VIDEO GAMES IN THE UNITED STATES:

AN ECONOMETRIC ANALYSIS OF A HOUSEHOLD-LEVEL DEMAND SYSTEM

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Abstract

The majority of economic literature on video games industry focuses on the details of the manufacturer side of this market. This study is an attempt to deviate from the popular trend and investigate the consumer side of the market. Making use of the data collected via Consumer Expenditure Survey (CES) provided by the Bureau of Labor Statistics (BLS), this article investigates the household demand model for video games in the United States. Result of this estimation state that video games are a necessary normal good in the U.S. Market since households' expenditure per capita and income level have significant effects on the demand of video games and households' demographic composition have no significant effects on the goods demand. These results are estimated using cross-sectional data for the year of 2016 and Ordinary Least Square (OLS) procedure due to time constrains.

KEYWORDS: Video Games, United States, Household, Consumer Demand Model, OLS

JEL CODES: D12

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED

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Aabhusan Khadka

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1. Introduction

It is well known that the video-game industry has its origin in the United States. (Kent, 2001; Kline et al., 2003; Sheff, 1993). The first ever-video game *Space War* was developed at Massachusetts Institute of Technology (MIT) in the early 1960s. This early lab based video game industry evolved to making arcade games and later linked itself to the booming personal computer industry in the U.S. (Izushi, 2006). Since then the video game industry that was considered a cottage-scale industry in the U.S. has grown to be a goliath that rivals the Film industry for household entertainment expenditures (Babb & Terry, 2013).

The U.S. Media and Entertainment (M&E) industry, which is the largest M&E market world wide, represents a third of the global industry. The M&E industry includes mainly of four sub-industries i.e. filmed entertainment, music, book publishing and video games. The gaming industry makes up a significant proportion of the M&E industry, as it earned $23 billion dollars in revenue in 2017.[1] Since the U.S is the world's biggest video games market and manufacturer: worth more than $20 billion dollars annually in software and hardware sales, making the current day industry more than four times its market size compared to the 1990s (Chatfeild, 2010).

A remarkable milestone for the video game industry transpired in 2008 when Grand Theft Auto IV (GTA-IV) took the title of the most successful entertainment release in the history. Within 24 hours GTA-IV grossed $310 million, which was considerably more than the most successful books (Harry Potter & The Deadly Hallows, at $220 million in 24 hours) and movie (Spider-Man 3, at $117 million in 24 hours) (Babb & Terry, 2013).

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[1]1. This figure is obtained from the website selectusa.gov, a government program led by the U.S. Department of Commerce.

Other games such as ‘Call of Duty’ series by Activision has produced a series of annual records for revenues over the course of a 3-year period. For example, in 2009, ‘Call of Duty: Modern Warfare 2’ sold 4.7 million copies in 24 hours in the UK and USA, earning $310 million in revenue. In November 2010, ‘Call of Duty: Black Ops’ sold 5.6 million units in its first day and generated $650 million revenue in its first 5 days. The title went on to earn $1billion in its first month of release. (Cox, 2013)

A distinguishing aspect of the output of the video games industry, for instance with GTA-IV, is that a game is a durable product, retailing at roughly $60 per copy, which generally entertains players for up to 100 hours of open-ended and user-directed experience in a highly-detailed virtual world (Chatfield, 2009). In the contemporary video games industry, the production value to develop a game easily rivals that of many television and film programs, with characters and storyline treatments worthy of the large budget. If GTA-IV presented a historical feat for the gaming industry, it did so by offering a somewhat superior entertainment experience whose level of sophistication and production values was increasingly becoming the rule for video game entertainment. (Babb & Terry, 2013)

Compared to other M&E sub-industries the video game industry is experiencing rapid technological progress in its game consoles (hardware) and complementary to this progression, there is an ever growing release of new content i.e. new game titles (software). The advancement in technology has also reduced the price of video games hardware significantly allowing more people to indulge in this form of entertainment by removing the price barrier. This has triggered consumers to play more video games and spend less time consuming other forms of M&E such as reading books and listening to music. Hence, increasing the mean expenditure on video games (Hong, 2007). The industry is constantly innovating and bringing new applications to the market. Virtual Reality (VR)[2] games, which are include in home, mobile and portable sets, are expected to increase sales up to 80% between 2017 and 2018. (selectusa.gov)

Furthermore, with the skyrocketing growth of the gaming industry there has been an emergence of electronic sports also known as "e-sports", where professional gamers compete before a live audience for prize money and celebrity status like any other sporting event. The e-sports industry is growing at a 22.6% rate, signaling tremendous opportunity. In 2017, e-sports ticket sales in the U.S. grew at a rate of 19.7% (selectusa.gov). The popularity of e-sports in the U.S. is so incredible that the U.S. professional gamers are just below China in the list of highest prize money earnings, in the e-sports realm. (www.esportsearnings.com)

In today's day and age video games are not just a fad for the young but increasingly an activity that incorporates nearly everyone: 68% of American households now play video games and many of these are online players; additionally, 43% of the online U.S. game players are female, breaking the stereotype that men mostly indulge in video games (Aldrich, 2009; Reeves & Read, 2009). While there is many market mechanics governing home video game sales, it is important to stress that the demographics in many developed

[2] 2.VR is the use of digital technology to replace reality with a complete and realistic, immersive

(and some developing) economies suggest that video games are now fairly entrenched as a part of daily life (Johns, 2006; Williams, 2002).

Since the video game industry has emerged and grown rapidly in the past few decades and has evolved interesting features in the process, it has attracted a number of studies, especially in the area of empirical economics. However, these empirical studies have focused mostly on firm/manufacturer side by looking into topics such as the aggregate software sales for each game title and game console, installed bases of each console and prices of consoles, indirect networking effects, platform based model, reasons why a game is a blockbuster, dynamic pricing of video games etc. (Cox, 2013; Babb & Terry, 2013; Zhou, 2012; Gretz, 2009; Clements & Ohashi, 2005). While these were detailed analyses, the household side of the U.S. video game market has been neglected, in spite of the apparent existence of households as the main consumers of video games in the market.

In this paper, we attempt to model the household demand for video games in United States using the household data collected from the Consumer Expenditure Survey (CES)[3] provided by the United States Department of Labor. The model for video game demand used in this paper is a version of Deaton and Paxson's (1998) Engle Curve model and Harada's (2007) version of the Engle Curve model. This model investigates if and how households' expenditure per capita, households' size and households' age composition as a demographic factor affects the demand

simulation.

3. Consumer Expenditure Survey (CES) is a national survey conducted quarterly over decades from around 30-40 thousand U.S. households which shows how the households allocate their budget on different consumption good and services.

of video games[4].

Result of my investigation suggests that video games in the U.S. are necessary normal goods since households' expenditure per capita and income level have significant effects on the demand of video games. Different household demographic factors have no significant effects on its demand. Specifically, there exist a negative relationship between households' expenditure per capita and a positive relationship between households' income level with the household's share of expenditure on video games. An increase in the households' expenditure per capita by 1% will decrease the households' share of expenditure on video games by 0.3795% and an increase of 1% in the households' income increases the households' share of expenditure on video games by 0.0062% and vise-versa.

The remainder of the paper is organized as follows. Section 2 introduces the theoretical and empirical background, Section 3 elaborates on the data used and the empirical method used in this paper, Section 4 presents the econometric results along with a discussion of its relevance and section 5 concludes.

2. Background

2.1. Empirical Background

There is an extensive literature that models the household demand for various goods consumed by the household. The literature on household demand has explored the demand for individual goods as wells as bundle of goods categorized together based on

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4. "video games" collectively refers to video games software, hardware and accessories.

the similarity of their product and life cycle characteristics.

An example study for a bundle of similar goods is the investigation of life-cycle patterns of demand for household durables conducted by Browning, Crossley and Luhrmann (2016) that use the data provided by the British Household Panel Survey (BHPS), which has data for household in Great Britain since 1991. In this study, the authors model the household demand of durable and non-durable goods with careful accounts of prices, demographics, labor supply and health using the framework of neoclassical model of durable demand provided by Deaton and Muellubauer (1980) and its extension provided by Deaton and Paxson (1998). According to Browning, Crossley and Luhrmann (2016) these above mentioned models assumes that the time-effects are mean zero and orthogonal to (linear) time trend. If this is true and time effects in the data contain a linear trend the procedures will force the linear trend into both the estimated age and cohort demographic effects in the study, resulting in a biased estimation. Hence, the demand model suggested by Deaton and Muellubauer (1980) and its extension by Deaton and Paxson (1998) must be altered from placing statistical restrictions on modeling one or more of these effects of time with observable variables and that is what Browning, Crossley and Luhrmann (2016) have done.

However, majority of the literature on household demand models the demand for individual goods such as meat and beverages, ornamental plants, telephones, cell phones etc. Hovhannisyan and Khachatryan (2016) conducted an empirical analysis of demand for group of ornamental plants where they see the quantified effects of socio-economics and demographic factors on demand for plants. Their study collected primary data via online survey where they used hypothetical open-ended choice experiment (OECE) for data collection. The authors used the base framework of traditional theory based demand. However, when dealing with consumer level data there arises the problem of demand censoring which means that a proportion of consumers indicate they would not purchase the given product by having zero in price indication scenarios. Thus, traditional theory based demand estimation methods results in biased and inconsistent estimates for the economic effects. Thus, the authors alternatively uses a much more robust theory of demand that is Almost Ideal Demand System (AIDS) model purposed by Deaton and Muellbauer (1980) to model the demand for ornamental plants in this study.

Another strand of literature investigated the effects of multiple information indices linking different health concerns with diet change (particularly, change in meat consumption) in household dynamics (Tonsor, Mintert and Schroeder, 2010). In order to conduct this investigation they used the data provided by the U.S. Department of Agriculture's Economic Research Services. The authors made use of the absolute-price version of Rotterdam model. This model is widely used in meat demand analysis as it is of particular interest because it easily accommodates multiple covariates that can be estimated to satisfy the combined effect of homogeneity and symmetry restrictions that are suggested by the demand theory. It also outperforms the AIDS model when it comes to out-of-sample forecasting accuracy.

Ogundari (2013) does another body of research on consumer demand analysis where she investigates the demand characteristics of beverage consumption with focus on the role of income in Nigeria using the data from 2003/2004 Nigeria Living Standards

Survey (NLSS). The standard framework for this investigation is the Tobit model purposed in Tobin (1958). However, the Tobit model assumes that the decision to purchase beverages and how much to spend on beverages (actual expenditure on beverages) are governed by the same process. Cragg (1971) has reasoned the assumption of these decisions being made jointly to be wrong and instead has purposed the Double Hurdle Model (DHM). The DHM divides the two decisions into different steps where the first step considers the individual's decision to consume beverages where as the second step explains the expenditure on beverages. Hence, due to this reason Ogundari (2013) uses the DHM in her study. So far we have explored different studies that model consumer demand for various individual goods. These goods (i.e. ornamental plants, meat and beverages) that have been modeled in the above examples are goods that have different commodity characteristics in comparison to video games. We will now explore the part of literature that analyzes the consumer demand for electronic goods such as telephone and cell phones, which have similar commodity characteristics to video games, as they are both electronic good which have similar consumption life cycles.

Narayana (2010) estimates the socio-economic determinants of household demand for mobile phones and fixed phones for the state of Karnataka, India. He makes use of data collected by the Karnataka state government from their annual survey. The standard framework used in the analysis is the standard binary Logit model. However, Narayana (2010) specifies that the model needs to be altered to unconditional Logit model because there is no mention of the names of service providers in the survey. This implies a case for constant mobile prices without variations across subscribers and providers. This obstacle was tackled by consorting a single and variable access price and a usage price, which caused prices to enter the demand estimation model. With the inclusion of such prices there is an underlying assumption that mobile subscribers belong to one service provider and were charged the same price by the single provider. Throughout the model, they consider single and variable access price and usage price as the characteristics of subscriber rather than a choice because they are acquired characteristics of them being a resident of a rural or urban area with an exchange of a particular switching capacity. Hence, the estimates are unconditional Logit estimates rather than a standard binary Logit estimates.

Similar to the above study, we came across another research conducted by Thacker and Wilson (2015) which investigates the effects of cell phones on telephones demands where they used the data collected via Consumer Expenditure Survey (CES) from 1994 to 2012, which are provided by the U.S. Department of Labor. The paper uses a mixed Logit model as a function of consumer characteristics, unobserved alternative-specific attributes and price over time. Thacker and Wilson (2015) justify using this model as it enhances the independence of irrelevant alternative assumptions required by other Logit specifications and allows for heterogeneity in response to prices.

Having explored the strand of literature on consumer demand of goods that are both similar and dissimilar when it comes to commodity characteristics to video games, we came across two research papers that specifically model the consumer demand for home video games[5] for a specific country. The two studies are explored below.

The first study is by Sun (2010) which estimates the demand for video game consoles in the U.S. home video game market using the data from Consumer Expenditure Survey (CES) for 2005 to 2008 obtained from the Bureau of Labor Statistics provided by the U.S. Department of Labor. The standard framework used in this research paper is the discrete-choice model of demand which was established by Berry (1994) and its extension by Berry, Levisohn and Pakes (1995) because these models treat products as the set of characteristics which helps solves the problem of dimensionality of linear expenditure model. However, Sun (2010) observes that some product's characteristics are observed only by consumers and not by econometricians and they are summarized into errors terms, which are correlated with the product price giving rise to price endogenity. Hence, Sun (2010) uses Regression Discontinuity Demand (RDD) model as it relies on proper exogenous instrumental variables to deal with the endogenity of prices. This allows us to obtain the correct estimates for price coefficient where they find that the consumer demand for video game consoles is elastic with elasticity between -1.11 and -5.40.

Lastly, we came across the research conducted by Harada (2007) which analyses the household demand for video games in Japan, exploring the effects of household income and demographic factors such as household size and number of individuals in an age cohort in the household and prices of goods. This study is the closest fragment of literature on household demand that attempts at

[5] 5. In this article 'video games' refers to both software and hardware components of video games.

investigating the research question asked in our paper.

Harada (2007) collects his data for analysis from the System of National Accounts (SNA) provided by the Economic and Social Research Institute from the Cabinet Office of Japan as well as Family Income and Expenditure Survey (FIES) provided by Japan's Statistical Bureau of the Ministry of Internal Affairs and Communication. The standard framework of the model used in this research paper is based on the principle of Engle Curve from Deaton and Paxson (1998) where they use cross-sectional data and choose to exclude the time dimension in the model. Harada (2007) extends their model by making three adjustments. First, time component is added to the model. Second, he incorporates price effects that households face. Lastly, yearly fixed effects are added to the model to control other various fluctuations in each year as suggested by Asano (1997). These changes make the model more robust. As Harada (2007) observes these modifications make the model almost similar to Almost Ideal Demand System (AIDS), particularly linear-approximation AIDS (LA/AIDS). This allows him to obtain relatively unbiased estimates for the household demand analysis of video games for a specific country.

In the case for Japan, Harada (2007) found that the logarithm of the real total expenditure per capita shows a significantly positive effect on the share of video games from the total income of the household. He finds that an increase (decrease) of 10% on real expenditure per capita yields approximately 0.00018 increase (decrease) of the expenditure share of video games from the total household income. This shows that the expenditure elasticity of video games is more than one, which means that video games are luxury goods. In terms of demographic factors, the size of household did not have statistically significant impact on the share of video games expenditure from the total household income. However, household's demographic composition particularly the age cohort labeled as 'young' (number of household members under 18 years of age) showed significant positive effects, meaning household with more young people tend to spend more on video games.

Upon reviewing the literature on household demand for various consumer goods, we have identified that a gap exists when it come to analyzing the household demand for video games in the United States. Since, video games is the fastest growing sub-industry of the M&E industry in the United States, where 68% of American households now indulge in video games (Aldrich, 2009; Reeves & Read, 2009), this short coming in the literature provides an opportunity for us to make a contribution by conducting the analysis intended in this research paper.

2.2 Theoretical Background

We employ the theoretical framework developed by Deaton and Paxson (1998), which was further extended by Harada (2007). Deaton and Paxson's (1998) Engle curve model examined the nature of a households' food demand for several countries by estimating a demand model where the share of households' food expenditure was mainly explained by the logarithm of the total household expenditure per capita, the logarithm of household size which showed the households' scale effect and households' demographic composition by age. The parametric equation for Deaton and Paxson's (1998) model is shown below in equation 2.2.1.

$$w_f = \alpha + \beta \ln\left(\frac{x}{n}\right) + \gamma \ln(n) + \sum_{k=1}^{K-1} \eta_k \frac{n_k}{n} + u \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.2.1)$$

Where x is the total expenditure per household, w_f is the share of food's expenditure of x , n is the number of people per household, n_k is the number of household members in the specific segment of age demographic where the value of k represents the particular age segment and K represents the number of segments that the age demographic factor is divided into and u is the error term.

Harada used equation 2.2.1 obtained from Deaton and Paxson (1998) and substituted w_f (share of food's expenditure of x) with w_{game} (share of video game's expenditure of x) to model the household demand for video games, which give us

$$w_{game} = \alpha + \beta \ln\left(\frac{x}{n}\right) + \theta \ln(n) + \sum_{k=1}^{K-1} \eta_k \frac{n_k}{n} + u$$

…………………(2.2.2)

As mentioned in the empirical background section, Harada's version of the household demand model for the expenditure share of video games shown in 2.2.2 is derived from Deaton and Paxson's household demand model for expenditure share of food show in equation 2.2.1. However, Harada (2007) adds to his model making further modifications. He made three adjustments to equation 2.2.2. The first adjustment is the addition of time component, which is done by the including different time periods for which the analysis is done. Second adjustment is the incorporation of price effects that household faces. These price effects were added by considering two types of specifications whose differences are whether individual price effects are described as the logarithm of level of prices or the logarithm of its relative prices to the video games. Lastly the third adjustment is the incorporation of yearly fixed effects to control other various fluctuations in each year. The new household demand model for the share of video game expenditure (w_{game}) with these modifications, then become

$$w_{game,it} = \alpha + \beta \ln\left(\frac{x_{it}/p_{it}}{n_{it}}\right) + \theta \ln(n_{it}) + \sum_{k=1}^{K-1} \eta_k (\frac{n_{k,it}}{n_{it}}) + \delta_0 \ln\left(P_{game,it}\right) + \delta_1 \sum_{j=1}^{J} \ln\left(p_{j,it}\right) + \lambda_t + v_{it}$$

……………………………………(2.2.3)

Or,

$$w_{game,it} = \alpha + \beta \ln\left(\frac{x_{it}/p_{it}}{n_{it}}\right) + \theta \ln(n_{it}) + \sum_{k=1}^{K-1} \eta_k (\frac{n_{k,it}}{n_{it}}) + \delta_j \sum_{j=1}^{J} \ln\left(\frac{p_{j,it}}{p_{game,it}}\right) + \lambda_t + v_{it}$$

………………..…………………(2.2.4)

where p is the general price to deflate x, p_{game} is the price of video games and the p_j the price of goods j other than video games. Subscripts i and t represent city and time period, respectively. The error term u is divided into two terms of yearly fixed effects λ_t and other disturbances v_{it}. Correspondingly, equation 2.2.3 represents the model for the first specification of price effect where individual price effects are described as the logarithm of level of prices and equation 2.2.4 represent the model for the second specification of price effects where individual price effects are described as the logarithm of its relative prices to the video games.

In our analysis, due to time constrains, I have not been able to replicate Harada's (2007) model completely. This paper uses a very similar model to Deaton and Paxson's (1998) model for analyzing the household demand for food show in equation 2.2.1, which was then modified by Harada to model the household demand for video games show in equation 2.2.2. Just like Deaton and Paxson we use cross-sectional data in this model looking at the yearly snapshot of the demand for video games in the United States. Our model differentiates from Deaton and Paxson's (1998) and Harada's (2007) early model as we have

included many other demographic characteristics apart from the age composition into the model in order to comprehend their effects on the share of expenditure allocated to video games from a total household budget. The additional demographic characteristics that I have included are total income of the household, gender of the household head, educational level of the household head, marital status of the household head, race of the household, urban or rural location of the household and the region, which the household belongs to in the U.S. The equation of the model that we use in this paper is shown below:

$$W_{game} = \beta_0 + \beta_1 \left(\frac{x}{n}\right) + \beta_2 I + \beta_3 n + \beta_4 a_{<18} + \beta_5 a_{64+} + \beta_6 a_{16\_64} + \beta_7 S_{HHH} + \beta_8 E_{HHH} + \beta_9 M_{HHH} + \beta_{10} R_{black} + \beta_{11} R_{white} + \beta_{12} R_{asian} + \beta_{13} U + \beta_{14} L_{NE} + \beta_{15} L_{MIDW} + \beta_{16} L_S + u \quad \text{……………………………(2.2.3)}$$

where x is the total expenditure made by the household, n is the size of the household, I is the income of the household, $a_{<18}$ represents the number of people below the age of 18 years, a_{64+} represents the number of people above the age of 64 years, a_{16_64} represents the number of people between the age of 18 and 64 year, S_{HHH} represents the gender of the Household head, E_{HHH} represents the gender of the Household head, M_{HHH} represents the gender of the Household head, R_{black}, R_{white} and R_{asian} are variables to represent the race of the household head if they are black, white or

Asian respectively, U represents if the household is in a urban or rural location and L_{NE}, L_{MIDW} and L_S are variables to represent the region where the household belongs which could be the North East, Mid West or South respectively and lastly u is the error term.

The coefficient β_0 in this equation is the constant where as coefficient β_1 shows the relationship between expenditure per capita of the household $\left(\frac{x}{n}\right)$ to the share of expenditure allocated to video games (W_{game}). Similarly, coefficient β_2 to β_{17} shows the relationship of share of expenditure allocated to video games (W_{game}) with the variables associated with the particular coefficient.

Here, if the coefficients β_2 to $\beta_{17} > 0$, then we can conclude that the variables associated with the coefficient have a positive effect on the share of expenditure allocated to video games (W_{game}) and if β_2 to $\beta_{17} < 0$ then the variables associated with the coefficient have a negative effect on the share of expenditure allocated to video games (W_{game}).

3. Data and Methodology

3.1. Data

This study is a cross-sectional study which models the household demand of video games in the U.S. for the year of 2016, where it uses the quarterly data from the Consumer Expenditure Survey (CES) provided by the Bureau of Labor Statistics (BLS) which is a governmental body under the United States

Department of Labor. The information on the share of expenditure on Video Games (W_{game}) is collected from the APB16 file of the CES. The APB16 file includes a collection of data for one of the surveys conducted by the BLS, which contains information on the households, which were interviewed to disclose their expenditure in dollar amount for various consumer good categories of their expenditure. There is 43 different classification of expenditures in this survey out of which three were pertinent to our study which were encoded 640, 650 and 700 that listed the expenditure on Computer hardware and Computer Software including Computer Games; Computer software including games (non-business use) and Video game hardware and accessories respectively. The summation of expenditure for these three codes is how we get our total share of expenditure on video games (W_{game}).

Rest of the data, which were pertinent to the Household and its demographic characteristic, were collected from the FMLI16 file of the CES. For the data on total expenditure of the household we used the information provided for each household on their expenditure in the particular quarter and for the data on income we used the household's income after tax in the past 12 months.

Demographic data such as the number of people in the household was provided directly and did not require any manipulation. However, to get the data on the demographic characteristics of the Household head we had to do some data manipulation. The gender of the household head was encoded with the numbers 1 and 2 where it represented male and female respectively. In order to use this information as a dummy variable, we manipulated the data set and assigned the value of 1 to male and 0 to female to use in the model. The education level of the household head was divided into 8 categories which were 00: never attended school; 10: belonging in grade 1 to 8; 11: belonging in 9-12 grade, 12: High school graduate, 13: having taken some college classes; 14: completed some vocational program; 15: completed undergraduate level and 16: completed graduate level. We then decided to generate a dummy variable for the level of education to compare for different household heads, which were college graduates and non-college graduates. In order to achieve this, the household head whose education level was greater or equal to 14, we coded them as college graduates and assigned a value of 1 and for the rest we coded them as non-college graduates with the assigned value of 0. Similarly, in the survey, the marital status was divided into five categories which were 1: Married, 2: Widowed, 3: Divorced, 4: Separated and 5: Never married. In the model, we decided to include the marital status of the household head also as a dummy variable. The household head whose marital status was equal to 1 we coded it as married and assigned the value of 1 and for the rest we coded as unmarried and assigned a value of 0.

Likewise, to include the race of household head into the model we created three different dummy variables. In the CES, race was coded into six different categories which were 1: white, 2: black, 3: Native American, 4: Asian, 5: Pacific Islander and 6: Multiracial. We wanted to see the influence of the three major races in the U.S., which we deemed to be White, Black and Asian, and created dummy variables for them where we coded 1 for household head being from that particular race and 0 if they were not associated with that race. Furthermore, to include the region of household in to the model we also created three different dummy variables. In the CES, household was coded into four different categories

which were 1: Northeast, 2: Midwest, 3: South and 4: West. Hence, three dummy variables were created for the Northeast region, Midwest region and South region where if household belonged to the region they were assigned the value 1 and if they were not, they were assigned the value 0.

In the model we decided to explore if the age composition of the household affects the W_{game}. We divided the age category into three groups, which were under 18 years, above 64 years and between 18 to 64 years. We did so by getting the data from FMIL16 file on household members below the age of 18 and household members above the age of 64, which gave us direct numbers for the first and the second age categories. For the age category between 18-64 years we summed the values of number of people in the under 18 category and above 64 category and subtracted that from the family size data for each household.

3.2. Methodology

Recent literature on modeling the household demand of video games makes use the standard framework of discrete-choice model of demand which was established by Berry (1994) but then it was amended to use the Regression discontinuity demand (RDD) model because Sun (2010) observed that some product's characteristics are observed only by consumers and not by econometricians and they are summarized into errors terms which is correlated with the product price giving rise to price endogenity.

In another research done for the same literature, Deaton and Paxson's (1998) Engle curve is used as a standard framework to model the demand of video games. However, Harada (2007) noticed that the Engle curve model lacked time dimension, had no accounting for yearly fixed effects since it used cross-sectional data and the price effects of other goods consumed by the household was not taken into account. Hence, Harada (2007) added these components to the Engle curve model making it more robust estimate for the household demand of video games.

Ideally, the use of Harada's (2007) modified model would be the best standard framework to build upon in order to estimate the household demand of video games in the U.S. with addition of other pertinent demographic factors of the household. However, due to lack of time, we have settled with using Ordinary Least Square (OLS) version of Deaton and Paxson's (1998) Engle curve model, shown below in equation 2.2.3, for our analysis.

The OLS procedure conducts the f-test, goodness of fit test and t-test. First, the result of f-test tells us if our model has explanatory power for the dependent variable, which in our case is the household's share of expenditure on video games. The null hypothesis for the f-test is that the r-squared value is equal to zero. In order reject the null hypothesis i.e. have a significant model the probability of the f-test should be less than 0.05 or 0.01, as they are the conventional trigger points, which corresponds to 95% or 99% confidence level that our model has explanatory power.

Second, the goodness of fit test helps us get the coefficient of determination (r-squared value). The value of r-square can be in between 0 and 1 where r-squared value closer to 1 means that the model is comparatively better than when the r-squared value is closer to zero.

Lastly, the results obtained from the t-test have very similar interpretation to the results obtained from the f-test. The f-test examines the significance of the entire model to explain the variation in dependent variable whereas the t-test examines the significance of each independent variable to explain the dependent variable. The null hypothesis of the t-test is that the coefficient of the dependent variable is 0, which means that the dependent variable we have chosen, has no effect on the independent variable. Similar to the f-test, in order reject the null hypothesis, the probability of t-test should be less than 0.05 or 0.01 which corresponds to 95% or 99% confidence that our particular independent variable has an affect on the dependent variable.

Then we analyze the coefficients for each dependent variable obtained from doing the OLS procedure. If the coefficient β_1> 0, then the good is a luxury good, whereas if β_1< 0, it is a necessity good. The total expenditure elasticity can be achieved by {1 +(β_1/ W_{game})} where it will vary with the (W_{game}). However, in the case of β_1 > 0, it is guaranteed that the expenditure elasticity is more than one for any value of (W_{game}) and that the good is not only a luxury good (i.e. non-inferior) but also has positive (in fact, more than one) expenditure elasticity, which means that the demand for the good positively relates to the household income, for all ranges of (W_{game}). However, if β_1 < 0 in which case it is difficult for us to guarantee the relationship between the demand for the good and its relationship with household income, we have the coefficient β_2. If β_2 > 0 than good is a normal good where as if β_2< 0 then the good is inferior good.

In the case of the coefficient β_3, if it is positive and significant than the null hypothesis is rejected and an increase the household size will increase the households' share of expenditure on video games. Likewise, β_4, β_5 and β_6 are coefficients for the number of household members in different age groups namely under 18 years, above 64 years and between 18 and 64 respectively. If β_4, β_5 and β_6 are positive and significant that we can conclude that having more household members in the each of the age

category associated with the parameter will increase the share of expenditure on video games, making us reject the null hypothesis.

Similarly, coefficients β_7, β_8 and $\beta_9$are associated with three dummy variables which describe the demographic characteristics of the household head namely gender, education level and marital status respectively. If β_7 is positive and significant, that we can argue that having males as the household head in a household will increase the share of expenditure on video games. Likewise, if β_8 is positive and significant, than we can say that having a household head with a college degree will increase the households' share of expenditure on video games. Lastly, if β_9 is positive and significant, we can claim that if the household head is married than the share of expenditure on video games will increase. We can make this generalization only if the coefficients β_7, β_8 and β_9 are significant and have positive values as they allow us to reject the null hypothesis of the OLS procedure.

Correspondingly, the coefficients β_{10}, β_{11} and β_{12} are parameters to analyze the affect of race of the household head on the share of expenditure of video games. These coefficients are associated with three dummy variables for the three major races (i.e. black, white and asian) as observed in the CES. From OLS results, if β_{10}, β_{11} and β_{12} are positive and significant than we can argue that if the household head belongs to the black race, white race or asian race respectively to the coefficients β_{10}, β_{11} and β_{12}, than the share of household expenditure on the video games will increase as we are able to reject the null hypothesis for each of the dummy variable.

The case for the coefficients β_{14}, β_{15} and β_{16} which are coefficients for three dummy variables that represent the region where the household belongs, is analogous with the case of race for the household head. If β_{14}, β_{15} and β_{16} are positive and significant than we can state that if the household is from the Northeast region, Midwest region and South region respective to the coefficient β_{14}, β_{15} and β_{16}, than there is an increase in the share of household expenditures on the video games.

Lastly, the coefficient β_{13} is the parameter for the dummy variable urban vs. rural location of the household. From OLS estimations if β_{13} is positive and significant that we can state that a household from urban area will have increased share of expenditure on videogames.

4. Results and Discussion

4.1. F-Test

Table 4.1.1: Results of the F-Test

Number of observation	F-statistic	P-value for F-Test
25441	5.71	0.0000**

Notes:
[1] ** Denotes that the null hypothesis of the f-test is rejected at a 1% level.

As we can see from table 4.1.1, the p-value of the f-test for our model is 0.0000. This p-value is significant at a 1% level in other words; we are 99% confident that we can reject the null hypothesis of this test. Hence, the model has some explanatory power.

4.2. Goodness of Fit Test

Table 4.2.1: Results of the Goodness of Fit Test

Coefficient of determination (r^2)
0.0030

The coefficient of determination (r-squared) obtained from the goodness of fit test is 0.0030. This can be interpreted as only 0.3% of the variation in our dependent variable, household's share of expenditure for video games, is explained by the independent variables used in our model.

This is a significantly bad coefficient of determination for our model. The very low value of 0.0030 tells us that the independent variables chosen in this model are not the right factors that affect the household's model. The insignificant independent variables in this model should be discarded. More research should be done on the literature of household demand for video games in order to include significant independent variables in our model so that our independent variables can explain more variation in our dependent variable.

4.3. T-Test

Table 4.3.1: Result of the T-Test

Variables	t-statistics	P-value
x/n	-7.98	0.000**
I	3.57	0.000**
n	-0.15	0.880
$a_{<18}$	-0.23	0.814
a_{64+}	omitted	
a_{16_64}	-1.62	0.105
S_{HHH}	0.17	0.869
E_{HHH}	-1.17	0.244
M_{HHH}	0.33	0.741
R_{black}	0.82	0.412
R_{asian}	0.57	0.596
R_{white}	0.79	0.428
U	-1.24	0.214
L_{NE}	-0.70	0.486
L_{MIDW}	-1.00	0.315
L_S	-1.43	0.152
constant	4.65	0.000**

Notes:
[1] ** Denotes that the null hypothesis of the t-test is rejected at a 1% level.

The T-test allows us to examine the significance of each independent variable to explain the dependent variable in a model. From the table 4.3.1 we can see that only two of the dependent variables expenditure per capita and income of the household have a p-value of <0.001. Only these two variables have significant explanatory power when it comes to describing the variation in our independent variable, household's share of expenditure on video games. The rest of the dependent variables in our model are highly insignificant which means that we cannot rely on these variables to explain the variation in the household's share of expenditure on video games.

This test confirms the result of goodness of fit test. The majority of the explanatory variable, which we have chosen in this model, have no significant affect on our dependent variable. Furthermore, the significant p-value of 0.000 on the error term from the t-test strengthens this analysis.

Thus, leading us to the same conclusion as section 4.2. where we need to improve the model by removing the current independent variables and replace them with explanatory variable that have a significant impact on households' share of expenditure on video games. We can also observe that the variable for number of household members in the age group 16 to 64 (a_{16_64}) years has been omitted in the OLS regression for our model. This is because there was a presence of high levels of multi-colinearity that exists between this variable and some other independent variables in our model. In the case, it

was difficult to suspect multi-colinearity in the model because the r-squared value was already very low to being with. STATA upon recognizing the presence of multi-colinearity removes one of the variables arbitrarily and in our case decided to omit the variable a_{16_64}. This is not a big issue in our case because the p-values obtained for majority of the independent variables are insignificant and if STATA had made the decision to remove the other multi-colinear variable arbitrarily instead of this a_{16_64} our results from the t-test would not change by much.

4.4. OLS Coefficient of Dependent Variable

Table 4.4.1: Coefficients obtained by running the OLS procedure

Parameter	Coefficients values	P-value
β_1	-0.003795	0.000**
β_2	0.0000621	0.000**
β_3	-0.4189861	0.880
β_4	-0.6699684	0.814

β_5	0	omitted
β_6	-3.430108	0.105
β_7	0.4437578	0.869
β_8	-3.301629	0.244
β_9	1.080548	0.741
β_{10}	8.109823	0.412
β_{12}	6.217935	0.596
β_{11}	7.24766	0.428
β_{13}	-6.732727	0.214
β_{14}	-2.816405	0.486
β_{15}	-3.96677	0.315
β_{16}	-4.926781	0.152
constant	52.18555	0.000**

Notes:

[1] ** Denotes that the null hypothesis of the t-test is rejected at a 1% level.

We observe that that β_1 and β_2 are the only coefficients that are statistically significant in this model with a confidence level of 99%. The value of β_1 is -0.003795, which implies that an increase in the household's expenditure per capita by 1% will decrease the household's share of expenditure on video games by 0.3795% and vice-versa. This negative value of β_1 tells us that video games are a necessity good. This result is empirically in disagreement with Harada's (2007) finding in his research paper for the household demand for video games in Japan, where his coefficient is positive meaning that video games are luxury good. However, the negative value of β_1 could make sense in the case of household demand for video games in U.S. as we have identified in the introduction section of this paper, that video games is the fastest growing sub-industry among other Media and Entertainment sub-industries where 68% of the American household play video games. This could mean that video games have become a staple mode of entertainment in an American household where it is seen as an essential means of entertainment. However, the negative value of β_1 does not allow us to guarantee that the expenditure elasticity for video games is going to be more than one which means that we cannot conclude that the demand for video games is positively related to the household income (in fact it is unambiguous and depends on the relative value of W_{game}).

Building on that, the other statistically significant coefficient in this model β_2 has a value of 0.000062, which means that with a 1% increase in the households' income the households' share of expenditure on video games will increase by 0.0062%. This allows us to conclude that video games are normal good for the U.S. households, which is in
empirical agreement with Harada (2007) where video games are also normal goods for the Japanese households.

All the other coefficients which are related to the demographic characteristics of the household and the household head i.e. β_3 all the way up to β_{16} are all statically very insignificant when it come to estimating the demand model for video games in the U.S. The high coefficient value of the constant term further reiterates the findings of section 4.2. and 4.3. Such a high value of coefficient for the constant is only possible when the error term in the model hold tremendous significance since the model does not include good explanatory variables, which is the cause in our estimation.

5. Conclusions and Further Research

5.1. Conclusion

This research paper makes use of Deaton and Paxson's (1998) Engle curve estimation in conjunction with Harada's (2007) version of the Engle curve model to estimate the household demand of video games in U.S. Cross-sectional data collected from the Consumer Expenditure Survey (CES) provided by the Bureau of Labor Statistics (BLS) was collected for the year 2016.

Our results indicate that the household's expenditure per capita and income have a significant impact on the household demand for video games in the U.S. We find that video games in the U.S. household are necessary and normal goods. However, demographic factors of the household such as size of the household; age composition of the family members; urban or rural location; region where the household is located; household head's race, education level, marital status and gender have no significant affect on the household demand of video games.

5.2. Further research

As mentioned earlier, video games is a sub-industry, part of the goliath Media and Entertainment industry in the U.S., is breaking new records more often that expected and growing at a lightning speed. In order to completely understand this rapidly changing industry we cannot avoid the consumer side of this market such as the households who are their biggest consumers. Contrary to the results of this paper, which did not include proper demographic explanatory variables and time dimension in the model is why I am still not convinced that demographic factors of the household does not affect the household demand of video games in the U.S. Future researchers who are interested in this field should extend this literature by doing analysis with better demographic explanatory variables and include the time dimension, price effects of other consumers good that a household faces and yearly fixed effects to control other various fluctuations in each year as Harada (2007) does in his investigation.

Furthermore, video games are not just a growing indulgence in the U.S. but a worldwide phenomenon. With the growing consumption of video games due to its rapidly advancing technology, accessibility, value to both consumers and manufacturers of the indirect network effect in the online gaming realm and most importantly the birth of e-sports as a major competitive attraction: a dynamic study of how the households' change their video game consumption pattern would be a valuable study of for this industry.

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