The Effect of Video Game Features and Consumer Ratings on it's Relative Price

Maximianne Castaneda

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Introduction

Video games constitute part of an industry that captures a large percentage of Americans, where 75% of American families identify a gamer in their household[1]. The video game industry continuously strives to provide the best product for their consumers while ensuring their gaining maximum profit. The following research focuses on exploring how video game features and consumer ratings may affect the relative price of the game. The current price of the video game analyzed served as the dependent variable and allowed for determining the influence of these factors on changes in video game price. Theory was utilized to determine factors that contribute to a game's success, which in turn influences its price. The regression run measured the relationship between the current price of a game and the independent variables (months, rating, percent likes, platforms and multiplayer feature). Overall, the data results presented the statistical significance of months, ratings, and percent of likes, while multiplayer feature and platform availability presented statistical insignificance. The model expressed 39% variation with evidence of omitted variable bias, an irrelevant variable and an alternative functional form that would improve the fit of the model. Multicollinearity, heteroskedasticity, and serial correlation were absent from the model.

After reviewing Economical Writing by Deirdre Nansen McCloskey, the two economic writing strategies this essay focuses on are: "Write in Complete Sentences" and "Avoid Elegant Variation." I have the tendency to write run-on sentences or incomplete sentences. In terms of elegant writing, I do not like to repeat words, however in terms of this essay, the lack of variation may be better due to the nature of the topic, for example referring to multiplayer as multiplayer

[1] *2019 Essential Facts About the Computer and Video Game Industry*, ESA, collected data on over 4,000 Americans and their gaming habits.

and not online gaming. In order to ensure that readers understood without need prior information on the topic, the vocabulary must remain consistent to avoid confusion.

Literature Review

In order to explore how factors such as video game likability, availability, and time on the market, among other factors, can potentially determine the current price of a video game, multiple articles/research papers were reviewed. The sources could all be related to the topic of video games and sales of products, directly or indirectly. These sources were found through the search engines JSTOR and Google Scholar.

The successful sale of a product and potential profit of the producer may often depend on the quality of the product itself and consumer opinion. Researchers Bao-Jun Jiang and Bin Wang (2008) explored the impact of consumer reviews and ratings on sales, prices, and profits of a product using theory and evidence. They concluded that a firm's optimal pricing strategy depends on the quality of their product. Their analysis states that producers benefit from improved consumer rates on a low-quality product because it then leads to an opportunity for price increase (12). However, in regards to a high-quality product, a high rating may benefit the product only if it does not surpass the maximizing profit's quantity (12). In order to reach their results, they analyzed two different markets: monopoly and duopoly[2], and the effect of changes in product ratings on their sales. They modeled five propositions using economic theory where the first two propositions revolved around a monopoly market and the last three on a duopoly market. Proposition One stated that in monopoly, a higher product review causes the optimal price to be higher which leads to a higher profit (5). Proposition Two states "when a monopolist's product rating increases, the firm can increase its price and make higher profits

[2] Defined as a situation in which two suppliers dominate the market for a commodity or service.

because the improved rating increases the perceived quality of the product" (5). Propositions Three and Four focused on the result of one firm's product rating changes in a low quality and high-quality product. Proposition Five discussed the effect of changes in the product's rating on the consumer surplus (5-7). In order to validate their Propositions, they collected data on 355 point-and-shoot digital cameras and 139 multivitamins from Amazon (8). They concluded that if a firm is a monopoly, it should take advantage of higher review ratings to raise their price, as stated in Proposition One (12). Consequently, based on their results, another product's price, such as a video game, has a direct relationship with the quality of the game, as determined by the consumers themselves. This leads me to believe that ratings and YouTube reactions can have an effect on the price of a game, meaning that if a game has higher ratings on a credible gaming site, then their price could be higher than a game with a lower review.

Independent researchers Matthew Bond and Russell Beale (2009) discuss the categories to consider during game development in order to receive positive feedback from consumers. By receiving positive feedback, it ultimately leads to a company obtaining a large profit (418). In their research, they managed to cross reference sales of top games along with reviews to conclude that there are 13 "Good Factors" and 12 "Bad Factors" identified by the consumers themselves. The "Good Factors" included the value, the price, variety (multi-player) and maintenance. Thus, when a game includes more of the "Good Factors" identified by users, the game receives positive feedback and more opportunity for profitability (419). Similarly, Sailer's research (2017) focused on different game design elements and their effects on the consumer's psychological need for satisfaction. The game design elements they focus on are: points[3],

[3] Numerical representation of the player's progress/skill (Sailer 373).

badges[4], leaderboards[5], performance graphs[6], meaningful stories, avatars and teammates. They use the Self-Determination Theory to explain a player's need to play/succeed in a game: "*The need for competence* refers to feelings of efficiency and success while interacting with the environment…. *The need for autonomy* refers to psychological freedom and to volition to fulfill a certain task ...*The need for social relatedness* refers to one's feelings of belonging, attachment, and care in relation to a group of significant others" (374). They concluded that *the need for competence* is fulfilled when playing a video game with points, performance graphs, badges, or leaderboards; *the need for autonomy* is fulfilled by avatars and storyline; and *the need for social relatedness* is fulfilled through storyline and teammates (374). This directly ties in with my topic because the research explores how a video game's "satisfaction" determines its general appeal to the consumer and examines the elements of a game that increase its likability. When a player feels satisfaction while playing a game, they may be more likely, for example, to buy an expansion pack or the next game in the franchise, thus increasing the company's profit on that product. Although Bond and Beale's (2009) factors are theoretically correct, they present issues due to its subjectivity, unless they utilize a specific target audience or genre.

Nair (2007) explored video game prices by considering consumer behavior and the idea of price discrimination as a method for companies to maximize prices. Price discrimination refers to producers charging the maximum amount a consumer is willing to pay for a product. He analyzes price discrimination in the market for video-games in the United States with a model that approximates how consumer behavior affects the ability of a firm to implement price discrimination (1). Nair notes that when prices drop, consumers become aware: "the more the

[4] Visual representations of achievements (Sailer 373).
[5] Rank players according to their relative success, measuring them against a certain success criterion (Sailer 373).
[6] Provided information about the player's performance compared to other players (Sailer 373).

firm skims the market, the more the extent to which it can expect such strategic delay, since consumer expectations of future prices may get revised based on observed price cuts" (2). Consequently, producers must use caution when setting up their prices/cuts, because consumers will recognize their methods and hold off buying products at release price. Therefore, producers must familiarize themselves with their consumer's behavior and preferences in order to judge the initial price of their game.

HongJu Liu (2010) focuses on how consoles can dominate the gaming market and influence consumer's preferences in terms of gaming systems. He explains that in regards to video games, variety matters when attracting consumers. This ties to Bond and Beale's (2009) statement about the importance of variety within game design. Liu (2010) concludes that, "Nintendo could have won the console war either with 10% more games or with a head start of one million units in installed base at the time of the [PlayStation] introduction. Switching from cartridges to CD-ROM would not have helped unless it could increase the number of games for [Nintendo 64] by more than 40%" (441). In essence, a video game console's success may ultimately be dependent on the games available on this console. In terms of pricing, Liu discusses two different pricing strategies: Skimming and Penetration Pricing. Skimming Pricing refers to firms charging a relatively high price at first and lowering it over time, thus "skimming" off consumers willing to pay more (20). Penetration Pricing occurs when a new firm first introduces the product at a low price in order to "penetrate" a market and obtain a consumer base before increasing its prices (20). Unfortunately, choosing between Skimming and Penetration Pricing may present difficulties since these must be based on prior sales themselves. However, by gaining awareness of how consumer preference influences game popularity and sales, a choice on pricing method may be justified and lead to maximum results.

The current research surrounding the world of video games provides an overview on the factors often associated with producer's reasons behind a certain price. These allow us to understand the shift in pricing that occurs throughout the years and how some game producers may be more affected than others. This can allow video game creators to market their product differently or perhaps alter the presentation and aspects that they choose to include in their final product. Overall, the video game industry is a business and given the high level of competition, they should be aware of the aspects that can predict their products rate of success, especially as the years go by. Considering the wants, needs and preferences of the public is key and although the game may differ, the consumer's approach remains the same.

Model

This research consists of a sample of 31 video games released between the years 2013-2019. They were chosen at random. The model is as follows:

$$\log(\text{curP}_i) = \beta_0 + \beta_1 \text{months}_i + \beta_2 \text{rating}_i + \beta_3 \text{perL}_i + \beta_4 \text{platforms}_i + \beta_5 \text{multi}_i + \varepsilon_i$$

The dependent variable is the log of the current price of video game *i* in USD. The independent variables are: months_i, the number of months game *i* has been out in the market; rating_i the rating, on a scale of 0-5, game *i* has on gamestop.com; perL_i which is the fraction of total likes over total viewer response on game *i*'s certified release trailer taken from Youtube.com; platforms_i which is the number of platforms on which game *i* is available; multi_i which is a dummy variable for whether game *i* has a multiplayer feature (multi=1, means that the game does have a multiplayer feature, multi=0 means that the game does not have a multiplayer feature) where multiplayer refers to the ability to play online with other players on the same server in live time.

Since video game prices fluctuate, the amount of time game *i* has been out in the market is important. Therefore, the inclusion of the variable months is relevant because products usually devalue over time. For example, if games are part of a franchise, when a newer game is released, it devalues the older game. Specifically, *Activision,* the Call of Duty game publisher, tends to release a new Call of Duty game every couple of months, where the new game has "better" graphics, additional features, or an enhanced storyline, which leads to new consumers on the market to stray away from the older game and invest in the newer game. Thus, the hypothesized sign is (-), the longer the game is on the market for consumer purchase, the more the price will decrease.

Consumer appeal relates to a product's price, therefore if game *i* does not meet consumer expectations, the rating will be lower than that of a game that did meet consumer expectations. That in turn causes game *i*'s price to decrease accordingly. A higher rating means that the player enjoyed the game and often in the comment portion of the review they recommend the game or boast about what they enjoyed of the game. Bao-Jun Jiang/Bin Wang reached this conclusion in their research on consumer rating's effect on sales, prices, and profits. The lower the rating/consumer likes on game *i*, increases the likelihood of price decrease and vice versa. Therefore, if game *i* obtains high ratings and high percent of likes, the price will also be higher; thus the hypothesised sign is (+). That also means the sign of the variable perL will also be (+), since these two variables are two different ways of measuring consumer expectations and their potential effect on the relative price of game *i*.

The number of platforms on which a game is available carries importance, because not every consumer likes the same console. Sony and Microsoft are rivals when it comes to Playstation vs. Xbox. There are some games which are Playstation exclusive, Xbox exclusive,

and nintendo exclusive, among others- which limits the game's accessibility; the hypothesised sign is (+) because if the game can be played on more platforms, then more consumers have the opportunity to play and enjoy the game. Lastly, games with multiplayer allow for consumers to keep playing even after the main storyline/objective has been completed; I expect the sign to be (+), since a game's increase in likeability correlates to game demand and the price remains higher than other games.

Data

The data set was collected from scratch, no prior data set existed that could be utilized as a base, the collection of these variables took place on April 1st 2020. The games were selected at random ranging from release years between 2013-2019, and of various genres. The variables current price (curp), rating, platforms, and multiplayer(multi) were taken from GameStop.com, which is a certified American video game, console, and gaming merchandise retailer. Each game was searched individually on GameStop and the data was filled in accordingly. The perL was calculated by searching each video game's official reveal trailer on YouTube and the ratio of likes to total viewer responses (the sum of likes and dislikes) was calculated. The number of months was collected by adding how many months necessary to reach March 2020 from their official release. The summary of each variable is as follows:

Variable	**(min, max)**	**Mean**
log(curP)	(1.6074, 4.094)	3.35
months	(6,90)	35.61
rating	(2.8,4.8)	4.19
platforms	(1,7)	2.54
multi	(0,1)	.74
perL	(15.233, 99.379)	91.15

The variable curP was logged in order to speak of game *i*'s price in terms of percents instead of dollars. The multiplayer variable was originally a "yes" or "no," it was converted into a dummy variable where if multi=1, then the game does have a multiplayer feature and if multi=0, then the game does not have a multiplayer feature.

Results

After running a regression of my main model, the results are as follows:

$$\log(\text{curP}_i) = 1.25 - 0.01\ \text{months}_i + 0.31\ \text{rating}_i + 0.01\ \text{perL}_i - 0.04\ \text{platforms}_i + 0.14\ \text{multi}_i$$

	(0.003)	(0.154)	(0.005)	(0.072)	(0.208)
t =	−3.13	+2.07	+2.29	−0. 56	−0.72

$\underline{R}^2 = 0.39$ N= 31 $\hat{p} = 0.002$

An additional month in the market for game *i* is predicted to cause a 1 percent decrease in the price of game *i*, holding rating, perL, platforms and multi constant. An additional positive rating on game *i* is predicted to cause a 31 percent increase on the price of game *i*, holding months, perL, platforms and multi constant. An additional like on YouTube for game *i*'s release trailer has a 1 percent increase on the price of game *i* holding months, rating, platform and multi constant.

Every additional platform that may be utilized to play game *i*, is predicted to cause a 4 percent decrease on the price of game *i*, holding months, rating, perL and multi constant. If game *i* has a multiplayer feature, the price of game *i* will increase by 14 percent holding months, ratings, platform and perL constant. After running a one-sided t-test with 5 percent level of significance where the t-critical was 2.015, the variables months, rating, and perL were statistically significant, the variables platforms, and multi were statistically insignificant. The model is able to explain 39% of the variability of the data surrounding it's mean.

Every variable's sign fit my prediction except the sign of platforms. However, given that the data set contained Nintendo Switch games, the negative correlation made sense, since the Nintendo Switch is a relatively new console and the games are most, if not all, Nintendo exclusive. By being Nintendo exclusive, they have total market power of the price of that particular game, as said by Jiang Bao-Jun and Wang Bin, if a company has a monopoly on a product, they should maximize the price. In terms of statistical significance, I would have predicted that the multiplayer feature was important in regards to the price of a game.

Omitted Variable Bias

An omitted variable in this model is the amount of money invested in game *i*'s creation. The true model is as follows:

$$\log(\text{curP}_i) = \beta_0 + \beta_1\text{months}_i + \beta_2\text{rating}_i + \beta_3\text{perL}_i + \beta_4\text{platforms}_i + \beta_5\text{multi}_i + \beta_6\,\text{MonSp}_i + u_i$$

Where MonSp_i is the amount of money company *i* spent on the creation of game *i,* measured in thousands of dollars. The amount of money a company invests in a game is important and should have been included in this model because the more money a company spends on a game, the more likely it is that game *i* will be of better quality, since they will have more funds for more programmers, graphic designers, more beta testers etc. Thus the sign on this variable is (+). The variable would be interpreted as: an additional thousand dollars spent on game *i* is predicted to cause a β_6 percent increase on the price of game *i*, holding months, rating, perL, platforms and multi constant. Therefore by excluding this variable, we are not seeing the true model that can efficiently answer our question. The bias excluding this variable in the model can be seen using the following equation:

$$E(\hat{\beta}_2) = \hat{\beta}_2 + \hat{\beta}_6\hat{\alpha}_2$$

where $\hat{\beta}_2$ is the biased presented in the ratings variable in the main model, consequence of omitting $\hat{\beta}_6$. The exclusion of this variable is going to inflate the variable rating, making rating higher than it should be.

$$(+) \quad (+) = (+)$$

$$\hat{\beta}_2 + \hat{\beta}_6\hat{\alpha}_2 = \mathrm{E}(\hat{\beta}_2)$$

The true causal effect of excluding the variable is positive because we are given an overestimate of our model, thus the OLS assumptions 1 and 3 are violated because our model is not correct and the explanatory variables *are* correlated with the error terms since a positive correlation exists between MonSp and rating, more money, better quality thus higher rating.

Irrelevant Variables

The variable that appears to be irrelevant in the model is platforms; this variable was the least statistically significant. A regression excluding platforms is as follows:

$$\log(\mathrm{curP}_i) = 1.06 - 0.01\ \mathrm{months}_i + 0.33\ \mathrm{rating}_i + 0.01\ \mathrm{perL}_i + 0.17\ \mathrm{multi}_i$$

$$(0.003) \qquad (0.148) \qquad (0.005) \qquad (0.202)$$

$$t = \quad -3.30 \qquad +2.27 \qquad +2.34 \qquad +0.85$$

$$\underline{R}^2 = 0.41 \qquad N = 31 \qquad \hat{p} = 0.001$$

When removing the variable platform, β_0 goes down 0.19, months doesn't change, ratings increase by 0.2, perL doesn't change and multi increases by 0.3. The standard error of months does not change, the standard error of rating goes down by 0.006, the standard error of perL does not change and the standard error of multi goes down by 0.004. The absolute value of the t-stat of months increase by 0.17, the absolute value of the t-stat of rating increase by 0.2, the absolute value of the t-stat of perL increase by 0.05 and the absolute value of the t-stat of multi increases by 0.13. While the t-stat for multi increased, after running a one-sided t-test with 5%

significance and 4 degrees of freedom, the t-critical being 2.132, the variable is still statistically insignificant. The adjusted-R^2 improves by 0.02.

Overall, I prefer the model which excludes the variable platforms since not only did the adjusted-R^2 improve, but the statistical significance of the variables improves and the standard errors either experienced no change or became smaller.

Functional Form

We know that the price of a video game is relatively elastic and continuously changes in terms of demand (price discrimination, as discussed by Nair in his research on price discrimination in the gaming market). Therefore the alternative functional form is a double-log. The variable logged was months since it had the most statistical significance. The results are as follows:

$$\log(\text{curP}_i) = 3.36 - 0.94\text{logmonths}_i + 0.01\text{months}_i + 0.39\ \text{rating}_i + 0.01\ \text{perL}_i - 0.06\ \text{platforms}_i + 0.18\ \text{multi}_i$$

	(0.314)	(0.009)	(0.136)	(0.004)	(0.63)	(0.181)
t =	−3.00	+1.69	+2.88	+1.89	− 0.95	−1.03

$\underline{R}^2 = 0.54$ N= 31 $\hat{p} = 0.002$

The variable logmonths is interpreted as: if game *i* is out in the market an additional month, the additional month will cause a 94% change in the price of game *i*, holding months, rating, perL, platforms and multi constant.

After including additional logged variables, β_0 increases by 2.11, months stays the same, rating increases by 0.08, perL stays the same, platforms increase by 0.02 and multi increases by 0.04. The standard error for months increases by 0.006, ratings decreases by 0.018, perL decreases by 0.001, multi decreases by 0.27. The new one-sided t-critical at a 5% level of significance with 6 degrees of freedom is 1.943. The variable logmonths is statistically

significant. The absolute value of the t-stat for months decreases by 1.44 rendering the variable months insignificant, the t-stat for rating increases by 0.81, the absolute value for the t-stat for perL decreases by 0.4, rendering it insignificant, the absolute value of the t-stat for platforms increases by .39 and the absolute value for the t-stat of multi increased by 0.31. Adjusted R^2 increases by 0.15.

I prefer this model due to the large increase of adjusted R^2 , and the theory behind the inclusion of a double-log.

Multicollinearity

To check for multicollinearity, the VIF, variance inflation factor, test was applied to the main model. Multicollinearity occurs when an independent variable is a perfect linear function of another, given the independent variables in this model and applying theory, none of the variables seem to have multicollinearity. However, to verify, the VIF test was applied. The results are as follows:

Variable	VIF	1/VIF
rating	1.32	0.759
perl	1.20	0.833
months	1.11	0.898
multi	1.09	0.913
platforms	1.09	0.913
Mean VIF	1.16	

The VIF value tells you the correlation between one variable with another. If the VIF has a value of 1 it means that the variables are not correlated. The higher the VIF score, the higher the multicollinearity. If the VIF score is above 5, we consider the model to have

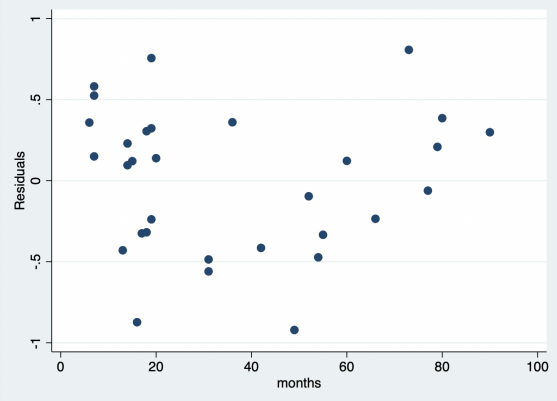
multicollinearity. None of the VIF scores were above 5 therefore there is no multicollinearity in this model.

Serial Correlation

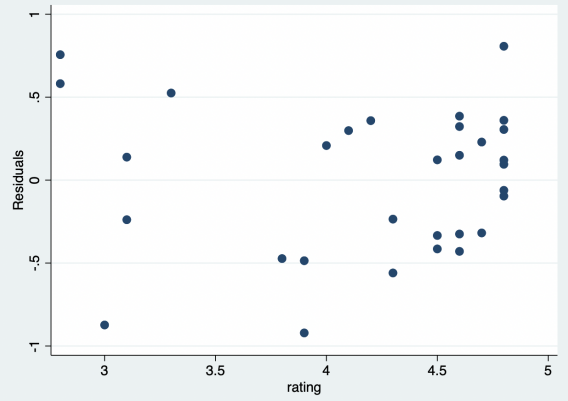
No serial data, thus no serial correlation.

Heteroskedasticity

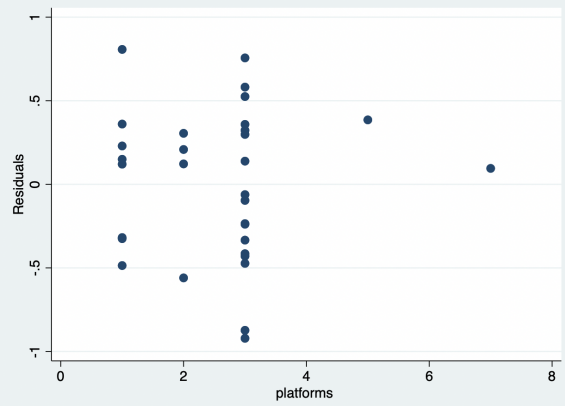
In order to test my main model for heteroskedasticity, which is when the standard errors are not constant across the model, the residuals were calculated and scatter plots were generated to note for any abnormalities:



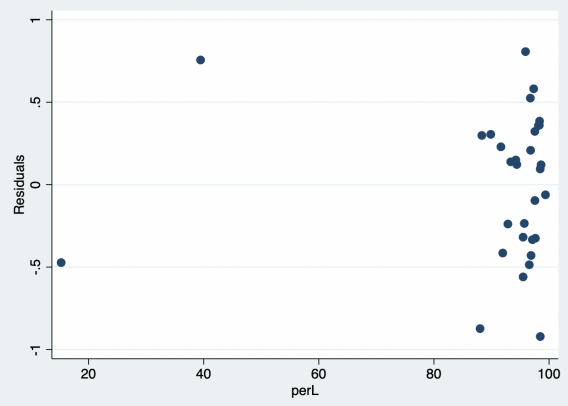
(a) Scatter Residuals months



(b) Scatter Residuals rating



(c) Scatter Residuals platforms



(d) Scatter Residuals perL

At first glance, the scatter plots for all the independent variables seem inconsistent and lacking a pattern, which makes me believe that there could be Heteroskedasticity. However, to confirm whether or not this model contains heteroskedasticity, the Breusch-pagan/ Cook-Weisberg test was applied to the main model.

The Breusch-pagan/Cook-Weisberg test tests the null hypothesis which is: the model has constant variance in the error terms. The alternative hypothesis is the model has inconstant variance in the error terms. The variables tested were: months, rating, perL, platforms and multi. The Breusch-pagan/Cook-Weisberg test results are as follows: the chi2(5) came out to be 6.09. The chi-critical with 5 degrees of freedom, testing for 5% significance is 11.07. Since the chi-critical > the chi2(5), I fail to reject the null hypothesis, therefore there is no heteroskedasticity, only homoskedasticity- meaning that the error terms *do* have constant variance. In terms of the graph, the inconsistency presented can be explained by the small sample size, if more data was collected the graphs could show more consistency and patterns, since the Breusch-pagan/ Cook-Weisberg showed no heteroskedasticity, this model does not violate the 5th OLS.

Conclusion

Many factors should be considered when designing a game. Those factors should increase the likelihood of a game's success and determine the correct price as time passes. While the main model served as a start to understanding the complexity behind game pricing, parts of the model can be improved. The functional form can be improved by changing the model from single log, to a double-log as to better explain price elasticities, as shown in the section Function Form where the inclusion of an additional logged variable improved the adjusted-R^2. The variable platform can be removed from the model because it was proven to be an irrelevant

variable, and data for the amount of money spent on the creation of game *i* should be collected in order to fix the omitted variable bias.

Nair (2007) and Liu (2010) discuss price disrimination in a market, which is pertinent to this topic since video game prices do fluctuate and as time passes the price does go down, at different rates. In my research I attempted to discover how different factors such as availability, features and ratings affected the price of a video game. Nair (2007) and Liu (2010) concluded that companies have to be careful when they are cutting prices since consumers are aware of price cuts present in the gaming market. In my research I attempted to determine the price of a game given time on the market with certain criteria.

Researchers Bao-Jun Jiang and Bin Wang (2008) discuss the effect of ratings on a product's price, concluding that higher review means better quality product and higher price. In terms of video games, a higher review means that the game is of better quality since more players enjoyed the game, therefore the game will maintain a higher price since demand for the product is kept high due to new consumers of the game influenced by the positive feedback. Their research also explains the sign of platforms. Originally I thought availability on different platforms would allow for more consumers to experience the game thus causing the opportunity for positive feedback and higher demand to keep a price high, however this research proved that if a product is part of a monopoly the price should be kept high since they have total market power. Meaning that if a game is exclusive to a console (the company has a monopoly in terms of that game and availability) they should charge at the profit maximizing quantity, Nintendo with their switch games.

Bond and Beale (2009) research on factors to be considered during game design helped my research in terms of determining independent variables such as multiplayer. Their inclusion

of a variety factor gave me the idea to include the variable multiplayer since it is allowed for variety within a game- once the storyline is finished the user can continue to play the game online. Similarly, with Sailer's (2017) on their research on their design elements needed for psychological satisfaction, their inclusion of teammates also supports my variable multiplayer in the model since it gives players a sense of social relatedness with the ability to play with others that also enjoy the game.

In terms of issue with the model, more data needed to be collected for the data set and the data should have focused on a genre, specific console, or a content rating. This is an issue because you cannot truly hold the games constant when comparing them. For future research, I would like to make sure the data set is larger and is consistent with genre/content rating. The subjective features that Bond and Beale (2009) discussed can be quantified using a survey, for example asking multiple individuals within the age group of the content rating of the game to rate the gameplay quality and averaging it. This was a successful start but more research must be done in order to establish stronger conclusions about the topic.

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Data Appendix

GameStop: The current prices, multiplayer, platform, genre and ratings were collected from GameStop by individually searching each game. They were collected April 1st 2020.

"Consoles, Collectibles, Video Games and VR: GameStop." *Consoles, Collectibles, Video Games & VR*, www.gamestop.com/.

Youtube: The perL variable was collected from youtube, finding the official release trailer of each individual game, posted by the verified channel of the franchise/company, and calculating the percent of dislikes the trailer had by adding the total likes and dislikes and dividing the dislikes by that number. Each game was individually searched.

YouTube, YouTube, www.youtube.com/.