, where the "real" profits are made. Console makers are thus willing to forego lower console prices in order to increase video game sales, in particular their own developed games. Lastly, my model which accounts for video game heterogeneity and software competition provides a better fit to the data than the previous models found in the literature.

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1 Introduction

There are many high tech industries in which consumers associate with a platform in order to utilize the its complements. For example, a consumer chooses between a HD-DVD or Blueray machine or a Playstation 2, Microsoft Xbox or Nintendo Gamecube before he is able to use dvd titles or video games. Moreover, with a large portion of complements available on multiple platforms the additional differentiation they create is quite minimal. There are complements, however, that are exclusive to one platform–to purchase the Apple iPhone consumers must subscribe to AT&T Wireless or to play Tiger Woods PGA Tour 2001 or 2002 consumers need to own a Sony Playstation 2. Exclusive complements bring added differentiation to platforms and influence the competitive landscape of an industry.

In the mid 1980s Nintendo faced anticompetitive concerns over its exclusive dealings with game developers. Prior to this time Atari's game console was the industry leader, but in early 1985 Nintendo launched a new platform to consumers. Unlike Atari, Nintendo did not permit independent *third party* developers to create games for both consoles.[1] Developers instead entered into exclusive contracts with Nintendo which restricted a game's playability to Nintendo for the first two years of its release. Accordingly, a gamer who wished to play a particular Nintendo game was required to purchase a Nintendo console.

Exclusive contracts were one method Nintendo used to increase console differentiation from its competitor Atari. Nintendo's vertical integration into the software market may have also played an integral role in creating greater differentiation by restricting the games it produced to its own platform. Vertical integration in this situation and as will be defined throughout the paper is a result of Nintendo (or in general any other console manufacturer) electing to design, produce and sell games themselves and not by acquiring a *third party* game developer.[2]

There are numerous papers by many authors which study vertical integration.[3] Many of

[1] A third party developer is an independent company which produces video games but is not affiliated with any console

[2] However, vertical integration via the purchase of a developement company does also occur. For instances, Sony's recent purchase of ZIPPER INTERACTIVE and Microsoft's talks to acquire Epic Games

[3] See i.e. Rasmusen, Ramseyer and Wiley (1991), Bernheim and Whinston (1998) or for an overview

these papers however focus on vertical integration in markets which do not possess similar characteristics as the above example. For instance, in the video game industry indirect network externalities exist.[4] The price structure associated with a two-sided market like that of the video game industry also diverges from the traditional structure. In order to properly study the outcome of vertical integration in two-sided markets one must account for these differences.

The focus of this paper is twofold. The first objective is to construct an empirical demand model for consoles which capture the complementary nature between hardware and software while accounting for software heterogeneity and consumer substitution among video game titles. The second objective is to determine the effects of vertical integration in two-sided markets. Specifically, does vertical integration affect platform prices? And if so, how does it alter consumer welfare and firm profit?

These questions are answered with data from the 128 bit video game industry which consists of Nintendo Gamecube, Sony Playstation 2 and Microsoft Xbox. A new methodology is formed to estimate the demand for video game consoles. The technique deviates from prior research by allowing the indirect network effect to account for heterogeneity among video game titles as well as consumer substitution. The methodology measures the externality by implementing an index which captures the expected maximum utility of choosing from a set of video games as oppose to the number of available games.[5] Employing the number of games implicitly presumes all video games provide the same utility to each consumer, which is a nice approximation when consumers only care about product variety. However, in the case of the video game industry where software heterogeneity is a distinguishing characteristic it is rather important to allow consumers to differentiate between a "hit" and a "bust" game. Accounting for video game heterogeneity is an important aspect of console demand; a 2002 study by Forrester Research concluded 96% of people surveyed believed the quality

Whinston (2006) and Rey and Tirole (2007)

[4]See i.e. Church and Gandal (1993), Rysman (2004), Dube, Hitsch, Chintagunta, (2007) for a few references of literature on network effects

[5]See i.e. Nair, Chintagunta and Dube (2004), Clements and Ohashi (2004), Prieger and Hu (2007), Corts and Lederman (2007) and Dube, Hitsch and Chingtagunta (2007)

of video games was an important characteristic in choosing a game console. To understand how important software quality is in constructing console demand consider the following: assume two competing consoles are identical with the exception of one console having two mediocre homogeneous video game titles while the second console also has two titles but one is of equal quality of the titles on the competing console and the other is of high quality. Under a demand model which only accounts for the number of games compatible to a console, demand for each console would by identical. A more flexible model which accounts for software heterogeneity would have greater demand for console two than for console one, thus providing differing equilibrium outcomes.

After the construction of a random coefficient model of demand for consoles I investigate the impact of vertical integration with a counterfactual simulation where all *first party* games are prohibited.[6] In addition to the counterfactual experiment I study the importance of incorporating video game heterogeneity and software substitution into the indirect network externality as well as a two-sided market structure by simulating the same counterfactual experiment using previous research methods. I conclude it is essential to incorporate each of these factors.

There are typically two prices levied in a two-sided market. However, an additional price is analyzed when studying the video game industry. These prices consist of the price console makers charge consumers for its device, the price they levy on game developers to create compatible games and the price consumers pay to game developers to purchase and play these games. Although all three prices can be studied the forthcoming analysis is directed toward the effect of vertical integration on consumer price for consoles. Analysis regarding video game prices is omitted because of its intuitiveness; when vertical integration is banned the number of available video games shrinks and reduces the number of possible substitutes for consumers. Consequently, competition decreases and prices rise. The effect on pricing between video game console makers and game developers is also disregarded but for reasons which are specific to the industry. The price in which console manufactures charge game

[6] Note: a first party title is a game which is produced by a console manufacturer ie: Nintendo, Microsoft or Sony

developers is constant across games and time. This price is set at the launch of the game console and remains fixed for its life cycle. It is also identical across all console makers and therefore provides no information for substantial analysis.

The effect of vertical integration on consumer price for platforms in two-sided markets is unclear. There are two important trade-offs to vertical integration. The first is a demand or product differentiation effect. The production of a *first party* game and its release exclusively for the producing console has an apparent benefit since its production increases the value of the console relative to others through the indirect network externality. The added differentiation consequently forces prices higher.

There is also a market structure effect. Integration increases price competition among consoles. When a console manufacturer elects to design video games as well as produce consoles its price structure adjusts to reflect its decision. Without vertical integration, console prices are discounted by the profit console manufacturers receive from their interactions with developers when an additional consumer purchases a console. With vertical integration a third profit stream is created. Price is further discounted by the profit the console receives from designing, producing and selling its own video games when one more console is sold. Vertical integration, therefore, levies added pressure on price and is a by-product of the market structure.

Analyzing the outcome of vertical integration requires the study of both trade-offs. I find that the market structure dominates the demand effect for all consoles. When consoles are allowed to vertically integrate prices fall on average $5.36, 2.32$ and 1.00 percent for Nintendo Gamecube, Microsoft Xbox and Sony Playstation 2, respectively. Average market shares decrease from 56.50% to 52.95% for Playstation 2 and increase by approximately three quarters and two and three quarters percentage points for Xbox and Gamecube, respectively. Vertical integration is also found to increase console manufacturer profits. The increase price competition from vertical integration leads to an increase in the number of consoles sold and thus generates greater demand for video games, where the "real" profits are made. Consequently, console makers are willing to forego lower console prices in order to raise video game sales, in particular their own *first party* games.

2 Literature Review

Although there are numerous theoretical studies which analyze exclusionary strategies, a limited number of empirical studies exist. Conversely, the literature covering network effects is a burgeoning topic. A 2004 paper from Nair, Chintagunta, and Dube which measures the impact of indirect network effects in the PDA market has sparked a line a research that analyzes indirect network externalities. In their paper the authors construct a structural model to estimate the indirect network effect. The model captures the effect with the use of the number of software titles compatible with a given PDA. Papers by Clements and Ohashi (2004) and Hu and Prieger (2007a, 2007b) follow the same methodology as is presented in Nair et al. but with their focus on the video game industry. The use of the number of video game titles as a measure of the indirect network effect is quite restrictive–it does not allow consumers to differentiate between video games. In the attempt to ease this restriction Lee (2008) allows consumers to differentiate between video games but in doing so a strong assumption regarding the nature of competition in the software market is made.

Hu and Prieger, and Lee all study the impact of exclusive titles in the video game market and determine whether exclusive titles are anticompetitive. Hu and Prieger (2007a; 2007b) employ a structural model to estimate the demand for video game consoles–identical to that of Nair et. al.. As explained above, this method is quite restrictive and does not allow for "hit" or "bust" video games. Nonetheless, Hu and Prieger move forward and run a "counterfactual experiment" which concludes exclusive games do not alter the demand for video game consoles.[7] More importantly they find exclusive video games are not anticompetitive or create significant barriers to entry.

Lee (2008) addresses the same question as Hu and Prieger–are exclusive titles anticompetitive? Lee implements a methodology which simultaneously estimates dynamic demands

[7] They do not officially run a counterfactual experiment which finds a new equilibrium price vector. Instead they take the approach of re-estimating the demand model without exclusive video games

for software and hardware but in doing so a strong simplifying assumption is made regarding the software market.[8] He assumes software titles are neither substitutes nor complements to each other; he effectively places each title into a market of its own and does not allow substitution to occur among video games. Lee also abstracts away from the firms' dynamic pricing decision. He does not attempt to model the dynamic price setting behavior for software or hardware firms. In his counterfactual exercises he presumes all prices follow the same price path as is observed in the data. However, he does endogenize the re-contracting of video game developers (e.g. allow game developers to re-select which consoles its game will be produced for, given first party games are no longer produced). The counterfactual is thus a partial counterfactual; it does not find new equilibrium console prices.

In this study an empirical model is constructed which relaxes the simplifications made in the prior research by introducing software heterogeneity and substitution in the software market. I additionally implement the two-sided market structure and solve for new equilibrium console prices.

The empirical methodology presented in the sections below are closest to Nevo (2001), Berry, Levinsohn and Pakes (1995) and Berry (1994). More specifically, console demand is estimated using a random coefficient utility function to recover parameters for use in a counterfactual exercise.

The structure of the paper is as follows. First, I provide an overview of the 128 bit video game industry. I then discuss the data used in estimation and follow with the presentation of an empirical model and its estimation methodology. Next, I discuss the estimation results. Sections 8.1 and 8.2 describe the counterfactual experiment and its results while Section 8.3 analyzes the importance of the assumptions made in the prior literature. Lastly, I review the innovations of my work and results of my analysis.

[8] He makes such an assumption for computational purposes

3 The 128 Bit Video Game Industry

During the early 2000s the video game industry saw three of the most revolutionizing consoles come to market, the Sony Playstation 2, Microsoft Xbox and Nintendo Gamecube. These consoles brought larger computing power, more memory, enhanced graphics, better sound and the ability to play dvd movies. In addition, the producing firms each launched an expansive line of accessories to accompany their platform.

Sony enjoyed a yearlong first mover advantage with its launch of Playstation 2 debuting in October 2000. Its success was attributed to moving first but more significantly was its large catalog of games which were exclusively produced for its console by its development studio and by *third party* developers. Many of its biggest software hits were exclusive to Playstation 2 but only one was Sony produced.

Microsoft Xbox launched in very late October 2001 and was by far the most technologically advanced console. It was technically superior to the dominant Sony Playstation 2 possessing faster processing speed and more memory. Microsoft, however, struggled to gain market share as a result of their inability to attract developers to its platform to produce software titles exclusively for Xbox, in particular the many prominent Japanese developers (Pachter and Woo). The inability to secure *third party* exclusive games forced Microsoft to design and produce video games internally.

Nintendo Gamecube launched in November of 2001, within weeks of Microsoft Xbox. The Gamecube was the least technically advanced of the three consoles. Instead of competing in technology with Sony and Microsoft, Nintendo targeted its console to younger kids. "The Gamecube's appeal as a kiddie device was made apparent given the fact that the device did not include a dvd player and its games tilt[ed] towards an E rating" (Pachter and Woo). Gamecube's limited success was a result of Nintendo leveraging its "internal development strength and target[ing] its loyal fan base, composed of twenty somethings who grew up playing Nintendo games and younger players who favored more family friendly games" (Pachter and Woo).

The structure of the video gaming industry is a prototypical two-sided platform market where video game consoles act as platforms to two different end users, consumers and game developers.[9] Consoles permit two end users to interact via its platform creating externalities for each side of the market. Determining the size of these cross group externalities depends on how well the consoles perform in attracting the other side. On the gamers' side of the market, consoles interact with players by selling game consoles for a fixed fee where as on the game developers' side console producers interact with developers by levying royalty payments for the right to produce and sell games compatible with their console.[10]

*****Insert Figure 1 Here *****

Typically, *third party* vendors make games accessible to all consoles as a result of the high fixed costs of production where as *first party* games are kept exclusive to the gaming console. The average fixed cost for a game on Nintendo Gamecube, Sony Playstation 2 or Microsoft Xbox is roughly two and half to four million dollars (Pachter and Woo). Even with the high costs associated with producing a video game, consoles invest in the development of *first party* games.[11]

In Table 3.1 I illustrate the total units sold of *first party* games for each console in January of the reported years as well as the number of first party games and a "pseudo" HHI.[12] The HHI index measures the concentration of vertically integrated games for each console. A small index indicates *first party* games garner little impact on video game sales while a large number signifies the opposite. The HHI is a more encompassing index as oppose to the number of games or the total units of *first party* games sold since each of the two other measures do not inform one of the quality of the games while the latter measure also does not indicate the number of games available. The table shows the importance of vertically

[9] See i.e. Kaiser (2002), Rochet and Tirole (2002), Caillaud and Jullien (2003), Kaiser and Wright (2005), Armstrong (2006), Hagiu (2006) and for general literature on two-sided platform markets

[10] Console manufacturers actually manufacture all video games themeselves to ensure control over the printing process

[11] An effect which is not studied in this paper but would be a valuable line of research is that vertical integration is one method to solve the chicken and egg problem–which comes first? With the implementation of vertical integration console makers commit to providing video games to consumers which then fosters the development of third party games

[12] The HHI measure is calculated by summing the squared marketshares of each integrated game

integrated games, in particular for Nintendo and Microsoft. In January 2002 both Nintendo and Microsoft HHI's is on the magnitude of 500 and 300 times the size of Sony's, respectively. In January 2004 the relative importance of vertically integrated games remained the same (Nintendo, Microsoft and Sony) however the HHI magnitude was only five and three times the size of Sony's.

*****Insert Table 3.1 Here*****

4 Data

The data used in this study originates from two independent sources, NPD Funworld and TNS Media Intelligence. Data from the marketing group NPD Funworld tracks sales and pricing for the video game industry and is collected using point-of-sale scanners linked to over 65% of the consumer electronics retail stores in the United States. NPD extrapolates the data to project sales for the entire country. Included in the data are quantity sold and total revenue for Microsoft's Xbox, Nintendo's Gamecube and Sony's Playstation 2.

In order to incorporate the indirect network externality, which accounts for software heterogeneity and consumer substitution, into the demand model for consoles video game data is needed. Unlike previous studies data on sales and total revenues for over 1200 unique video games is available. The accessibility of this data allows for the implementation of a less restrictive model that captures the utility consumers garner from the consumption of compatible software.

Each data set covers 35 months starting in January 2002 and continuing through November 2004. The terminal date was selected for an important reason: Microsoft's release of its next generation console in November 2005. To ensure there is no bias from consumers postponing their consumption, I terminate the sample one year prior to the release of the new Xbox 360.

The second data set originates from TNS Media Intelligence; it collects information on total advertising expenditures for each of the three consoles across 19 media channels within the United States.

General statistics of the video game industry are provided in Table 4.1. Below I discuss two important stylized facts regarding the industry.

Seasonality: The video game industry exhibits a large degree of seasonality in both console and video game demand. Figures 1 and 2 illustrate the total number of consoles and video games sold in each month. Both increase considerably in November and December. It is therefore important to consider the large degree of seasonality in estimation.

*****Insert Figure 2 and Figure 3 Here*****

Video Game Heterogeneity: Video games are heterogeneous goods. There are over eleven genres of games which range from action to simulation. The largest genre being action with 24% of the market and simulation games the smallest with only 1%. Video game sales for individual games also range in the number of units sold. There are large hits such as Grand Theft Auto: Vice City which has cumulative sales of over six million on Playstation 2 and "busts" like F1 2002 which sold only forty-eight thousand units on the same console.

*****Insert Table 4.1 Here*****

5 Model Formulation

Previous research from Hu and Prieger (2007a, 2007b) and Clements and Ohashi (2004) employ a structural approach to estimate the indirect network externality associated with console demand. These papers include the number of games which implicitly assumes all video games are identical to each consumer rather than employing a model that accounts for software heterogeneity. Consequently, the model does not differentiate between "hit" and "busts" games.[13] In this paper I construct an empirical model which relaxes the simplifi-

[13] A study conducted by Forrester Research Group in 2002 provides sufficient evidence to support the notion that consumers find the quality of games as equally important to the number of games available on a console

cations made in prior research. Heterogeneity among software titles is permitted as well as substitution.[14]

In each period a potential consumer purchases a video game console or chooses not to. After purchasing a console a consumer decides which game to purchase, if any, from a set of available games. Once a consumer has purchased a video game console I assume he exits the market for consoles; however he continues to purchase video games in future periods.

A consumer derives utility when he purchases a given video game. This utility must be accounted for in the utility he receives when consuming a specific console. Moreover, at the stage in which a consumer decides to purchase a console he is uncertain about the utility he receives from video games. The consumer only realizes the utility after the purchase of a video game console. It is therefore important to link the realized video game demand with the ex ante expected utility from video games in console demand. I make the two above assumptions based upon the idea that if a consumer is perfectly aware of the utility he garners for each video game there would be no need to separate the decision process into two stages. The consumer would essentially purchase a bundle consisting of a console and a video game and thus any discrete choice model over the bundle of goods would be adequate.

Given the sequential nature of the model and the model assumptions, a nested logit structure is employed for console demand. The use of the nested logit structure provides a natural extension for the inclusive value to function as the indirect network effect as well as being consistent with the model assumptions. The formation of the inclusive value is generated from the assumption that video game demand is a discrete choice in each month and is of logit form. Employing the methodology of Berry (1994) I am able to construct the inclusive value (video game index) without any estimation–all that is required is data on video game sales and potential market size.

[14] I provide in detail the model formation and estimation procedure of the two previous structural approaches in the appendix. The inclusion and estimation of these models will allow me to later illustrate the importance of incorporating differentiation among video games consumer substitution and the platform market structure

5.1 Structural Model Preferences

The consumer decision process is as follows. In time t, each consumer makes a discrete choice from the set of $\mathcal{J}$ available consoles. If a consumers elects to purchase console $j \in (0, ..., J)$ where 0 is the outside option of not purchasing, he then purchases complementary video games which are compatible to console j. In choosing a console, a consumer only considers the expected maximum utility generated from the set of available video games in period t as a result of the consumer's uncertainty of the utility each video game generates at the stage in which he elects to purchase a console. The timing is as follows:

Stage 1: Consumers choose which console to purchase $j \in \mathcal{J}$

Stage 2a: Consumers realize the utility video games generate

Stage 2b: Consumers purchase video games which are compatible to console j.

A consumer who purchases console j at time t will generate utility equal to

$$U_{ijt} = U_j(\varepsilon_{ijt}, X_{jt,}\xi_{jt}, \Gamma_{jt}(\cdot); \theta^{hw})$$

where Γ_{jt} is the expected maximum utility from the set of available games on console j in period t. Denote X_{jt} as product characteristics, ξ_{jt} unobserved product characteristics and ε_{ijt} an idiosyncratic taste variable for individual i for console j in time t.

From the above utility function a consumer will purchase console j if and only if the utility from console j is greater then the utility of all other consoles and the outside option

$$U_j(\varepsilon_{ij}, X_{j,}\xi_j, \Gamma_j(\cdot); \theta^{hw}) \geq U_r(\varepsilon_{ir}, X_{r,}\xi_r, \Gamma_r(\cdot); \theta^{hw}) \forall r \in \mathcal{J}.$$ [15]

Let

$$A_j = \{\varepsilon : U_j(\varepsilon_{ij}, X_{j,}\xi_j, \Gamma_j(\cdot); \theta^{hw}) \geq U(\varepsilon_{ir}, X_{r,}\xi_r, \Gamma_r(\cdot); \theta^{hw}) \forall r \in \mathcal{J}\}$$

denote the set of values of ε_{ij} which induce consumers to purchase console j. Assume a distribution of $F(\varepsilon)$ for ε with the corresponding density $f(\varepsilon)$ then the probability that a

[15] For the remainder of this section the time subscript will be omitted

consumer purchases console j is given by

$$s_j(X, \xi, \Gamma; \theta^{hw}) = \int_{A_j} f(\varepsilon) d\varepsilon.$$

I examine the utility a consumer receives from purchasing software in order to define $\Gamma_j(\cdot)$. Consider a consumer who purchases console j. The indirect utility consumer i receives when purchasing software k is

$$U_{kj}(\eta_{ik}, x_k, \psi_k; \theta^{sw,j})$$

where η_{ik} is an idiosyncratic taste variable for individual i for game k, x_k are game characteristics, ψ_k are unobserved product characteristics and $\theta^{sw,j}$ are video game demand parameters specific to console j. Parameters vary by console to allow for the possibility that consumer preferences differ across consoles. Unlike a model where software titles are neither substitutes nor complements, a consumer makes his decision based upon the notion that titles are substitutes to each other.[16] Consequently, a consumer purchases software k if and only if

$$U_{kj}(\eta_{ik}, x_k, \psi_k; \theta^{sw,j}) \geq U_{gj}(\eta_{ig}, x_g, \psi_g; \theta^{sw,j}) \forall g \in \mathcal{K}.$$

Similar to the above console model, denote the set of values of η which induce consumption of software k be defined as

$$L_k = \{\eta : U_{kj}(\eta_{ik}, x_k, \psi_k; \theta^{sw,j}) \geq U_{gj}(\eta_{ig}, x_g, \psi_g; \theta^{sw,j}) \forall g \in \mathcal{K}\}.$$

With software titles being substitutes for one another and consumers knowing which games are available on a console but not the utility a game provides at the console selection stage, the consumer forms an expectation as to the utility he would receive from video games. The expectation of software utility is the indirect network effect and equals the expected

[16] This is in the spirit of a static version of Lee's (2008) paper

maximum utility from video games available on console j

$$\Gamma_j = E(\max_{k \in \mathcal{K}} U_{kj}).$$

6 Econometric Specification and Estimation

This section describes the econometric specification and estimation procedure of the above model. I follow the estimation techniques of Berry (1994), Berry, Levinsohn and Pakes (1995) and Nevo (2001).

6.1 Video Game Specification

A consumer's utility for software k in period t conditional on having purchased console j is

$$u_{ikt} = \alpha^{sw,j} p_{kt} + x_{kt} \beta^{sw,j} + \psi_{kt} + \eta_{ikt} \equiv \delta_{kt} + \eta_{ikt}$$

where p_{kt} is software k's price, x_{kt} is vector of game characteristics, ψ_{kt} is the unobserved software characteristics and η_{ikt} is a type one extreme value distributed random variable which is independently and identically distributed across individuals, software and time.

Demand for video games follows a multinomial logit structure. Consumers may repurchase an already owned title. This assumption may not seem as far fetched as one might think. Consumers are likely to repurchase a game after it has been lost or damaged. Under such assumptions the software index is analytic and can be determined without estimation. Only monthly quantity and potential market size data are needed.

The implementation of the standard logit utility function as oppose to a more complex random coefficient function allows me to construct the software index without any estimation as long as the indirect utility function for software is of a linear form. However, the ease of the technique has its drawbacks. For instance, the above model does not allow me to determine how prices change as a result of a merger among video game developers or the elimination of any games. To analyze this question I would need to the estimate the demand model for video games and recover the model parameters.

In order to construct the software index I proceed by following the methodology of Berry (1994).

Let S_{kt} be the observed probability that game k is purchased in period t and s_{kt} be the model's predicted probability then the following equation will hold for population values of δ :[17]

$$S_{kt} = s_{kt}(\delta) \qquad \forall\ k = 0...K.$$

where 0 is the outside option of not purchasing a game. Given the logit distribution for unobserved consumer taste the above system of equations can be inverted analytically. The mean utility (in vector form) is

$$\delta = s^{-1}\left(S\right).$$

The mean utility is determined uniquely by the observed probabilities along with a normalization of the outside good's utility to zero

$$\ln \frac{S_{kt}}{S_{ot}} = \delta_{kt}.$$

The software index for console j in time t is

$$\Gamma_{jt} = E(\max_{k \in \mathcal{K}} U_{kj}) = \ln\left(\sum_{k=0}^{K} \exp[\delta_{kt}]\right) + \varphi$$

where φ is eulers constant. The software index is of the familiar logit inclusive value form and holds the same interpretation: the expected maximum utility for the choice of video games in period t for console j. Again, note that the software index is determined only with

[17] Observed probabilities are constructed by dividing sales in period t by the potential market. This is done for each game which leads to the probability that no purchase is made

$$S_{ot} = 1 - \sum_{j=1}^{J} S_{jt}.$$

potential market size and sales data. No estimation is needed.

6.2 Console Specification

6.2.1 Demand

In every period t, each potential consumer makes a decision on whether or not to purchase a game console. If a consumer purchases a console he exits the market. Consumers are indexed by i, consoles by j and time by t. A consumer's indirect utility for console j is characterized by a set of observed physical characteristics X_{jt}, the software index Γ_{jt}, unobserved product characteristics ξ_{jt} and an individual taste parameter ε_{ijt}, distributed i.i.d. type-1 extreme value across i, j and t. A consumer's indirect utility for console j is

$$\begin{aligned} u_{ijt} &= \delta_{jt}(X_{jt}, P_{jt}, \Gamma_{jt}, \xi_{jt}; \theta_1^{hw}) + \mu_{ijt}(P_{jt}, v_i\,; \theta_2^{hw}) + \varepsilon_{ijt} \\ \delta_{jt} &= \alpha^{hw} P_{jt} + X_{jt}\beta^{hw} + \phi\Gamma_{jt} + \xi_{jt}, \qquad \mu_{ijt} = P_{jt}(\Sigma v_i) \\ v_i &\backsim N(0,1), \end{aligned}$$

where δ_{jt} is the mean utility, common to all individuals, and $u_{ijt} + \varepsilon_{ijt}$ is the mean-zero heteroskedastic deviation from the mean utility. The model parameters are $\theta^{hw} = (\theta_1^{hw}, \theta_2^{hw})$. θ_1^{hw} contains the linear parameters of the model $(\alpha^{hw}, \beta^{hw}, \phi)$ and $\theta_2^{hw} = (\Sigma)$ the nonlinear parameter.[18] Σ is a scaling parameter.

Examples of physical characteristics are price, processing speed, graphics quality, volume of the console, CPU bits, advertising expenditures and advertising expenditures squared. Unobserved characteristics include other technical characteristics and market specific effects of merchandising. I control for these unobserved product characteristics as well as observed characteristics which do not vary over time with the inclusion of brand specific fixed effects. In the attempt to capture some dynamic aspects of the consumer's valuation for consoles over time, I allow the console fixed effects to be year specific. I also control for the large

[18] Software utility enters linearly into the utility function for consoles so the expected utility of software is a sufficient statistic for calculating utility for hardware

seasonal spikes during holiday months with quarterly dummy variables. Lastly, I assume consumers observe all console characteristics and use them in their decision making.

6.2.2 Pricing

Each console producer sets price in order to maximize profits. Moreover, makers of consoles act myopically. The profit function of a console manufacturer differs from that of a standard single product firm. Console firms face three streams of profits (selling consoles, selling video games and licensing the right to produce a game to game developers) and take each into consideration when setting console price. Assume console producers face a marginal cost of two dollars when interacting with game developers (this cost is associated with the production and packaging of video games).[19] Additionally, a developer's marginal cost for a game equals the royalty rate charge by a console and is set at ten dollars per game.

> **A1:** Console producers, game developers and consumers all act myopically
>
> **A2:** Console firms face a marginal cost of two dollars when interacting with game developers
>
> **A3:** Developer's marginal cost equals the royalty rates charged by console manufacturer and is set at ten dollars per game.[20]

Console maker $j's$ profit function is

$$\Pi_{jt} = (P_{jt} - mc_{jt}) M_t S_{jt}(P, X, \Gamma; \theta^{hw}) + \sum_d (\underbrace{IB_{jt-1} + M_t S_{jt}(P, X, \Gamma; \theta^{hw})}_{\text{Potential Market for game d=IB}_{jt}}) S_{dt}(\delta)(p_{dt} - c) + \sum_k (\underbrace{IB_{jt-1} + M_t S_{jt}(P, X, \Gamma; \theta^{hw})}_{\text{Potential Market for game k=IB}_{jt}}) S_{kt}(\delta)(r - c) - F_j - \sum_d F_d$$

[19] Game developers do not actually create the physical disk which is sold to consumers. Instead, the console manufacturer stamps all video games for quality control purposes

[20] Assumptions two and three are made from inside knowledge regarding the industry

where P_{jt} is the console price, mc_{jt} the console marginal cost, M_t the potential market for consoles, S_{jt} is the probability a consumer purchases console j, IB_{jt-1} is the number of j consoles sold up to and including period $t-1$, S_{dt} is the probability game d,which is produced by the console manufacturer, is purchased by a consumer, S_{kt} is the probability a consumer purchases game k, a *third party* game, F_j is the fixed cost of producing console j and F_d is the fixed cost to produce a game. Lastly, IB_{jt} is the installed base of console j and the potential market size for a video game.

The profit function differs from a standard single product profit function. The first term is the usual single product profit. The second and third terms are profits the console maker receives from interacting with game developers and selling its games. Specifically, term two is the profit a console maker garners from creating and selling its own games and the third term is the profit it receives from *third party* developers. The resulting first order condition with respect to console price for the above profit function in matrix notation is

$$S(P)\Delta^{-1}+P-mc+\Omega=0.$$
$$\Delta=diag\left[\frac{\partial S_{jt}(\,\cdot\,)}{\partial P_{jt}}\right]$$
$$\Omega=\sum_d S_{dt}(\delta)(p_{dt}-c)+\sum_k S_{kt}(\delta)(r-c)$$

where Ω is the profit a console producer receives from *third party* developers and selling *first party* games when one additional console is sold.

Although I do not simultaneously estimate the price equation with the demand model, I use the above first order conditions to infer marginal cost. Rewriting the first order conditions, marginal cost equals:

$$mc=P+S(P)\Delta^{-1}+\Omega.$$

From the first order conditions the impact of vertical integration is evident (by rearranging the first order condition for price $P=mc-S(P,X,\Gamma;\theta^{hw})\Delta^{-1}-\Omega$ the effect becomes more clear). There are two opposing trade-offs. The first is a demand or differentiation effect while the second is a market structure effect. In order to see these effects mathematically allow console j to design and produce one vertically integrated game d and interact with a portfolio of *third party* developers while banning all other console makers from designing any *first party* games. Suppose the utility associated with game d increases, δ_d. What are the effects? The utility for console j increases, through the indirect network externality creating greater differentiation between consoles. This effect is the demand effect. The second trade-off is a market structure effect. With producer of console j designing and selling game d, the profit adjusts to reflex the fact that game $d's$ attractiveness increases. Designate this pressure on price as the market structure effect.

Proposition 1 *Given an increase in δ_d console price has two effects- a demand and a market structure*

Proof. For a logit demand model (the results hold for a random coefficient logit demand model)

$$\begin{aligned}
\frac{\partial P_j}{\partial \delta_d} &= -\frac{\partial S_j(P)}{\partial \Gamma_j}\frac{\partial \Gamma_j}{\partial \delta_d}\Delta_j^{-1} - S_j(P)\frac{\partial \Delta_j^{-1}}{\partial S_j(P)}\frac{\partial S_j(P)}{\partial \Gamma_j}\frac{\partial \Gamma_j}{\partial \delta_d} - \frac{\partial S_d(\delta)}{\partial \delta_d}(p_d - c) - \sum_k \frac{\partial S_k(\delta)}{\partial \delta_d}(r - c) \\
\frac{\partial P_j}{\partial \delta_d} &= \frac{\partial S_j(P)}{\partial \Gamma_j}\frac{\partial \Gamma_j}{\partial \delta_d}\left(-S_j(P)\frac{\partial \Delta_j^{-1}}{\partial S_j(P)} - \Delta_j^{-1}\right) - \left(\frac{\partial S_d(\delta)}{\partial \delta_d}(p_d - c) + \sum_k \frac{\partial S_k(\delta)}{\partial \delta_d}(r - c)\right) \\
\frac{\partial P_j}{\partial \delta_d} &= \underbrace{\phi S_j(1-S_j)S_d\left(S_j\frac{\alpha - 2\alpha S_j}{\{\alpha S_j(1-S_j)\}^2} - \frac{1}{\alpha S_j(1-S_j)}\right)}_{\text{Demand Effect}} - \underbrace{\left(S_d(1 - S_d)(p_d - c) - \sum_k S_d S_k(r - c)\right)}_{\text{Market Structure Effect}}
\end{aligned}$$

■

The last equation in the above proof illustrates the two effects a change in the attractiveness of game d has on console price. The first half of the equation is the demand effect or the impact a change in the attractiveness of game d brings to the standard product margin. The second half is the market structure effect or the impact an increase in δ_d has on marginal revenue from designing and producing game d as well as interacting with *third party* developers. Furthermore, the market structure effect can be decomposed into two effects, $S_d(1-S_d)(p_d-c)$ and $\sum_k S_d S_k(r-c)$. The first term represents the additional profit console maker receive from its *first party* game when its attractiveness increases. The increase in attractiveness leads to a greater probability that a consumer purchases game d. Such an increase comes at a cost–the probability that a consumer purchases any *third party* game consequently decreases. Thus, the console maker's expected profit from interacting with *third party* developers decreases, which is represented by the second term. In the following two propositions I show that both the demand and market structure effects are positive.

Proposition 2 *Given an increase in δ_d and $S_j < \frac{1-\alpha}{2-\alpha}$ the demand effect will increase console price*

Proof.

$$\begin{aligned}
\phi S_j(1-S_j)S_d\left(S_j\frac{1-2S_j}{\{\alpha S_j(1-S_j)\}^2}-\frac{1}{\alpha S_j(1-S_j)}\right) &> 0\\
\phi S_d\left(S_j\frac{1-2S_j}{\alpha^2 S_j(1-S_j)}-\frac{1}{\alpha}\right) &> 0\\
S_j\frac{1-2S_j}{\alpha^2 S_j(1-S_j)} &> \frac{1}{\alpha}\\
\frac{1-2S_j}{1-S_j} &> \alpha\\
S_j &< \frac{1-\alpha}{2-\alpha}
\end{aligned}$$

■

Proposition 3 *Given an increase in δ_d the market structure effect will decrease console price*

Proof.

$$S_d(1-S_d)(p_d-c)-\sum_k S_dS_k(r-c)>0$$
$$\frac{(p_d-c)}{(r-c)}>\frac{\sum_k S_k}{(1-S_d)}$$
$$\text{by assumption of the magnitude of } r \text{ and } c\ \frac{(p_d-c)}{(r-c)}\geq 1$$
$$1>\frac{\sum_k S_k}{(1-S_d)}$$
$$1>S_d+\sum_k S_k$$
$$\text{By definition } S_d+\sum_k S_k<1$$
$$\text{since } S_d+\sum_k S_k+S_0=1$$

■

The presented experiment is analogous to a situation where I allow a console manufacturer to add one new *first party* game. However, I employ the above scenario in order to show both the demand and market structure effect in the same scale. A console is able to generate a demand effect by vertically integrating since the games which are produced by the console maker are always exclusive to the console. Likewise, if a game is not on a given console and a consumer wants to play this game he must purchase the respective console which therefore increases the demand for the console. Do note that indirect network effects are present without vertical integration but if all games which are not produced by console makers are available on all consoles than the indirect network effect does not provide any additional differentiation. It is vertical integration with exclusivity that creates further differentiation. In conclusion, the above propositions illustrate the effect of vertical integration on console price is an empirical question.

6.3 Estimation

The estimation methodology for console demand follows that of BLP (1995) and Nevo (2001). In particular, simulated shares are matched to observed shares in order to use a simulated method of moment procedure to estimate the model parameters.

Estimation is as follows. For given $\theta_2^{hw} = (\Sigma)$ simulate ns "consumer" purchases and determine the average probability of consumption associated with each console. Then, perform a contraction mapping, the one proposed by BLP, to recover the mean utility δ_{jt} linked to all individuals

$$\delta_t^{h+1} = \delta_t^h + \ln S_{.t} - \ln \widetilde{S_{.t}} \quad t = 1...T, \quad h = 1...H.$$

Follow with the regression of δ_{jt} on covariates $X_{jt}, P_{jt}, \Gamma_{jt}$ to determine the linear estimates of β^{hw} α^{hw} and ϕ. Once the parameters are estimated calculate ξ_{jt} from

$$\xi_{jt} = \delta_{jt}(X_{jt}, \Gamma_{jt}, P_{jt}; \theta_2^{hw}) - \alpha^{hw} p_{jt} - X_{jt}\beta^{hw} - \phi\Gamma_{jt}.$$

After computing ξ_{jt} generate a matrix of exogenous instruments $\mathbf{Z}$ and assume the condition

$$E[\boldsymbol{\xi}|\mathbf{Z}] = 0.$$

The unobservables are used to determine the sample analogue of the above orthogonality condition

$$M_N(\boldsymbol{\theta}) \equiv \frac{1}{G} \sum_{g=1}^{G} \mathbf{Z}_g \boldsymbol{\xi}_g$$

and the simulated method of moment objective function

$$M_N(\boldsymbol{\theta})' W^{-1}(\boldsymbol{\theta}) M_N(\boldsymbol{\theta})$$

where G equals the number of observations in the data set and $W^{-1}(\boldsymbol{\theta})$ is a weighting matrix that is a consistent estimate of $[M_N(\theta) M_N(\theta)']$.

For each guess of θ_2^{hw} repeat the estimation procedure until the objective function is minimized. The weighting matrix in the above equation is computed using an iterative approach similar to Hansen, Heaton, and Yaron (1996).

In summary, the estimation procedure is

1. construct the video game index Γ
2. given θ_2^{hw}, simulate 5000 individuals' purchases of video games consoles
3. perform a contraction mapping to invert out the structural error terms
4. compute the sample analogue, weighting matrix and the objective function
5. search for the parameter values that minimize the objective function
6. recalculate the weighting matrix given the parameter vector of the prior minimization iteration
7. repeat steps (2)-(6) until parameters do not vary.

6.4 Identification

Consumer heterogeneity for price is parameterized as $\alpha_i = \overline{\alpha} + \Sigma v_i$ where $\overline{\alpha}$ is the mean sensitivity across all consumers, Σ is a scaling parameter, v_i is a random variable distributed $N \sim (0,1)$.[21]

With every console there is a mean utility found to match the observed and predicted purchase probabilities. If we assume consumers are identical then all variation in sales would be a result of variation in product characteristics. Thus, monthly variation in product characteristics with monthly variation in shares aids in the identification of the mean utility parameters such as price and software index.

[21] Note: I have tried to further decompose the unobserved consumer heterogeniety v_i by including income and other demographic variables but I was unable to identify any of these additional parameters.

Identification of Σ pertains to how price sensitive households are and how they substitute. If the price of one product changes and substitution occurs to other products with a similar price then there are signs of consumer heterogeneity. Likewise, if consumers substitute equally to all other goods then consumers are homogenous. Changes in product characteristics therefore aid the identification of the nonlinear parameter. For instance, assume console A and B are very similar in characteristics, think of A and B as Playstation 2 and Xbox while console B and C, Xbox and Gamecube, have the same purchase probabilities. Suppose we have sales and price information for two periods and that the only change to occur is a reduction in the price of console A. The logit model predicts purchase probability for B and C fall by equal amounts where as the random coefficient logit model predicts console B, the console most similar in characteristics to console A, to fall by more than that of console C. Therefore, by observing the actual relative changes in purchase probability of consoles B and C I can determine whether the model is a logit or random coefficient logit model of demand. Additionally, the degree of change allows the parameter that determines the distribution of the random coefficient to be identified.[22]

6.5 Instruments

The underlying assumption to estimating the above model is

$$E[\boldsymbol{\xi}|\mathbf{Z}] = 0$$

where the demand unobservables are mean independent of the set of instruments $\mathbf{Z}$. Since the unobservables are not observed by the econometrician but are by the consumers, there exists an endogeneity issue. If price is positively correlated with unobserved product characteristics the price coefficient will be biased. I resolve this correlation through the use of year specific console dummy variables. Even with the use of console dummy variables the proportion of the unobservable which is not accounted for may still be correlated with price as a result of

[22] This example is a modified version of the example provided in Nevo (2000)

consumers and producers correctly observing and accounting for the deviation.[23] Under the assumption, market specific markups will be influenced by the deviation and will bias the estimate of console price sensitivity. Instrumental variables correct this bias. Berry (1994) and BLP both show that proper instruments for price are variables which shift cost.

Besides console price being endogenous, one might suppose the software index is as well. Nonetheless, an assumption regarding the autocorrelation of $\boldsymbol{\xi}_{jt}$ is made to properly identify the indirect network externality. I assume the residuals of the structural error terms, the proportions which are not captured by the year specific console fixed effects, are independent of each other. The assumption negates any impact an aggregate demand shock in period $t-1$ has on the software index in period t and therefore eliminates the need for instrumental variables.

The instruments which control for the endogeneity of price must be correlated with the underlying variable but independent of the unobserved error terms. Instruments follow the logic of BLP. However, instead of using instruments constructed from observable product characteristics I employ variables which proxy for marginal cost. I use the monthly producer price index for computers, the average monthly Japanese to US exchange rate and the age of a given console, which has become standard in the video game literature (see Hu and Prieger (2007) and Clements and Ohashi (2004)). Exchange rates are also suitable since most of the manufacturing of consoles occurred in Japan and would consequently effect retail console price. Lastly, the producer price index for computers is a nice proxy to console marginal cost since the internal hardware of a video game console consists of items found in desktop computers. The time variation within the exchange rate and producer price index assists in identifying console demand. Note however, these measures are industry aggregates and do not vary by console. In order to construct console specific instrumental variables the producer price index and exchange rates are interacted with console dummy variables.[24] The intuition for interacting input prices and exchange rates with product dummies is to allow each to enter the production function of a given console differently. First stage regression results

[23] See Nevo 2001 for futher explanation

[24] This method is similar to that of Villas Boas (2007)

are presented in Table 7.1c for the logit models of the above model, a model which includes video game quality differentiation but no video game substitution and a model which uses the number of video games as its measure for the indirect network externalities. The table is found in the appendix. The large R squared and F statistic indicated the instruments have some power.

7 Estimation Results

Estimates of the demand equation are found in Table 7.1. Multiple specifications are shown. Column one provides results from estimating a logit demand model; column two introduces instrumental variables; column three allows for consumer heterogeneity; column four estimates a model which does not allow for video game substitution but incorporates video game differentiation and lastly, column five estimates a model employing only the number of video games as the indirect network measure.[25] Below I present the estimates for model three.

*****Insert Table 7.1 Here*****

The non-linear set of parameters $\theta_2^{hw} = \{\Sigma\}$ is estimated and is found to be significant. The estimate of Σ is 0.084 and informs me how consumer price sensitivity is distributed among individuals. A positive and significant value indicates that the model of demand is identified as a random coefficient logit model where as an insignificant measure of Σ would indicate a logit demand model without consumer heterogeneity.

The estimates of the linear parameters $\theta_1^{hw} = \{\alpha, \beta, \phi\}$ follow below. The parameter estimate of $\overline{\alpha}$, the mean price sensitivity of consumers, is -0.0288 and significant. The bias associated with the endogeneity of price is quite evident when comparing the ols estimate of the logit model to the price coefficient under the iv-logit model. The ols estimate is -0.0041

[25] See appendix for a detailed explanation of models 4 and 5.

while the iv-logit estimate is -0.0140. A Hausman test for endogeneity concludes price is endogenous.

The year specific console fixed effects are found in Table 7.1b. Fixed effects decrease signaling consumers value consoles less over time. The above estimation does not consider Sony Playstation 2's large catalog of video games from its previously produced console, the Playstation, nor does it account for any brand loyalty consumers may have from owning a console of a previous generation. The estimates of the quarter dummy variables are all negative demonstrating that holiday periods bring consumers larger increases in utility relative to the three other quarters. The parameter associated with the software index is 0.8664 and significant. The positive sign indicates video games and consoles are complements. Lastly, the parameter associated with advertising expenditures is 0.2417 and significant at the 95% confidence level while advertising squared is $-5.1025e-008$ and not significantly different from zero at the conventional 95%. The positive sign on the advertising expenditure parameter illustrates an increase in consumer demand when advertising dollars are spent.

As in BLP (1995), standard errors are corrected for simulation. I assume the population sampling error is negligible given the large sample size of over $78,000,000$ households. Simulation error, however, cannot be ignored as a result of the need to simulate the integral which defines console market share S_{jt}. In order to calculated the variance from simulation I fix (Σ) at its estimated value and recalculate θ_1^{hw} using 500 different simulation draws. Given the fact that simulation error and standard sampling error are independent I simply aggregate the effects to determine the total standard errors.

Estimating a structural demand model also supplies sufficient information to determine price elasticities. Table 7.2 below provides average elasticities estimates for the given time period. Elasticity calculations are below.

$$\epsilon_{jrt} = \frac{\partial S_{jt} P_{rt}}{\partial P_{rt} S_{jt}} = \begin{Bmatrix} \frac{P_{jt}}{S_{jt}} \int \alpha_i S_{ijt}(1 - S_{ijt}) dP_v^*(v) & if \quad j = r \\ -\frac{P_{rt}}{S_{jt}} \int \alpha_i S_{ijt} S_{irt} dP_v^*(v) & otherwise \end{Bmatrix}$$

The average own-price elasticities for the given time period are $-2.6527, -3.1972$ and -3.1401 for Gamecube, Playstation 2 and Xbox, respectively. Estimates of cross-price elasticities establish Sony's Playstation 2 as the closest substitute for the Nintendo's Gamecube while the closest competitor to Microsoft's Xbox is Sony's Playstation 2 and vice versa. As Table 7.2 illustrates the cross-price elasticities are not of the logit form. The implementation of the random coefficient utility function eliminates the independent of irrelevant alternative (IIA) bias associated with the logit model and provides more realistic substitution as a result. Moreover, the estimated elasticity measures are consistent with the beliefs of an industry insider to which console is the closest competitor to a given console.

*****Insert Table 7.2 Here*****

8 Counterfactual Simulation

Determining the effects from vertical integration entails a counterfactual exercise. Since the data allows vertical integration to occur I assume a "what if" situation where all *first party* games are removed from their respective consoles and are not produced.

Implementing a counterfactual necessitates a few assumptions regarding the pricing of video games. Assume video game prices do not adjust to changes in competitive environments.[26] As was mentioned and explained in the introduction, console manufacturers issue the same royalty rates to all games and do not vary across console producers.[27]

[26] The difference between the average price of a *first party* and *third party* games is roughly sixty-five cents. I thus infer that any change in price as a result of less competition would be minimal

[27] The last assumption is supported by knowledge from an industry insider

8.1 Console Supply

Under the counterfactual experiment where consoles are unable to produce video games, console maker $j's$ profit function becomes

$$\begin{aligned}\Pi_{jt} &= (\widehat{P}_{jt}-mc_{jt})M_t S_{jt}(\widehat{P},X,\Gamma';\theta^{hw})+ \\ & \sum_k (IB_{t-1}+M_t S_{jt}(\widehat{P},X,\Gamma';\theta^{hw}))\widehat{S}_{kt}(\delta)(r-c)-F_j\end{aligned}$$

where $\widehat{P}_{jt},\Gamma',\widehat{S}_{kt}$ are new equilibrium prices, new video game index and new equilibrium game purchase probabilities, respectively. It is evident the additional stream of revenue from selling *first party* games is omitted under the counterfactual scenario.

Given a pure-strategy Bertrand-Nash equilibrium in prices and that the prices that support the equilibrium are strictly positive, then the new equilibrium price vector must satisfy the first-order conditions

$$S(\widehat{P},\Gamma')\Delta^{-1}+\widehat{P}-mc+\widehat{\Omega}=0.$$
$$\Delta = diag\left[\frac{\partial S_{jt}(\cdot)}{\partial P_{jt}}\right]$$
$$\widehat{\Omega}=\sum_k \widehat{S}_{kt}(\delta)(r-c).$$

After algebra a console's markup is a function of the inverse price derivative, the probability a consumer purchases console j and the additional profit associated with interacting with game developers when on more console is sold.

8.2 Counterfactual Results

The results of the counterfactual simulation are presented in Table 8.1.[28] The outcome from vertical integration is clear: *first party* games benefit Microsoft and Nintendo. Prices of these two consoles rise when vertical integration is prohibited. Nintendo's price for

[28] All results are calulated as a weighted average. The weight is the proportion of sales in each month relative to aggregate sales.

Gamecube increases on average 5.36 percent while Microsoft's Xbox price rises an average of 2.32 percent when *first party* games are forbidden. The increase in price provides support to conclude the market structure dominates the demand effect. I also compute new console shares. The increase in the price of Xbox and Gamecube decrease their respective shares by an average of two and three quarter and three quarters percentage points, an increase in industry concentration. One explanation as to why prices increase more for Microsoft and Nintendo than for Sony is a result of these two console makers producing "hit" *first party* games.

*****Insert Table 8.1 Here*****

Table 8.2 shows the ten leading titles on each platform for the given time period, nine of which are *first party* titles for Nintendo and four for Microsoft.[29] The banning of these top selling games in addition to all other *first party* titles homogenizes the consoles and drives price lower via the demand effect. The additional profit console makers receive from developers when one more console is sold is now only a function of its interactions with *third party* developers and no longer its *first party* games. The reduction consequently increases price relative to a scenario which permits vertical integration concluding the market structure effect offsets and overcomes the demand effect.

*****Insert Table 8.2 Here*****

Similarly, the production of *first party* games for Sony's Playstation 2 results in an increase in price but by a lesser amount than its competitors, roughly one percent and a rise in the mean market share by three and a half percentage points. The result is a consequence of the fact that the model accounts for fewer "hit" *first party* games for Sony than Microsoft and Nintendo. Sony's decrease in marginal revenue under the policy banning *first party* software is substantially smaller than those of its competitors. Table 8.3 presents the average marginal profit platforms receive when an additional console is sold under the two policies, with and without the production of *first part*y games.

[29] See Table 3.1 (HHI measures) for further support

After establishing that the market structure effect dominates the demand effect I analyze console manufacturer profits. I determine the profit manufacturers receive from selling consoles under the policy which bans vertical integration is found to be smaller than a policy which allows vertical integration. The intuition is that although console prices rise when vertical integration is prohibited the percentage reduction in the number of consoles sold is larger than the increase in price. Furthermore, the reduction in the number of consoles sold consequently decreases the demand for software and thus reduces the profit manufacturers receive from video games. Average total console profits decrease when vertical integration is banned. Or alternatively put, when vertical integration is permitted it drives console prices lower which in turn raises console sales and thus increases video game demand. Console makers therefore use vertical integration in order to drive sales of video games, in particular their own *first party* games, where the "real" profits are made.

*****Insert Table 8.3 Here*****

The benefit of estimating a structural model is the ability to analyze consumer welfare. I quantify the change in consumer welfare using compensating variation. For the presented model the compensating variation quantifies the amount of income necessary to maintain a consumer's utility at levels associated with vertical integration. It equals

$$\begin{aligned} CV_i &= -\frac{1}{\alpha_i^{hw}}\left(CS_i - CS_i^{'}\right) \\ CS_i &= \ln\left\{1+\sum_{j=1}^{J}\exp\left[\alpha_i^{hw}p_{jt}+X_{jt}\beta^{hw}+\phi\Gamma_{jt}+\xi_{jt}\right]\right\} \\ CS_i^{\prime} &= \ln\left\{1+\sum_{j=1}^{J}\exp\left[\alpha_i^{hw}p_{jt}^{\prime}+X_{jt}\beta^{hw}+\phi\Gamma_{jt}^{\prime}+\xi_{jt}\right]\right\} \end{aligned}$$

per individual or

$$M\int CV_i dP_v^*(v)$$

for the mean compensating variation in the population. The mean compensating variation needed to hold the populations' utility at the level associated with vertical integration is on average \$22.08 million dollars. Vertical integration enhances consumer welfare.

In summary, the market structure dominates the demand effect for all consoles. Prices of consoles with a larger degree of concentration in vertically integrated games fall more than consoles with less when vertical integration is permitted. As a result, consumer welfare increases an average \$22.08 million dollars. Likewise, console profits increase.

8.3 Sensitivity Analysis

In this section I test the fit of the above model as well as two alternative models–one which does incorporate video game differentiation but no substitution and another which assumes all video games are homogeneous. I conclude my methodology which models video game demand as a multinomial logit performs better at fitting the data than these models. I also show how the omission of important industry characteristics or improperly modeling these characteristics (eg: the market structure as a traditional one-side market, software is homogeneous, or video games do not compete against each other) result in incorrect policy conclusions.

The first goodness-of-fit test I implement is one which determines whether or not all the moment conditions are satisfied-a test of over identification. The test statistic is the GMM objective function and is a Wald statistic. It is distributed chi-squared with degrees of freedom equal to number of moment restrictions minus the number of estimated parameters. I find all three models are not rejected at a confidence of 97.5%.

I also would like to test the relative fit of the above model to the models presented in the previous literature parametrically in order to determine which demand model fits the data best; however a formal test of non-nested hypotheses requires additional assumptions on the distribution of the unobserved product characteristics ξ_j. With the given data suggesting no natural assumption for the error distributions there are other ways in which I am able to compare the above model to the two alternative models. One natural approach is to look at the role unobserved product characteristics play. In each of the three models the mean utility is chosen in order to match predicted market shares and observed market shares. While there is no explicit role for video game heterogeneity in the model which only employs the number of video games for the indirect network externality, I interpret the unobserved product heterogeneity terms (ξ_j) as containing this information. In order to gain insight into the importance of these unobserved product characteristics as well as indicate how well the model fits the market shares based solely on observables I restrict ξ_j to zero and recalculate the predicted market shares. In order to determine whether the model employing the number of video games fits the data better than a model which accounts for video game heterogeneity I compare how close the "pseudo" market shares are to the observed. The results of the closeness measure are presented in Table 8.4. The homogeneous video game model does not predict market shares better than a methodology which incorporates video game heterogeneity and consumer substitution. It is no surprise ξ_j plays a larger role in the homogeneous setting given the fact there is survey support to conclude consumers do indeed value video game quality. An alternative method is to look at a statistic such as the sum of the squared errors across each model. The conclusions from this method are consistent to those above–the model which allows for video game substitution and product differentiation fits the data better than the alternative models.

*****Insert Table 8.4 Here*****

Below I present the counterfactual results for each of the two alternative models. I compare the simulation results in Table 8.1 to those employing a measure of the indirect network effect with the number of available video games and a traditional "one-sided" market structure in addition to a model which incorporates video game heterogeneity and a two-sided market structure but does not allow for software substitution as robustness checks. Implementating a methodology which does not account for video game hetergeneity and the two-sided nature of the industry consequently results in a decrease in price when vertical integration is banned–a result counter to the those found above. The mean decrease in console prices is 0.63 percent for Gamecube, 0.27 for Xbox and 0.15 percent for Playstation

2. Market shares for consoles change appreciably; they become more compressed with Playstation 2's share falling from roughly 52.95% to 45.17%, while Xbox and Gamecube gain roughly three, and five percentage points, respectively. Moreover, the average number of consoles sold per month for each manufacturer decreases–almost 314 thousand units for Sony, twenty-five thousand for Nintendo and eighty thousand for Microsoft. The cause of the decrease in consoles sold is from the elimination of *first party* games. Some consumers substitute to an alternative console in the counterfactual simulation, however, a large number of consumers elect not to purchase a console as a result of their decreased attractiveness. Nintendo, Microsoft and Sony all see similar results but Nintendo and Microsoft are not at the magnitude of Sony, a consequence of each having a smaller number of *first party* games than Sony.[30]

Counterfactual results for this model are presented below in Table 8.5. Likewise the demand estimation results are included in Table 7.1 column (v).

*****Insert Table 8.5 Here*****

I next analyze a model which does not allow consumers to substitute between video games but does account for game quality differences and the unique market structure. Given the assumptions of this model, the impact on console pricing is larger than the effect predicted by the model which allows for video game substitution. This model over estimates the effect on price compared to my more flexible model. Prices rise by 6.46, 1.38, 3.18 percent for Nintendo Gamecube, Sony Playstation 2 and Microsoft Xbox, respectively. The model also predicts consumer welfare to decreases an average of $66.964 million dollars when vertical integration is prohibited, an amount three times the size of the model above. Average console market shares are calculated and determined to move in the opposite direction as seen in the model above. Under this model console shares fall drastically for Sony Playstation 2 and rise substantially for Nintendo and Microsoft, roughly five and half, three, and two and half percentage points for Sony, Nintendo and Microsoft, respectively. As a result,

[30] See Table 3.1 for review of the number of *first party* games in January of 2002, 2003 and 2004

the industry concentration is reduced. Like model which employs the number of games, the average number of consoles sold for each manufacturer decreases. I find the decline is roughly 335 thousand units for Sony, 113 thousand for Nintendo and ninety-four thousand for Microsoft, all larger than the model using only the number of video games predicts. The cause of the decrease is a consequence of the higher prices but also the elimination of the first party games. Although the formulation of the inclusive value does account for video game heterogeneity it does not substantially differentiate itself from using the number of video games–a consequence of not permitting consumers to substitute between video games.[31] With both measures closely related it is no surprise to see the mean market share for each console only slightly different than those under a model which assumes video games are homogeneous.

*****Insert Table 8.6 Here*****

In comparing the two alternative models to the more flexible model above, I find video game heterogeneity and consumer substitution to be important aspects to capture. Models used in the previous literature are unable to sufficiently account for the concentration (success) of vertically integrated games for Nintendo and Microsoft. Video game heterogeneity, software substitution and a two-sided market structure are thus industry characteristics which need to be accounted for in order to properly model the industry. Any model which does not correctly incorporate these characteristics will over estimate the impact of console demand on Sony and under estimate the effect on Nintendo. Additional consequences are the formulation of conclusions which i) over predicts the change in price competition and foresees a reduction of industry concentration or ii) predicts price competition and industry concentration to decrease when vertically integration is prohibited, both of which are counter to what a more flexible and structurally consistent model calculates. It is thus extremely important to correctly model the industry for policy reasons.

[31] See appendix for further explaination of the formulation of the inclusive value for the model,

9 Conclusion

This paper specifically analyzes the impact of vertical integration on console prices. I conclude vertical integration in the video game industry increases console price competition. With the implementation of a less restrictive model which includes a two-sided market structure and properly accounts for video game heterogeneity and software substitution vertical integration is not anticompetitive. However, under the more restrictive models which does not account for the two-sided market structure or software heterogeneity, prices rise leading to an anticompetitive conclusion and one counter to a more flexible model. It is thus important to properly model the video game market and incorporate the two sided nature of the market when studying competition in the video game industry.

The studying of the effects of vertical integration in a two-sided market has generated many additional areas of interest. The first and probably the most closely related to the above work is determining the impact of divestitures in two-sided markets (e.g. console manufacturers divesting their video game studios) and how competition changes in both the console and video game markets. A second topic which is also closely related to this research is to understand whether or not vertical integration helps solve the chicken and egg coordination problem of which comes first.

This paper analyzes the effect of vertical integration on two-sided pricing, specifically consumer price competition for video game consoles using data from the 128 bit video game industry consisting of Nintendo Gamecube, Sony Playstation 2 and Microsoft Xbox. The estimation technique differs from prior research by incorporating video game heterogeneity into the indirect network effect–consumers differentiate between a "hit" and "bust" games rather than assuming all video games are homogeneous. The methodology also allows consumers to substitute among video games. After constructing an empirical model, the effects of vertical integration on console prices are investigated by implementing a counterfactual simulation which eliminates all video game titles produced by console manufacturers. There are two important trade-offs to vertical integration. The first is a demand effect and the second a market structure effect. The counterfactual experiment determines the market structure effect dominates the demand effect for all consoles. When vertical integration is permitted aggregate consumer welfare increases by an average of $22.08 million dollars and prices fall by $5.36, 2.32$ and 1.00 percent for Nintendo Gamecube, Microsoft Xbox and Sony Playstation 2, respectively. Moreover, the rise in price competition is beneficial to console manufacturers. Lower prices lead to an increase in the number of consoles sold which generates greater demand for video games where the "real" profits are made. Console makers are thus willing to forego lower console prices in order to increase video game sales, in particular their own *first party* games. Lastly, my model provides a better fit to the data than previous models found in the literature. The results and conclusions found using these methodologies provide inaccurate predictions to the impact of vertical integration; A model which only allows for video game heterogeneity but does not incorporate the substitutability of video games over predicts the price effect relative to the above model while a model which does not account for software heterogeneity nor the two-sided nature of the industry discovers results counter to my more flexible model. It is thus extremely important to correctly model the video game industry. Without doing so, incorrect policy conclusions are made.

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Appendix

Construction of Indirect Network Effect and Console Price Structure for Alternative Models:

Model 4: Video game heterogeneity, no video game substitution

Although the consumer preferences and timing of the game remain the same, each model accounts for the indirect network effect in a different manner. The measure for gamma for a model which only accounts for video game heterogeneity is different from the model above. In such a model the inclusive value captures the expected maximum utility a consumer may receive, as mine does. However, the approach differs from the above model by assuming software titles do not compete. As a result, the model has many inclusive values and thus to derive a measure for the indirect netwo externality aggregation of these value across all available games in each time period needs to occur. The inclusive value or video game index takes the form

$$\Gamma_{jt} = \sum_{k \in \mathcal{K}} \left\{ E(\max_{k \in \mathcal{K}} U_{kj}) \right\} = \sum_{k \in \mathcal{K}} \{\ln(1 + \exp[\delta_{kt}]) + \varphi\} = \frac{\sum_{k \in \mathcal{K}} \{\ln(1 + \exp[\delta_{kt}])\}}{\varphi} + K_{jt}$$

where φ is euler's constant and K_{jt} is the total number of games on console j in time t.

The counterfactual experiment for this model is structured identically to the above model with one exception. Since video games are segregated into their own markets there exists no substitution between video games and thus the purchase probability for *third party* video games do not change when *first party* games are banned. The first order condition for console price under this model with vertical integration prohibited is

$$S(\widehat{P}, \Gamma')\Delta^{-1} + \widehat{P} - mc + \widehat{\Omega} = 0.$$

$$\Delta = diag\left[\frac{\partial S_{jt}(\,\cdot\,)}{\partial P_{jt}}\right]$$

$$\widehat{\Omega} = \sum_{k} S_{kt}(\delta)(r - c).$$

Model 5: Number of games

As mentioned in the above paper, papers by Clements and Ohashi and Hu and Prieger employ the number of available video games compatible with console j in time t. Thus the gamma is a simple count of video games available on each console. Implementing the counterfactual experiment for this model requires a new console profit function. The function is identical to the one employed above but with the elimination of the additional revenue that the console receives from interacting with game developers. I use this profit function as a result of it being standard practice in the current literature on indirect network effects. The profit for console j is

$$\Pi_{jt} = (P_{jt} - mc_{jt}) M_t S_{jt}(P, X, \Gamma; \theta^{hw}) - F_j$$

with the first order condition equal to in matrix notation

$$S(P, \Gamma)\Delta^{-1} + (P - mc) = 0$$

while the first order condition under the counterfactual scenario is

$$S(\widehat{P}, \Gamma')\Delta^{-1} + (\widehat{P} - mc) = 0.$$

Console Market Size

For consoles, I let the data determine the potential market size. I use an approach from Bass (1969) that illustrates how to infer the initial potential market size of a product from its sales data. "An approximation to the discrete-time version of the model implies an estimation equation in which current sales are related linearly to cumulative sales and (cumulative sales)^2" (Nair 2004). Let k_t and K_t denote the aggregate sales of all consoles in month t and cumulative sales up to and including month t respectively. Let the below equation be the regression we estimate:

$$k_t = a + bK_t + cK_t^2 + \upsilon_t.$$

Given the estimates, the Bass model implies the initial potential market size for all consoles is $\bar{M} = \frac{a}{f}$, where f is the positive root of the equation $f^2 + fb + ac = 0$ and a is from the regression above. The predicted initial market size is 78,354,700 households. The potential market in period t is $M_t = \bar{M} - \textit{cumulative console sales till month } t$[32].

Solving for New Equilibrium Prices

Solving for the new equilibrium prices requires the use of a numerical algorithm. The algorithm finds the new equilibrium price vector which solves the FOC under the counterfactual experiment given the estimated parameters and console characteristics. I also generate new marginal revenues for the search. Note that I do allow new equilibrium shares for video games to be determined for the recovery of the marginal revenue associated with the counterfactual scenario. However, these shares are calculated with video game prices remaining unchanged. The algorithm used is the nonlinear system of equations solver in Mathlab-fsolve.

[32] The construction of the potential market size reflects the idea that a consumer is a first time buyer and does not re-enter the market to purchase additional goods. Consequently, I do not account for multihoming consumers.

Table 3.1
First Party Game Statistics

Platform	**Units Sold of First Party Games**		
	2002	2003	2004
Gamecube	179,011	193,347	427,153
Playstation 2	267,545	925,290	546,351
Xbox	382,599	234,258	414,333
	Number of First Party Games		
Gamecube	5	12	21
Playstation 2	24	45	66
Xbox	10	20	38
	HHI of First Party Games		
Gamecube	535.94	59.49	54.44
Playstation 2	10.28	55.29	8.02
Xbox	305.02	17.39	29.09

Note: Statistics calculated for January of the corresponding year.

Table 4.1
Summary Statistics

	Gamecube	Xbox	Playstation 2
Release Date	Nov. 2001	Oct. 2001	Oct. 2000
Hardware			
Price			
Average (over months)	$133.18	$190.54	$240.10
Std. Dev. (over months)	34.27	42.56	54.97
Max	199.85	299.46	299.54
Min	92.37	146.92	180.66
Sales			
Average (over months)	200,420	264,140	522,860
Std. Dev. (over months)	218,410	226,920	501,050
Max	1,158,200	1,079,400	2,686,300
Min	58,712	77,456	188,670
Installed Base (Nov. 2004)	8,223,000	10,657000	25,581,000
Software			
Sales			
Average (over months)	7,436	7,962	10,488
Std. Dev (over months)	23,410	32,803	44,973
Max	826,352	1,777,697	2,053,983
Min	3	1	3
Total Number of Games (Nov. 2004)	398	560	931
Average	210.54	272.4	550.29
Std. Dev	114.99	153.62	203.65
Max	398	560	931
Min	22	41	223

TABLE 7.1
DEMAND RESULTS

Demand Parameters	Logit	Logit-IV	Random Coefficient	Random Coefficient-II	Random Coefficient-III
	(i)	(ii)	(iii)	(iv)	(v)
Price	-0.0041**	-0.0140**	-0.0288**	-0.0296**	-0.0297**
	(0.0017)	(0.0031)	(0.0084)	(0.0146)	(0.0147)
Gamma	0.6815**	0.6971**	0.8664**	0.0193**	0.0111**
	(0.0793)	(0.1064)	(0.1339)	(0.0060)	(0.0035)
Ad	0.1752	0.1550	0.2417**	0.0309	0.0317
	(0.1434)	(0.1022)	(0.1071)	(0.1504)	(0.1506)
Ad^2	-0.0000	-0.0000	-0.0000*	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Sigma	-	-	0.0084**	0.0083*	0.0084*
			(0.0030)	(0.0049)	(0.0049)
Q1	-0.5618**	-0.1771	-0.0898	1.0627**	1.0565**
	(0.1214)	(0.2075)	(0.1924)	(0.4743)	(0.4772)
Q2	-0.6494**	-0.5241**	-0.5061**	0.2424	0.2343
	(0.1069)	(0.1454)	(0.1532)	(0.3229)	(0.3240)
Q3	-0.5570**	-0.5100**	-0.4831**	-0.1401	-0.1464
	(0.1058)	(0.1367)	(0.1451)	(0.2322)	(0.2327)
GMM Objective			15.1251	13.7264	13.7929
Test Statistic-Over Identification[A]			16.01	16.01	16.01

[A] Test statistic at 97.5% confidence level

TABLE 7.1b

Demand Results-Console Fixed Effects

		Logit	Logit-IV	Random Coefficient	Random Coefficient II	Random Coefficient III
			(ii)	(iii)	(iv)	(v)
Gamecube	2002	-5.408	-3.8752	-2.4163	-3.1032	-3.0711
		(0.2981)	(0.4814)	(0.8391)	(1.2931)	(1.3060)
	2003	-5.0531	-3.9357	-2.6829	-5.2298	-5.1921
		(0.2356)	(0.3863)	(0.7425)	(1.0399)	(1.0481)
	2004	-5.0083	-4.2028	-3.1609	-7.3114	-7.2703
		(0.1898)	(0.2826)	(0.6607)	(1.0811)	(1.0859)
Playstation 2	2002	-3.5792	-0.7393	0.8958	-2.3030	-2.2471
		(0.5069)	(0.8928)	(1.0943)	(1.5852)	(1.5975)
	2003	-3.7247	-1.6474	-0.0773	-6.4803	-6.4165
		(0.3795)	(0.6817)	(0.9546)	(1.7442)	(1.7520)
	2004	-3.7597	-2.0590	-0.4983	-9.5208	-9.4434
		(0.3199)	(0.5312)	(0.8718)	(2.2461)	(2.2554)
Xbox	2002	-4.9086	-2.7779	-1.1907	-2.0519	-2.0141
		(0.3936)	(0.6654)	(0.9466)	(1.4875)	(1.5024)
	2003	-4.6757	-3.0312	-1.4398	-4.4591	-4.4145
		(0.3117)	(0.5331)	(0.8677)	(1.2152)	(1.2244)
	2004	-4.1875	-2.8060	-1.3912	-6.6334	-6.5787
		(0.2745)	(0.4492)	(0.7997)	(1.3804)	(1.3864)

TABLE 7.1c

First Stage Results

	Logit-IV (1)	Logit-IV (Binomial)	Logit-IV (Number)
F-test	60.35	61.26	61.31
Adjusted R^2	0.9194	0.9206	0.9206

Table 7.2
Console Elasticities

	Gamecube	Playstation 2	Xbox
Gamecube	-2.6527	0.1067	0.0374
	(0.0100)	(0.0027)	(0.0008)
Playstation2	0.0201	-3.1972	0.0531
	(0.0005)	(0.0248)	(0.0016)
Xbox	0.0190	0.1436	-3.1401
	(0.0005)	(0.0040)	(0.0180)

Note: Cell entry i, j, where i indexes row and j column, give the percent change change in market share of brand i with a one percent change in the price of j. All Standard errors in parenthesis

TABLE 8.1
COUNTERFACTUAL RESULTS

		w/o VI		w/ VI
MEAN PRICE	Gamecube	\$138.70		\$131.66
	Playstation 2	\$246.97		\$244.44
	Xbox	\$191.74		\$187.36
MEAN PRICE EFFECT	Gamecube		5.36%	
	Playstation 2		1.00%	
	Xbox		2.32%	
MEAN % MARKET SHARE	Gamecube	17.46%		20.30%
	Playstation 2	56.50%		52.95%
	Xbox	26.04%		26.75%
MEAN NUMBER OF CONSOLES SOLD	Gamecube	267,140		378,660
	Playstation 2	907,660		958,260
	Xbox	396,450		461,540
TOTAL NUMBER OF CONSOLES SOLD		31,542,000		34,559,420
MEAN CONSOLE PROFIT	Gamecube	\$9,048,000		\$12,506,000
	Playstation 2	\$61,229,000		\$64,802,000
	Xbox	\$18,252,000		\$21,072,000
MEAN PROFIT FROM GAMES	Gamecube	\$14,556,000		\$48,080,000
	Playstation 2	\$69,692,000		\$101,360,000
	Xbox	\$21,522,000		\$47,210,000
MEAN COMPENSATING VARIATION	*e+7		\$2.2080	

Table 8.2
Top 10 Video Game Titles for Each Console

Console	Title	Publisher	Quantity
Gamecube	MARIO KART: DOUBLE	NINTENDO OF AMERICA	1,731,903
	SUPER SMASH BROTHER MELEE	NINTENDO OF AMERICA	1,028,343
	ANIMAL CROSSING	NINTENDO OF AMERICA	799,842
	MARIO PARTY 5	NINTENDO OF AMERICA	774,623
	SOUL CALIBUR II	NAMCO	718,395
	LUIGI'S MANSION	NINTENDO OF AMERICA	702,401
	POKEMON COLOSSEUM	NINTENDO OF AMERICA	698,449
	SUPER MARIO SUNSHINE	NINTENDO OF AMERICA	600,091
	ZELDA: THE WIND WAKER	NINTENDO OF AMERICA	547,067
	METROID PRIME	NINTENDO OF AMERICA	499,929
Playstation 2	GRAND THEFT AUTO:VICE CITY	TAKE 2 INTERACTIVE	6,315,099
	GRAND THEFT AUTO 3	TAKE 2 INTERACTIVE	5,194,262
	GRAND THEFT: ANDREAS	TAKE 2 INTERACTIVE	3,590,284
	MADDEN NFL 2004	ELECTRONIC ARTS	3,419,157
	GRAN TURISMO 3:A-SPEC	SONY	2,781,235
	MADDEN NFL 2003	ELECTRONIC ARTS	2,727,112
	FINAL FANTASY X	SQUARE ENIX USA	2,192,461
	MEDAL HONOR FRONTLINE	ELECTRONIC ARTS	2,185,916
	KINGDOM HEARTS	SQUARE ENIX USA	2,120,314
	NEED SPEED: UNDERGROUND	ELECTRONIC ARTS	2,111,249
Xbox	HALO	MICROSOFT	3,789,232
	HALO 2	MICROSOFT	1,777,697
	HALO 2 LIMITED ED	MICROSOFT	1,489,406
	T.CLANCY'S SPLINTER	UBISOFT	1,483,843
	GRAND THEFT AUTO PACK	TAKE 2 INTERACTIVE	1,200,618
	PROJECT GOTHAM RACING	MICROSOFT	1,188,976
	T.CLANCYS GHOST RECON	UBISOFT	965,620
	ESPN NFL 2K5	TAKE 2 INTERACTIVE	938,203
	DEAD OR ALIVE 3	TECMO	885,781
	STAR WARS: KNIGHTS	LUCASARTS	881,740

Table 8.3
Average Marginal Profit from Games
when an Additional Console is Sold

	With Vertical Integration	Without VI RCL-I	Without VI RCL-II
Gamecube	$9.37	$3.32	$2.61
Playstation 2	$5.01	$3.53	$3.26
Xbox	$7.00	$3.62	$3.18

Table 8.4
Goodness of Fit
Percent Difference from Observed Shares

	Random Coefficient	Random Coefficient II	Random Coefficient III
Gamecube	19.14%	27.41%	27.50%
Playstation 2	38.00%	40.85%	40.85%
Xbox	21.81%	27.17%	27.39%
Total	26.32%	31.81%	31.91%

Error Sum Squared

	14.9382	23.3435	23.5254

Notes: Predicted market shares are evaluated at parameter estimates with unobserved product attributes restricted to zero

Table 8.5
Counterfactual Results-Random Coefficient Logit Model III

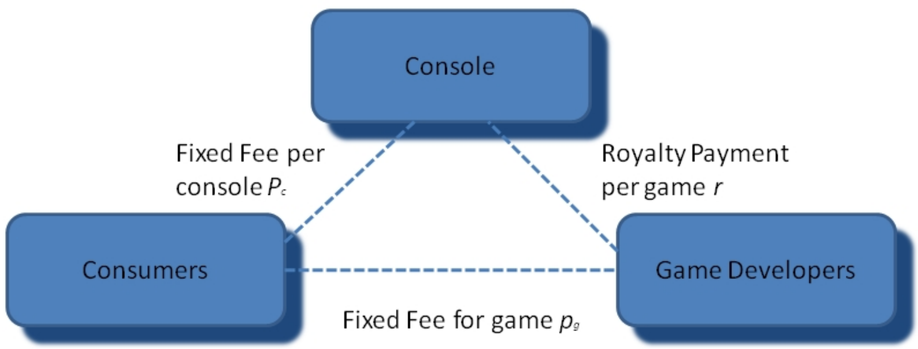
		w/o VI		w/ VI
Mean Price	Gamecube	$130.60		$131.66
	Playstation 2	$244.13		$244.44
	Xbox	$186.42		$187.36
Mean Price Effect	Gamecube		-0.63%	
	Playstation 2		-0.15%	
	Xbox		-0.27%	
Mean % Market Share	Gamecube	25.18%		20.30%
	Playstation 2	45.17%		52.95%
	Xbox	29.65%		26.75%
Mean Number of Consoles Sold	Gamecube	350,540		378,660
	Playstation 2	644,700		958,260
	Xbox	382,160		461,540
Total Number of Consoles Sold		29,145,000		34,559,420
Mean Console Profit	Gamecube	$15,605,000		$16,820,000
	Playstation 2	$47,014,000		$68,621,000
	Xbox	$20,209,000		$24,306,000
Mean Compensating Variation	*e+7		$2.2938	

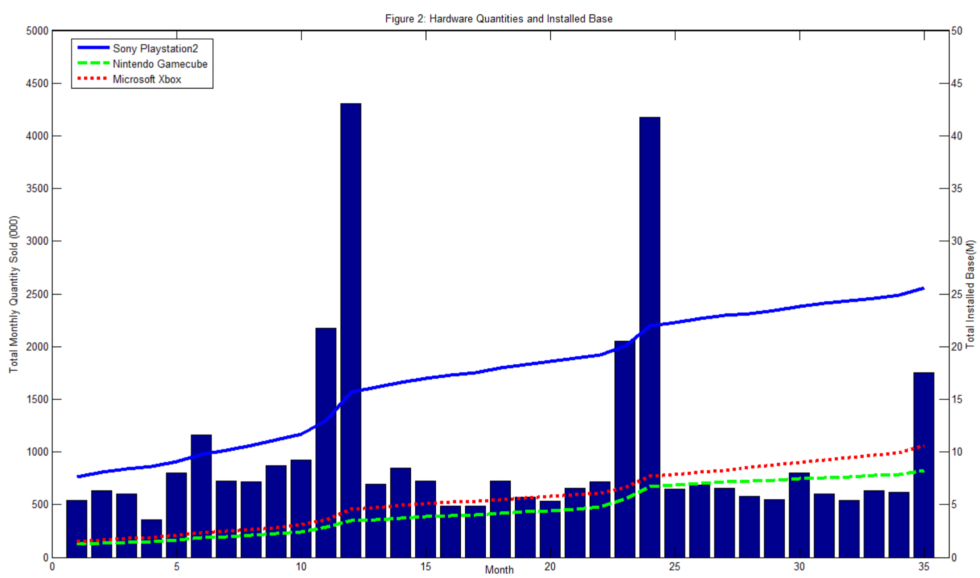
Table 8.6

Counterfactual Results-Random Coefficient Logit Model II

		w/o VI		w/ VI
Mean Price	Gamecube	$140.10		$131.66
	Playstation 2	$257.95		$244.44
	Xbox	$193.35		$187.36
Mean Price Effect	Gamecube		6.46%	
	Playstation 2		1.38%	
	Xbox		3.18%	
Mean % Market Share	Gamecube	23.13%		20.30%
	Playstation 2	47.56%		52.95%
	Xbox	29.31%		26.75%
Mean Number of Consoles Sold	Gamecube	283,900		378,660
	Playstation 2	623,620		958,260
	Xbox	348,630		461,540
Total Number of Consoles Sold		24,403,000		34,559,420
Mean Console Profit	Gamecube	$9,077,000		$11,935,000
	Playstation 2	$40,784000		$61,653,000
	Xbox	$15,270000		$20,102,000
Mean Profit From Games	Gamecube	$11,714,000		$48,080,000
	Playstation 2	$53,838,000		$101,360,000
	Xbox	$17,466,000		$47,210,000
Mean Compensating Variation	*e+7		$6.6964	

Figure 1: Video Game Market Structure





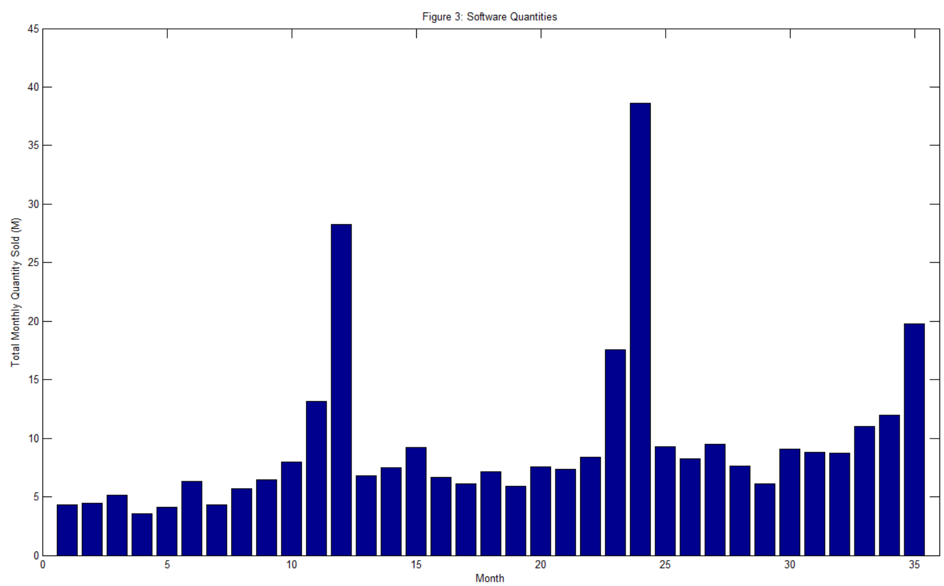


Figure 3: Software Quantities
Total Monthly Quantity Sold (M)
Month