A Model of the Effects of Casual Gaming on the Home Video Game Console Market

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Abstract

The Home video game industry has become one of the largest industries in the United States; until recently it has seen steady growth. With the introduction and rapid growth of smartphone and tablet gaming there has been a drop off in sales for the industry. This paper defines the industry as it was and creates theoretical framework that attempts to explain the ways that tablet and smartphone games could be affecting the home video game console industry. The model uses a finite horizon sequential game model to capture the effects of competition within the industry and heterogeneity of consumer console preferences as well as effects of smartphone/ tablet computer ownership on consumer preferences.

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Introduction

The purpose of this paper is to lay out the framework for a model that can analyze the effects of smartphone and tablet computer video game popularity on the home video game console market. For clarity I have defined a home video game console as a dedicated video game playing computer. It is the hardware product or platform on which video game software can be played. The software and game console are mutually incompatible. A video game console can only play software titles specifically design for that device and conversely the software designed for one console is not playable on a platform designed by a different firm.

Video game consoles historically have a long life-span; the modern video game industry is defined by generations that last several years before new platforms make them obsolete. The next section of this paper is a brief history of the video game industry from its beginning to the present day.

History of the Video Game Industry

Generation 0

The very first video game was programmed on an EDSAC vacuum-tube computer by A. S. Douglas in 1952. This game is regarded as the first computer game. The EDSAC computing machine was a one-of-a-kind machine that resided in the labs at the University

of Cambridge. This was not the first video game because the display was a cathode ray tube. The video game industry did not come until well after this invention because computing technology was still too primitive to have any sort of household application. In 1958 William A. Higinbotham developed "Tennis for Two," one of the first video games, which utilized an oscilloscope display. This game was a marvel of technology, but it was still a long way away from commercial sale due to its price and practicality.

In 1961 a group of students at MIT programmed a video game called "Space War!" on the DEC PDP-1, a new computer at the time. This was the first truly iconic video game ever made. "Space War!" helped shape the video game industry that was born a decade later. In 1971 the first ever arcade game was installed in a Stanford University union room. The arcade game was a computer and display that were dedicated to playing "Galaxy Game" one of many "Space War!" emulators. Later that year, Nolan Bushnell and Ted Dabney co-created a coin-operated video arcade game version of Spacewar! and called it Computer Space. Nutting Associates bought the game rights and manufactured over 1,500 Computer Space machines, with the release taking place in November 1971. The game was unsuccessful due to its steep learning curve, but it was a landmark in the industry formative years as being the first mass-produced coin operated video arcade game, and the first offered for commercial sale.

Computer Space-1971

Magnavox Odyssey Prototype-1966

The home video game industry was born in May 1972 with the first sale of the Magnavox Odyssey created by Ralph Baer. The system originally had twelve playable games that were integrated with the console that hooked up to a television set. With the introduction of the Odyssey there were two channels of distribution for video games, arcade games, and home video game consoles. These were separate industries that heavily influenced each other. The Magnavox Odyssey was the only home video game console available until 1975.

In 1975 Magnavox and Atari both released new home video game consoles to the public as video games became a part of mainstream culture. At this time video games were hardwired into microchips built into the consoles, which meant if consumers wanted new games they would have to buy a whole new system. This also meant that hardware designers had to design and finish all of their games before their console could be released. This technology was an adaptation of the technology already in use in arcades intended for living rooms.

Above Atari Pong- 1975

Generation 1

The video game industry almost died in 1977 during the first video game crash. The crash is attributed to an excess of pong imitators. Pong was introduced first as an arcade game in 1972 and later as a home video game system in 1975 by Atari. During the reign of Atari's iconic pong game competition came in the form of clones. Companies just copied the pong game and divided the market instead of expanding it by appealing to more customers with innovations or improvements. During the crash sales plummeted and video games nearly became a passing fad. The saving grace of the video game industry was Taito's "Space Invaders" which was released as an arcade game in 1978. "Space Invaders" ushered in the so-called golden age of video arcade games. Arcade games generated $8 billion in quarters in the US at the height of its popularity in 1983. The home video game market generated less than half of that at $3.2 billion in revenue that year.

A major innovation was the introduction of cartridge games and microprocessor chips which allowed for hardware companies to develop several games for one game unit, the most notable console with this design was the iconic Atari 2600, which was by far the company's best selling home video game console. The system was released during

the video game crash, but caught on quickly when a port of Space Invaders was released for the system.

This period from 1978 to 1983 was truly a renaissance for video games, but it was followed by a major recession after 1983. The number of companies creating games and consoles far surpassed market demand and yet another market crash ensued. In 1985 the home video game industry generated a meager $100 million in revenue. The crash occurred for a number of reasons, but the driving factor was the large number of companies that were following the same patterns that created the first video game market crash. There were too many companies producing sub-par games. At the time there were too many consoles each with their own unique libraries of software. Atari had a notable fall from grace when they attempted to copy Namco's arcade hit, Pac man with little success. Eventually Atari along with many other companies went bankrupt.

Atari 2600-1977

Generation 2

In 1983 a Japanese entertainment company called Nintendo started the console generation cycle that has persisted up to the present. By this time Atari, Magnavox, and its competitors fell away after the catastrophic market crash in 1983. Nintendo rekindled

widespread interest in gaming by selling record numbers of home video game systems by 1987. Nintendo invented a business strategy that is now the industry standard and a major factor in their success. Nintendo allowed outside video game developers to purchase licensing agreements so that these third party developers could create and sell games made for their NES or Nintendo entertainment system. Nintendo regulated their licensing agreements tightly to ensure that companies would not rush low-quality games to market. In the United States the Nintendo Entertainment System was peerless, but had stiff competition in Japan. Japanese company Sega offered a very similar product with their Sega master system, which offered the same sort of third party support and 8-bit graphics. In the US market Atari, Mattel, and Coleco all made consoles, but Nintendo largely dwarfed their success. The Nintendo Entertainment system shipped 33.49 million consoles in the US before it was discontinued. Sega Master System sold 2 million consoles in the US before being discontinued.

Nintendo Entertainment System-1983

Sega Master System-1984

Generation 3

In 1988 competition in the video game market broke down into all out war. Nintendo and Sega got caught up in a clash of titans with the release of Sega's best selling console the 16-bit Genesis. The Sega Genesis was revolutionary because it was so much more powerful than its predecessors. Sega's new system was peerless for 2 years until Nintendo responded with the 16-bit Super Nintendo Entertainment System. This is regarded as one of the most aggressive wars for market dominance in the history of the home video game industry. Despite the two year lead Sega had on Nintendo, the war was all but won. The Super Nintendo was a huge success largely because of its legendary line-up of hit games. Sega's initial success was slowed with the competition from Nintendo, but that did not cost them the console war. Sega made a huge blunder by fracturing their audience with peripheral devices that complicated their sales strategy. These peripheral devices were intended to improve game quality and offer new ways to play video games. By 1995 Sega was supporting 5 different systems and 2 special add-ons globally; there was not a concentrated effort to make games for any particular system which hurt sales when the Super Nintendo started to gain market traction. Nintendo produced the games that made the franchise iconic while keeping their strategy simple and concentrated. They made one system that went to every market. While Sega was changing up its strategy Nintendo focused on building their impressive game library. By the end of the console war Nintendo overtook the genesis in a hard-fought battle.

Nintendo won by building up their network effect, increasing the value of the Super Nintendo with each new game.

Generation 4

The next generation had a different face than the 16-bit war; the clear-cut winner was a new entrant, Sony. Sony won the war with the iconic PlayStation, a 32-bit disc-based system. The new format and higher resolution graphics brought 3D video games to the living room which was yet another major leap for the mainstream home video game market. At this point there had been no successful 3D home video game console. Sony's business strategy was highly effective because it allowed them to build up a huge library of third-party games. The play station came out one year before Nintendo released its Nintendo 64. Nintendo performed well, but its superior 64-bit graphics were not enough to combat the impressive network effect that Sony had built for its system. Sony made it much easier for third-party companies to develop games on its system than its competitor. Nintendo was not as hospitable towards third party developers; Nintendo charged higher royalties and more tightly regulated developers which narrowed the size of Nintendo's game library. Nintendo's system offered crisper graphics and more processing power paired with their high standards of game quality, but it was not enough. The PlayStation paved the way for its successor the PlayStation 2 which is the best selling console of all time.

Generation 5

This generation was not a hard fought victory for the Sony Corporation, the PlayStation 2 outsold its competitors, the Nintendo GameCube, and the Microsoft Xbox. The PS 2 also is singlehandedly responsible for sinking Sega's last ditch efforts to sell a successful console. PlayStation 2 was a success for many of the same reasons as the PlayStation before it, but it was also very successful for its DVD playing capabilities. The PlayStation 2 is peerless in terms of success, this may be largely due in part to the fact that after this generation the face of console gaming changed forever.

Generation 6

Finally, the current generation of video game console only has room for three major competitors: Xbox 360, Sony Playstation 3 and Nintendo Wii. With full 1080p HD graphics for both the Xbox 360 and Playstation 3, and Wii's innovative remote for sensing 3D movements, it seems that video gaming had indeed came a long, long way. In addition to these, all three consoles had expanded with add-ons such as the MotionPlus for Wii *(2009)*, Kinect *(2010)* for Xbox 360 and Move *(2010)* for Playstation 3. The Nintendo Wii won the largest market share by a huge margin, but its sales have declined sharply since 2009. Currently the Xbox 360 and the PlayStation 3 both outsell the Wii, but they are still very far away from beating the Wii lifetime sales. The Wii is famous for introducing videogames to a whole new group of people, casual gamers. Casual gamers are less committed to buying new games and play games much less frequently. The Wii appealed to these gamers buying creating games that are simple to play and accessible to

less-experienced gamers. The drop-off in sales for the Wii could potentially be contributed to the growing market for Smartphone and Tablet gaming which has taken off during this most recent generation.

Literature Review

Smartphones and tablet computers have become so sophisticated that their graphic and memory capabilities rival that of a traditional home video game system well enough to directly compete with home video game console brands for a share of video game consumers. With the explosion of smartphones and tablet computers in the last few years, dedicated gaming consoles are seemingly waning in popularity due to the competition from app style gaming found on smartphones and tablets.

The home video game console market has an additional layer of complexity that does not exist in many markets because it is two-sided. Several papers outline and analyze the dynamics of different two-sided markets. For the purpose of this paper we will use the definition laid out by Rysman (2009); "Broadly speaking, a two-sided market is one in which 1) two sets of agents interact through an intermediary or platform, and 2) the decisions of each set of agents affects the outcomes of the other set of agents, typically through an externality." In the case of home video game consoles, smartphones, and tablets the two agents are hardware consumers and video game software developers. The focus of most of the economic research is on the intermediary and their strategy to maximize market share. The definition of a market as two-sided is broad, several markets could be considered two-sided. For this reason a market is not worthy of study simply

because there are two agents and an intermediary. In this case of the video game market the two-sided nature of all of the companies determines market shares. Each firm that has created a console, smartphone, or tablet has employed a different strategy to attract consumers and software developers. Hardware producers generate revenue from royalty fees from the sale of hardware for their system and from the sale of their consoles.

The platform developers analyzed in this paper all have a definitive indirect network effect. Most of the market analysis done in the video game industry is distinctly classified as network literature. There is extensive literature focusing on the returns to a platform provider from network growth. One article, Gandal (1994) found empirically that spreadsheet software could be sold at a premium if it had widespread adoption between different computer operating systems. In the case of computer spreadsheets, consumers would pay more for a highly compatible program and operating system designers would want to adopt that spreadsheet program as more people bought it. Gandal et al. (2000) found that for a 10% increase in compact disc variety could make the price of a compact disc player go up as much as 5%. The conclusion of both of these articles was that two-sided markets exploit network effects in their pricing strategy. The literature is not exhaustive, but there is significant evidence that network effect exploitation can increase revenue.

There is exhaustive literature confirming and profiling network effect exploitation within the home video game market. Gretz (2010) found that as software provision increased the price of the console dropped over the life-cycle of the console. The current hypothesis of this paper is that smartphone and tablet firms exploit a similar pricing trend over the lifecycle of their products. The difference is that smartphone and tablet games

are smaller in size and produced in a higher volume at a much lower price. Since they are not on a dedicated gaming machine they have the added consumer utility, with the cheap games providing them an imperfect substitute for a home video game console; while the experience is not the same they can provide enough entertainment value to stand in for a dedicated hardware console. To date the apple corporation has approved development of approximately one million apps to be sold in their app store. Most of these apps are free or cost $1.00 on average. Today most new home video game console games cost upward of $50 dollars and contain several gigabytes worth of data. These two products are imperfect substitutes for each other, but their pricing strategies are very different. The Gretz (2010) article highlights the importance of network effect by defining the utility function of a consumer so that the console and the software have no standalone benefit. The consumer's utility of a console goes up with additional software and that increases the revenue generated from licensing fees by the hardware provider. The hardware price is then negatively correlated with software provision which completes the positive feedback loop created by the indirect network effect. The intention of this paper is to extend this analysis to smartphones and tablets which historically have dropped in price as software volume increases. Liu (2010) uses a similar set of variables to model alternate outcomes of the console war between the Nintendo 64 and the Sony PlayStation. This theoretical model used estimations of the product price of each console over its lifetime and accounted for the network effect created by the number of available video games. To take this model a step further tablet and smartphone users will be separated from non-users to figure out how smartphone and tablets could possibly affect consumer preferences for dedicated gaming hardware.

Table 1.

Console	Total US Sales (Millions)
PlayStation 2 (PS2)	53.65
Wii (Wii)	44.36
Xbox 360 (X360)	42.25
PlayStation (PS)	38.94
Nintendo Entertainment System (NES)	33.49
PlayStation 3 (PS3)	25.97
Super Nintendo Entertainment System (SNES)	22.88
Nintendo 64 (N64)	20.11
Sega Genesis (GEN)	15.98
Xbox (XB)	15.77
GameCube (GC)	12.55
GameGear (GG)	5.4
Dreamcast (DC)	3.9
Sega Master System	2
Sega Saturn (SAT)	1.83
Sega CD (SCD)	0

Framework

This is an oligopoly model with J competitive hardware firms. Each firm sells one hardware device that is an imperfect substitute any other firm's product in the market. The hardware products in the market are mutually incompatible; this means that the software designed for one hardware product is incompatible with any other hardware product. This means that introduction of new software for one product will have no effect on the utility of another device. This is a sequential game where all of the participants in the market move simultaneously at the beginning of each time period, t. The sequence of events is as follows: at the beginning of each period a consumer will decide based on factors exogenous to the model whether or not to buy a tablet or smartphone, the hardware firms make pricing decisions that maximize expected market share, and software firms make entry decisions given the current installed base for the hardware product. For simplicity every consumer has full information about pricing and software availability for every console when making the decision to purchase a console. We

assume that consumers exit the market after purchasing a console because they are considered a durable good.

Hardware Demand

Before a consumer chooses a console nature will determine whether or not they will buy a smartphone or tablet. The consumer will have a different utility for a console if they have purchased a smartphone or tablet.

(1) $$U_{ijt} = \alpha_{ij} - \beta_i p_{jt} + \gamma_i N_{jt}^{\lambda}$$

(2) $$U_{kjt} = a_{kj} - B_k p_{jt} + y_k N_{jt}^{m} + W_k z_{jt}^{j}$$

This follows a constant elasticity of substitution framework as laid out by Liu 2010. There is a key difference because nature will put a consumer at node i or k given their exogenous preference towards smartphones and tablets. Consumers at node i did not buy a tablet or smartphone in period t or any period before that so their payout is given by U_{ijt}. Their utility is a function of p_{jt}, α_{ij}, and N_{jt}^{λ} which are the price, intrinsic value, and software provision for console j at time t respectively. Consumers at decision node k have bought a smartphone or tablet at some point before period t. Smartphone and tablet video

game software provision for the consumer k at time t is a factor in this group's decision to purchase a hardware console. These utility functions summarize the indirect network effect on consumer choices by incorporating software provision which directly affects the expected utility of a console for a consumer. It should be noted that software provision is the most important summary statistic according to Clements and Ohashi (2005), but it does not account for consumer heterogeneity in software quality.

Despite being unable to capture consumer software heterogeneity we can capture consumer hardware heterogeneity following the latent class approach used by Liu (2010) in an empirical analysis setting. Consumers without smartphones or tablets are grouped into R segments that have their own specific set of parameters, $\{\alpha_{rj}\ ,\ \beta_r\ ,\gamma_r\}$, for each segment. Tablet and smartphone users are grouped into V segments with unique parameters, $\{a_{vj}\ ,\ B_v\ , y_v, W_v\}$, for each segment v. Consumers' heterogeneous tastes are assumed to an independent type 1 extreme-value distribution therefore the market share for console j in segments r and v are respectively:

(3)

$$s_{rjt} = \frac{\exp\left(\alpha_{rj} - \beta_r p_{jt} + \gamma_r N_{jt}^{\lambda} + \xi_{jt}\right)}{1 + \sum_{k=1}^{J} \exp(\alpha_{rj} - \beta_r p_{jt} + \gamma_r N_{jt}^{\lambda} + \xi_{jt})}$$

(4)

$$c_{vjt} = \frac{\exp\left(a_{vj} - B_v p_{jt} + y_v N_{jt}^{m} + W_v z_{jt}^{j} + \xi_{jt}\right)}{1 + \sum_{k=1}^{J} \exp(a_{vj} - B_v p_{jt} + y_v N_{jt}^{m} + W_v z_{jt}^{j} + \xi_{jt})}$$

Allow M_{rt} to be the size of segment r at time at and D_{vt} to be the size of segment v at time t:

(5)

$$Q_{jt} = \sum_{r=1}^{R} M_{rt} s_{rjt} + \sum_{v=1}^{V} D_{vt} s_{vjt} ;$$

Equation 5 is the quantity demanded of hardware product j at time t.

Software Provision

Let Y_{jt} be the installed base, or the aggregate hardware sales for product j up to period t – 1. As the installed base grows for a hardware platform, more software can be accommodated. The software provision equation below captures this relationship.

(6)

$$lnN_{jt} = \kappa_j + \varphi_j lnY_{jt}$$

This equation follows the assumption that all hardware consumers follow a constant elasticity of substitutions demand for software. This is a limiting factor of the model because it forces all software titles to be heterogeneous. By assuming that each consumer in the installed base of a console j has a CES demand for software we can derive equation (6) from the simultaneous Bertrand equilibrium of the software market. The interplay between the utility functions (Equation 1 and 2) and the provision function (6) causes a

positive feedback loop characteristic of the indirect network effect in the video game market.

Hardware Pricing

As I mention in the literature review hardware producers generate revenue from two sources as the intermediary agent in a two-sided market. Console companies levy a royalty fee from every compatible software title sold in addition to the revenue from console sales. For simplicity I assume hardware producer j receives an average amount of either f_{j2} or f_{j1} in royalties from the sale of one console. Smartphone/tablet owners generate f_{j2} on average and the rest of the consumers generate f_{j1} on average. At any given time t we assume that the retail margin for a console is held constant at $1-\tau$ giving us the profit equation:

(7)

$$\pi_{jt} = (\tau p_{jt} - c_{jt} + f_j)\left(\sum_{r=1}^{R} M_{rt} s_{rjt}\right) + (\tau p_{jt} - c_{jt} + f_j)\left(\sum_{v=1}^{V} D_{vt} s_{vjt}\right) - F_{jt}.$$

In this equation c_{jt} is the marginal cost of production of one hardware unit at time t. F_{jt} is the fixed cost term; note that it does not affect the hardware firm's pricing decision because it is unchanging. The marginal cost in this model can be exogenous or endogenous given enough information on the marginal cost of hardware components. In my analysis I make marginal cost changes exogenous for simplicity.

Equilibrium

In a finite horizon game such as this where the hardware firms are looking to maximize the current value of expected total profit for an entire product generation. Therefore, firms' pricing is inherently dynamic.

In each period t all of the hardware producers will make a pricing decision to maximize their total expected payout given the current market state based on the expected profit function. The current state is described by a state vector $S_t = \{Y_{rjt}\}$ where Y_{rjt} is the current installed base for every hardware product for each market segment. The state vector for time t summarizes all of the payoff information for every firm in that period because Y_{rjt} is related to N_{jt} by Equation (6). The new state is then given by:

(8)

$$Y_{rjt+1} = Y_{rjt} + M_{rt}s_{rjt} + D_{vt}s_{vjt},$$

which is simply the installed base in period t plus the hardware demanded in period t. Now the hardware firm profit function can be written as a function of the current state S_t and the hardware prices p_{jt}:

$$\pi_{jt}(S_t, p_{jt}).$$

The hardware firms are assumed to have perfect information about the competition pricing for all periods and perfect information about the current state. The hardware producers set the price for the next period using the expected profit function. Let $\sigma_{jt}: S_t \rightarrow p_{jt}$ be the firm j's pricing strategy in period t and let σ_j be the vector denoting the pricing strategy for firm j in all periods. All of the firms have access to the strategy profile $\sigma = \{\sigma_1, \ldots, \sigma_J\}$ for simplicity. Each firm sets their prices based on the expected profit function for the current period.

(8)

$$E[\pi_{jt}] = \int \pi_{jt}(S_t, p_t)$$

The expected present values of firm j's profits are given by:

(10)

$$\mathrm{V_{jt}}(\mathrm{Y_t}|\sigma) = E\left\{\sum_{t=1}^{T} \delta^{t-1}\pi_{jt}[S_t, \sigma_t(S_t)] \middle| S_1, \sigma\right\}.$$

The expected value of firm j's profits can be found for any specific interval within the finite horizon game as well.

The strategies used by the hardware firms in this price-setting game are Markov strategies. Firm j's hardware pricing strategy for each period $\mathrm{t} \geq 1$ is a function only of the current state. Pricing is based on the expected profit function given the current state Y_{rjt}, therefore any at every subgame no firm will have incentive to deviate from strategy profile σ.

Conclusion

The model presented above is an effort to model the possible effects of casual app style gaming on the home video game console industry. With the introduction of phone and tablet gaming, home video game consoles have to compete for the attention of gamers. Everything comes down to the utility and consumer surplus given by cheap games for phones and tablets. Consumers' desire to play video games can be partially or even completely satiated by a smartphones and tablets and that has many implications for

the home video game industry. With the proprietary data necessary, this framework could accurately capture the effect of these mobile devices on the home video game giants. The key to this model is how it captures market segmentation with smartphone/tablet gamers and separately from non-smartphone/tablet gamers so that there is a distinction in consumer preference between these groups. Smartphones and tablets are becoming increasingly more popular and their product life cycles are much shorter; which means cutting edge mobile technology gains quickly on aging consoles such as the Xbox 360 which is now 8 years old; in that time there have more than five different versions the apple iphone, each obviously more capable of creating high quality gaming experience than the last. This is a tumultuous time for the home video game industry as consumer tastes shift away from dedicated home video game consoles. For this reason the effect of smartphone/tablet gaming is worthy of study because there is indication that this will be a transitional period for the video game industry as revolutionary as the introduction of the first Nintendo Entertainment System.

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