OULUN YLIOPISTO
UNIVERSITY of OULU

OULU BUSINESS SCHOOL

Samuli Koskela

PRICING ECONOMICS OF VIDEO GAMES:
A PANEL DATA STUDY ON THE EFFECTS OF VERSIONING ON REVENUE

Master's Thesis

Department of Economics

December 2021

UNIVERSITY OF OULU
Oulu Business School

ABSTRACT OF THE MASTER'S THESIS

Unit			
Department of Economics			
Author: Koskela, Samuli		Supervisor: Kopsakangas-Savolainen, M. Prof.	
Title: Pricing economics of video games: a panel data study on the effects of versioning on revenue			
Subject: Economics	Type of the degree: Master’s thesis	Time of publication: December 2021	Number of pages: 69 + 3

Abstract

The video game industry has seen major changes in the 21st century. The industry has experienced exponential growth as digital markets have enabled the usage of new business and pricing models which differ from the traditional retail trade of boxed goods. Meanwhile, the technological development and demand for more complex games has caused the production costs of video games to rise. This thesis analyses the video game industry and the price determination of its products, video games. Under the scope are both the traditional pricing economics of video games, as well as the recently emerged new pricing and business models, which according to the economic pricing theory fall under versioning type price discrimination.

The research methods of this thesis include a literature review on the pricing economics of the video game industry, as well as an empirical panel data study on revenue gathering within the firms of the industry. The focus of the econometric research is to build a simple model to capture the main factors of revenue making among 7 big publishers of the industry between the years 2000 and 2020. Included factors are the quantitative data on published products, their qualities, and the pricing models used.

The results of the study add to the existing literature by providing quantitative results on the usage of different versioning type pricing models. The findings show that using microtransactions and expansive type downloadable content accounts for a significant share of the industry growth, while using the free-to-play model combined with these types of versioning tools also generates significantly more revenue compared to the traditional retail model. The amounts of mobile and multiplatform games released also had explanatory power over the revenues, while console games, qualities of games, and the usage of the subscription model did not play a significant part in explaining revenue gathering within the firms of the study.

Keywords
Video game industry, pricing economics, fixed effects panel data, price discrimination

Additional information

CONTENTS

1 INTRODUCTION 7

2 THE VIDEO GAME INDUSTRY 9

2.1 Industry structure 9

2.2 The Industry Spiral 10

2.3 A brief history of the video game industry 12

3 ECONOMICS OF THE TRADITIONAL VIDEO GAME INDUSTRY 16

3.1 Razors and blades model 16

3.2 Traditional pricing of video games 17

3.3 Intertemporal price discrimination 18

4 PRICING THEORY 21

4.1 Price discrimination 21

4.1.1 First-, second-, and third-degree price discrimination 21

4.1.2 Two-part pricing 22

4.2 Price discrimination of information goods 23

4.2.1 Information goods 23

4.2.2 Versioning of information goods 24

5 ECONOMICS OF THE CHANGED VIDEO GAME INDUSTRY 26

5.1 Versioning in video games 26

5.1.1 Subscription model 27

5.1.2 Expansion packs 27

5.1.3 Microtransactions 27

5.1.4 Freemium 30

5.1.5 Games as a service 30

5.2 Meagher and Teo's Model 31

6 PANEL DATA STUDY ON FACTORS OF VIDEO GAME REVENUE 36

6.1 Research methodology 36

6.2 Data 37

6.2.1 Variables 37

6.2.2 Variable selection 38

6.2.3 Data sources 42

6.2.4 Notes and limitations to data 43

6.3 Hypotheses 46

6.4 Descriptive statistics and figures 48

6.4.1 Descriptive statistics 48

6.4.2 Descriptive figures 50

6.5 Model selection 52

6.5.1 Unit root test 52

6.5.2 F-test and LM test 52

6.5.3 Models 53

6.6 Regression results 56

7 CONCLUSIONS 61

REFERENCES 64

APPENDICES 70

Appendix 1. Unit root tests 70

Appendix 2. F-test 71

Appendix 3. LM tests 72

FIGURES

Figure 1. Value chain in the video game industry. (Adapted from Zackariasson & Wilson, 2014). 10

Figure 2. Inflation unadjusted video game industry revenue by platform, with 2019 and 2020 as forecasts. (Adapted from Bloomberg, 2019). 15

Figure 3. Prices for 'AAA' video games 1982-2020. Inflation-adjusted to 2020 USD. (Adapted from Ars Technica, 2020). 17

Figure 4. First- and second-degree price discrimination. (Adapted from Baye, 2009). 22

Figure 5. Time series graph showing the percent of the sample playing games that feature different microtransactions. (Adapted from Zendle et al., 2020). 29

Figure 6. Frequency distributions and kernel density estimates for nominal revenues in billions USD. 40

Figure 7. Frequency distributions and kernel density estimates for revenues in billions of 2020 USD. 40

Figure 8. Frequency distributions and kernel density estimates for natural logarithms of nominal revenues in billions USD. 40

Figure 9. Frequency distributions and kernel density estimates for natural logarithms of revenues in 2020 billion USD. 41

Figure 10. Average annual titles released and average annual nominal revenues, in billions of USD. Data for 7 firms of the study. 50

Figure 11. Average annual usage of Free-to-play model, DLC and Microtransactions for titles released. Data for 7 firms of the study 51

Figure 12. Im-Pesaran-Shin unit-root test with nominal revenues as the dependent variable. 70

Figure 13. Im-Pesaran-Shin unit-root test with revenues conversed to 2020 USD as the dependent variable. 70

Figure 14. F-tests for both dependent variables. 71

Figure 15. Breusch and Pagan Lagrangian multiplier (LM) tests for Random Effects for both dependent variables. 72

TABLES

Table 1. Description of variables. 38

Table 2. General meaning of Metascore in video games. (Adapted from Metacritic.com)... 42

Table 3. Sources for variables. 43

Table 4. Descriptive statistics for variables.. 48

Table 5. Regression results. 56

1 INTRODUCTION

The global video game industry has changed so dramatically that even the singular concept of the video game industry could be questioned. (Hart et al., 2017). What once operated with a simple retail model, selling boxed goods to a niche of video game enthusiasts, is now an industry worth over 150 billion USD and is expected to grow at a Compound Annual Growth Rate (CAGR) of 12.9% from 2020 to 2027. (Grand View Research, 2020). At the heart of the explosive growth of the video game industry are the fundamental business paradigm changes that have happened over the last two decades as the industry's producers have moved towards more professional organizations. (Zackariasson & Wilson, 2014).

This thesis discusses the changes in pricing and business models of video games from economics' point of view. For this, we take a perspective of the industry as "traditional" in the context before the change in business models and the start of the rapid growth, and as "changed" after them. The traditional and changed pricing models of the industry are evaluated related to the literature of price and quality discrimination originally proposed by Pigou (1920) and then complemented by Shapiro and Varian (1999) in the context of information goods that video games are.

The motivation for this study comes from over two decades of hobbyism toward video games and seeing the industry change first-hand. In today's gaming world of endless virtual goods, a consumer has to continuously evaluate their demand and possible surpluses from extra purchases, while the producers also have to evaluate them to gain extra surplus. In addition to this, the motivation for this study is driven by the fact that there is very limited quantitative research on the pricing models of the industry, and the industry has been rather overlooked by researchers even though the industry is bigger than that of movies and music combined today.

The research methods of this thesis include a literature review on the pricing economics of the video game industry, as well as an empirical panel data study on revenue gathering within the firms of the industry. Chapter two introduces the economic framework of video games as a concept and as an industry, and the brief history of the industry is reviewed as a background to this study. Pricing economics of the “traditional” video game industry are then looked at in chapter three, before introducing the economic framework of price discrimination in chapter four. Chapter five then discusses this economic framework in connection with the “changed” video game industry.

The two research questions, of which the first one’s answer is searched for in the literature review, are following:

1. What kind of pricing strategies did/does the “traditional” video game industry use and what kind of pricing strategies does the “changed” video game industry use?

2. What are the factors affecting revenue generation in the video game industry?

The empirical part of this study is presented in chapter six, and it aims to answer the second research question. For this, a panel data study is conducted involving seven big publishers of the industry with their released games between the years 2000 and 2020. In total, these companies released 4315 games during the viewing interval that are included in the 138 observations for the study. The variables of the study are selected to show the impact that the amount of released games, their quality, and their pricing models have on revenue. The results are then analysed and compared to the literature review, before discussing the conclusions in chapter seven.

2 THE VIDEO GAME INDUSTRY

In this chapter, the basic facts of video games and the video game industry are reviewed along with brief history of the industry that gives a preliminary viewpoint to the change that occurred in the industry during the 21st century.

Oxford English Dictionary defines the term video game as a game played by electronically manipulating images generated traditionally by a computer program, but more broadly played on a games console, personal computer, or a mobile device. For this, a monitor or other display is used to point the images.

Zackariasson and Wilson (2014) define the term video game as a specific kind of digital entertainment where the player of the game, the gamer, is in interaction with a digital interface to encounter challenges of numerous kinds, which depend on the genre and the plot of the game. In Juul's (2005) classic game model, he suggests that a game consists of six attributes:

1. Rule-basedness
2. Variable and quantifiable outcomes
3. Values associated with each outcome
4. Player effort
5. Player attachment to outcome
6. Negotiable consequences

Juul (2005) argues that these features unite all games and Zackariasson and Wilson (2014) emphasize that the model includes video games.

2.1 Industry structure

The traditional video game industry is very similar to other publishing industries, like books, television, and film, with games being projects that have large fixed costs and no returns before publishing. (Hesmondhalgh & Pratt, 2005; Caves, 2000). According to Zackariasson and Wilson (2014), however, the structure of the video game industry differs significantly from the software industry by being more constrained. For example, developing console video games has required licensing with the console's manufacturer since the introduction of the Nintendo Entertainment System home video game console in 1985. Additionally, the Entertainment Software Ratings Board (ESRB) was put into service in 1994 to rate the contents of video games and their suitability for younger audience.

According to Meagher & Teo (2005), the innovation and growth in the video game industry can be described through the concept of Schumpeterian creative destruction. The products are replaced in a rather rapid cycles, and the lifespan of a product depends on the rate of creative destruction, but until a game is superseded, it possesses market power.

The participants in the video game industry are, according to Zackariasson and Wilson (2014), developers, publishers, distributors, retailers, customers, consumers, IP-owners, platform owners and hardware owners. Developers are the firms or other parties that make the game. They, however, usually lack the capability to finance their products, publishing and marketing, and thus the publishers are the party that manage these. Because the publishers are the main financing party in video games, they take home the biggest profits. Retailers are the ones selling the game either physically, digitally, or both, and the distributors are the middlemen between publishers and retailers. A customer is the party that buys the game, while consumer is the one that consumes it. IP-owners, platform owners and hardware owners set the boundaries for the production.

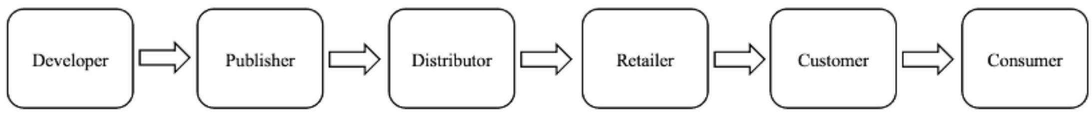

Figure 1. Value chain in the video game industry. (Adapted from Zackariasson & Wilson, 2014).

2.2 The Industry Spiral

Dymek (2010) explains the video game industry's dynamics with a repeating chain of events consisting of eight steps. In the first step, the video game consoles are designed.

The development of hardware and software technologies for consoles is expensive and time-consuming, but the effects thereof on the rest of the industry's economy are remarkable. According to Dymek (2010), the traditional video game industry's most influential medium development is done by console manufacturers.

The console manufacturers are concurrently present on two markets, the consumer market, and the developer market. In the second step, the game console manufacturers spread their visions to the developer market regarding technical, artistic, and business-related conditions associated with their console. The game console manufacturers thus act as gatekeepers for the developers to their platform. (Dymek, 2010).

The third step in Dymek's (2010) industry spiral is the releasing of the game console. This includes the manufacturing, distributing, marketing, selling, and supporting of the video game console, and the process is generally targeted towards the market of pioneering early adopters.

In the fourth step, the console platform has set the constraints for game publishers. Game publishers then select target markets and marketing strategies in constraint to the predefined sets of tools and expectations set by the console manufacturer. This leads to step five, where game publishers invest in game development. Dymek (2010) argues that there is extensive path-dependent mentality in publishers' content strategies, where any successful product leads to sequels and plagiarizing competitors.

The sixth step is when the publisher's game reaches retail. Dymek (2010) stresses that the window of opportunity for sales is very small – the game must succeed in retail in three to six months before it is removed from distribution channels if it does not sell. While being true to the traditional video game industry, however, this does not necessarily hold anymore with digital markets.

The seventh step of Dymek's (2010) industry spiral is the sales market information feedback to the industry that determines the continuation process. In traditional console video game markets, only a small fraction of the products make profit, but the profits they make are great. This is a characteristic of hit-driven industries that the video game industry is and supports the argument of the creative destruction-controlled industry structure.

Finally, in step eight, the process is repeated, with steps 4 to 7 recurring multiple times within a console's life cycle, and steps 1 to 7 repeating when a new console is introduced. Dymek (2010) claims that while the eight-step process is not entirely accurate for sectors other than console gaming, the dynamics of other sectors like PC and mobile games are very similar.

2.3 A brief history of the video game industry

As an industry, video games are rather young. An early omen of the industry coming to life was the recreation of computer scientists to make computers play traditional games, like chess, with them in the 1940s and 1950s. Yet still in the 1950s, many explored the basic idea of video games, but gave up believing it as a waste of time. (Donovan, 2010).

One of the first video games was *Spacewar!* developed by MIT students as a pastime in 1962. The students thought about how to make money with the game but abandoned the thought as the game required a 120,000-dollar computer to play it. The computers were still too expensive and too large for the game to be commercialized. It was not until the 1970s that *Spacewar!* and other video games were transformed into coin-operated (arcade) games and started competing with traditional arcade machines like *Pinball.* Simultaneously, the first home video game console, *Magnavox Odyssey*, hit the markets, with successors and competitors immediately following. This marks the beginning of the video games as an industry. (Donovan, 2010).

The invention of the microprocessor accelerated the development of the video game industry late in the 1970s, releasing it from the constraints of hardware-based design. Contrary to the objective that computer scientists had had decades earlier of making computers solve practical problems, the first home computers were to be used almost exclusively for playing video games. On top of that, home video game consoles' popularity increased, and arcades spread by the year. The industry worth in the United

States exploded from 454 million USD in 1978 to 5,313 million USD by 1982. This is said to be the golden age of arcade video games. (Donovan, 2010).

The rapid growth of the video game industry came to a drastic crash in 1983. The rising share of third-party companies in the developers of games for *Atari VCS 2600* flooded the market with poor-quality games hoping to make a quick buck with the excitement surrounding the industry. This led to a lack of consumer confidence towards the products of the industry as well as cannibalization of the market. The home console market that peaked at 3,200 million USD worth of sales in the US in 1983 regressed to 100 million USD by 1986. The industry forerunners *Magnavox* and *Coleco* exited the market while the industry leader *Atari* was sold. (Donovan, 2010).

In the mid-1980s, the industry was stagnated after the crash in the western countries. The video game business was said to have died with Atari's downfall and to never return. The existing market was mainly computer based but fragmented across different technologies and capabilities of home computers. Piracy was also a huge concern, as computer games could be copied unlike cartridge-based console games. (Donovan, 2010).

Japanese company *Nintendo*, however, had reaped success in its domestic country with its first home video game console *Famicom*. Nintendo noticed that the demand in video games as a concept had not decreased in the western countries either. Instead, the players were just tired of substandard games that had flooded the market. Nintendo released Famicom in the US with the name *Nintendo Entertainment System*, or *NES*, in 1985 along with licencing system to maintain a high-quality game market, which would later become the industry norm for the subsequent console systems. Although Nintendo revived the US video game industry single-handedly with the NES, bringing it from a 100 million USD business in 1986 to a 4,000 million USD business by 1991, it exploited enormous market power by controlling the licences dictatorially and charging publishers to profit even from badly selling games. (Donovan, 2010).

The monopoly power exhibited by Nintendo was short-lived. By 1990s *Sega* had stepped forward to compete in the industry and computer games raised their status once again with the application of CD-ROM-discs and 3D graphics. In addition to this, *Sony* released its first video game console *PlayStation* in 1994 that also made use of both technologies. In a few years Sony passed Nintendo as the global industry leader and reshaped the social image of video games towards growing popular culture relevance, and towards being taken more seriously as an industry. (Donovan, 2010).

The continuing technological development of personal computer and home video game consoles faded the popularity of arcade games that had started the commercialization of video games back in the 1970s. While one industry within the industry perished, several new ones were introduced, including handheld consoles, mobile games, and online games on computers, powered by the generalization of the internet. (Donovan, 2010).

The console market experienced further growth with Sony releasing its second video game console, the *PlayStation 2*, in 2000, which is globally the most sold console to this date. Microsoft soon also entered the console business with its *Xbox* released in 2001. A year later was launched the *Xbox Live* internet platform service that marked the video game consoles' stepping to internet age, with Sony and Nintendo soon following. (Donovan, 2010).

As the technology continued to develop and the video games became more complex by the year, the budgets for making video games increased in the 2000s. The industry began to call the newly emerged high-budget games the 'AAA' games, which would dominate especially console gaming. Contrastingly, the introduction of iPhone and the App Store by Apple in 2007 gave a platform for small developers to reach out to a mass audience. (Donovan, 2010).

It is the rise of the internet on all platforms that has denoted the change in the video game industry seen in the 2010s. Digital markets have enabled both small and large developers and publishers to reach the entire public, whilst providing the technology to offer updates and additional content.

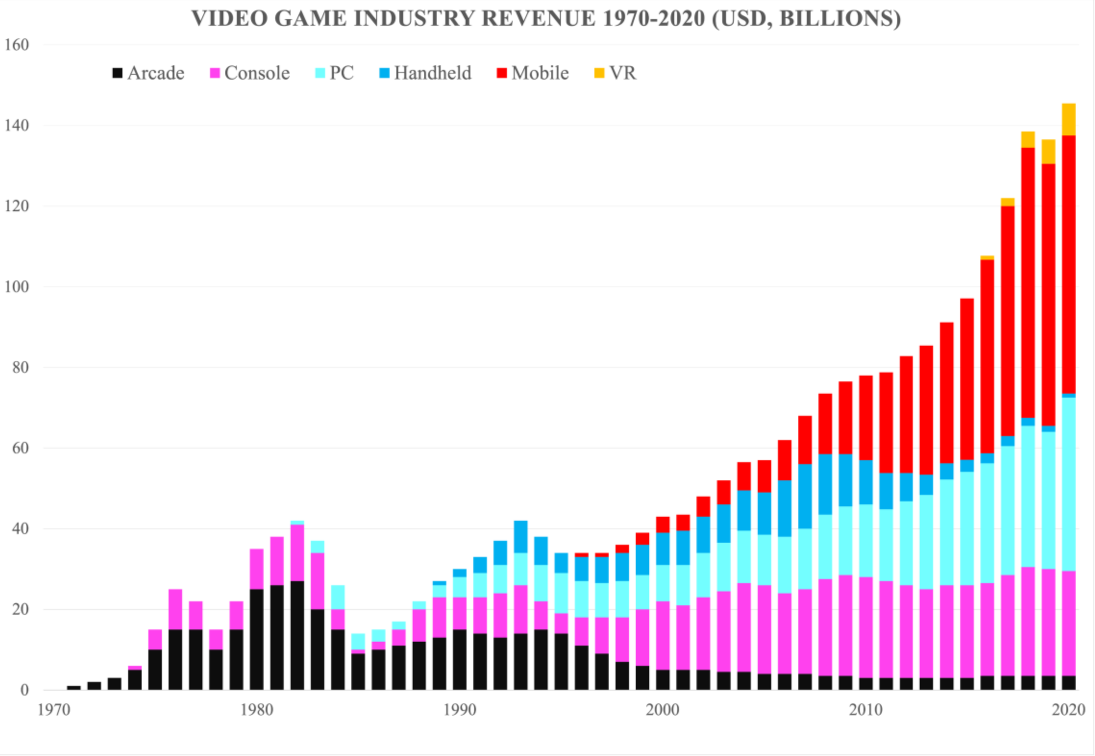

Figure 2. Inflation unadjusted video game industry revenue by platform, with 2019 and 2020 as forecasts. (Adapted from Bloomberg, 2019).

Figure 2 shows the video game industry's revenue stream growth by platform. As seen from the figure, after the crash of 1983 the industry revenue has been growing steadily until the 2010s explosive outburst. The effect that the internet platforms have had on the industry in the 2000s cannot be underestimated.

Today, the coin-op arcade business that started the industry in the 1970s has reduced to a relatively small-time field, so has the handheld devices' sector that has been offset by mobile phones. The recently emerged Virtual Reality sector is still relatively small, but is growing. PC gaming has seen fast and steady growth, while the console sector has been rather stagnated, but still breaking the all-time record in 2018 with 27 billion USD in revenue. (Bloomberg, 2019).

As seen from figure 2, it seems that revenue-wise the rapid growth is fueled almost entirely by the rise of mobile games. The figure, however, only categorizes video games by their platforms and does not consider the pricing and business model changes that have had their contribution in the industry growth.

3 ECONOMICS OF THE TRADITIONAL VIDEO GAME INDUSTRY

As noted, the pricing model change in video game industry has emerged only recently. Rayna and Striukova (2014) characterise the business model that ruled the industry from the 1980s to the late 2000s, with large studios producing games to PC and consoles, as the 'old' business model paradigm, and stress that the new business model paradigm that emerged in the late 2000s is radically different. In this chapter, the traditional pricing of video games is discussed.

3.1 Razors and blades model

Two-part pricing has existed in the video game industry for long. The basic business model for the video game industry's console hardware makers is the razor and blades model: they provide the platform for video games at a relatively low price, but additional purchases, the games, are needed to gain any utility from the platform. The name explains the simple model: razors are sold cheaply, but the blades are expensive and only fit one type of razor. (Zackariasson & Wilson, 2014). This pricing model was first introduced already with the Atari VCS 2600 in the 1980s (Donovan, 2010), but is still being used with the newest video game consoles. (Bloomberg, 2020).

Derdenger (2014) studies the dynamics of the razors and blades model in video game industry. Specifically, he evaluates the intensity of video game consoles' price competition when console hardware manufacturers technologically tie their software to their own hardware, making them incompatible with rival hardware.

Derdenger (2014) argues that at first, the integration of hardware and software incentivises the console manufacturer to raise its console's price because of the increased market power. The integration, however, generates a new stream of profits, and lower console prices increase the demand for both the console and the games, which in turn incentivises the firm to lower its console price. The intensity of console price competition then depends upon the trade-off between hardware and software profits, and as the industry profits are mainly made with video games, the console makers subsidize consumers in order to promote the sales of video games.

While Derdenger (2014) does not specifically mention the razors and blades business model, it can be said that the model described by him, involving complementary relationship between hardware and software, and the technological tying thereof for market power, accounts for the same dynamics captured by the razors and blades model, only more formally.

3.2 Traditional pricing of video games

While there is no dispute that price discrimination has existed in the video game industry for long now among the firms that produce both hardware and software, traditional pricing for new video games themselves has stayed rather constant for decades, with the price point being around 40-60 USD. (Rayna & Striukova, 2014). In fact, since the 1990s the prices for high-budget ('AAA') video games have been so fixed that they have not even been adjusted for inflation in over ten years. There are signs, however, that with the latest ninth generation of home video game consoles (Xbox Series X/S and PlayStation 5), publishers and developers are aiming to raise a game's basic asking price. (Ars Technica, 2020).

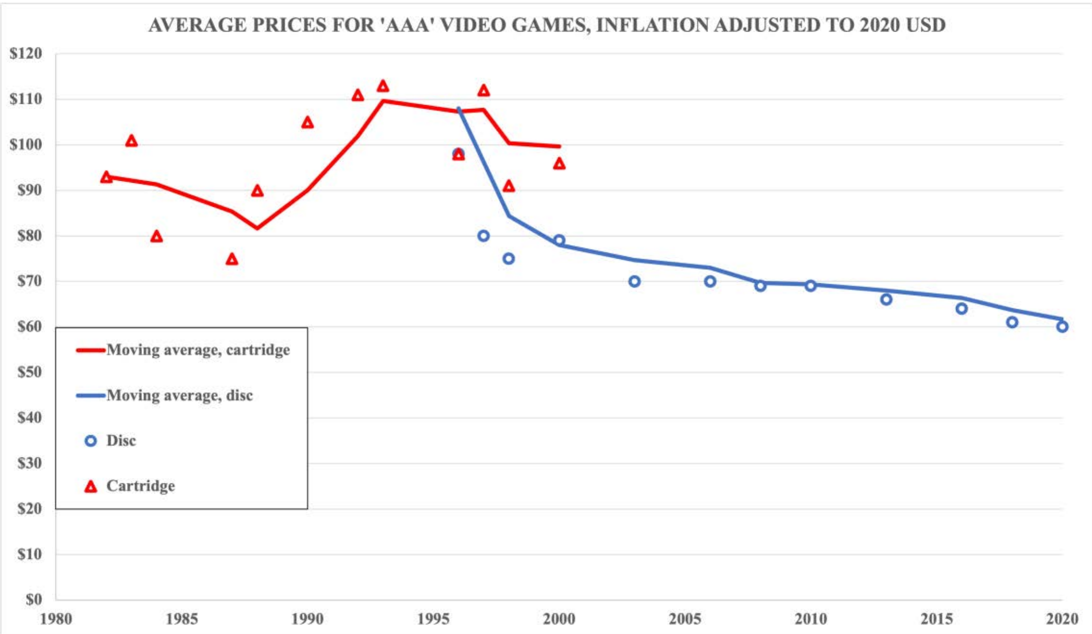

Figure 3. Prices for 'AAA' video games 1982-2020. Inflation-adjusted to 2020 USD. (Adapted from Ars Technica, 2020).

Figure 3 illustrates the prices of top-end ('AAA') console games in 2020 USD. The figure contains a total of 24 data points for prices of cartridge- and disc-based games from 20 different years between 1982 and 2020 and moving average lines of the three previous data points. As seen from the figure, the prices have stayed rather constant since the beginning of the 2000s.

As video games have become more complex and the costs of making them have grown (Zackariasson & Wilson, 2014; Donovan, 2010), why has the asking price for new video games stayed constant for so long? There is no distinct answer to the question in the economic literature, but insights can be found by looking at the durable-goods nature of video games.

3.3 Intertemporal price discrimination

Nair (2007) studies the pricing dynamics of console video games. He points out that video games are durable goods that have declining valuations over time (which in turn comes from the creative destruction-nature of the industry), with durability implying that the consumers who buy a game are not in the market for the said game after the purchase. This leads to varying demand conditions across the life cycle of the game, with high-valuation customers creating a relatively inelastic demand curve at the beginning of the life cycle, and the demand conditions then tending to become more and more elastic over time.

According to Nair (2007), the changing demand conditions across time generate an incentive to intertemporally price-discriminate by skimming the market. This means setting a high price at the start to generate maximum revenue from high-valuation consumers, and then lower the price as time passes to meet the demand indicated by low-valuation consumers. This enables the firm to capture maximum surplus from consumers with heterogenic willingness to pay.

A fundamental problem for profiting from intertemporal price discrimination, however, occurs when consumers are forward-looking. This means that the consumers know to anticipate the prices to decline and detain their consumption because of this. In his study, Nair (2007) models a game played between forward-looking consumers and forward-looking firm that takes the forward-looking consumer behavior into account in its pricing policy. Prices act as equilibrium outcomes in the model, and the model is then applied to data on sales and prices of video games for Sony PlayStation.

In the results, Nair (2007) finds that the forward-looking behavior of consumers is significant and economically important in reducing the price-discriminating firm's equilibrium profits, and the evidence suggests optimal pricing strategy does exhibit price-cutting. Additionally, he shows with a two-period model that a forward-looking price skimming monopolist should always set the price on the elastic region of the demand curve.

Nair's model (2007) is not entirely consistent with empirical data, however. Optimal initial price for a video game is 36.5 USD in the model, while the sample data shows a mean releasing price of 42 USD. Nonetheless, Nair's (2007) interviews with video game industry managers revealed that the rule-of-thumb pricing rules were relatively consistent with the proposed pricing model. Indeed, as already shown by Hall and Hitch (1939), among others, managers rely more on variety of mechanical rules in price-setting rather than actual profit-maximizing conditions.

It is entirely possible that an explanatory factor for prices is that the industry has found equilibrium prices through trial and error, and uncertainty on demand and elasticities prevents at least significant deviations from them. When time passes, the equilibrium is no longer necessarily the same, but the prices have not changed. Hence, it can be said that the traditional (console) video game prices are sticky. Tomić (2019) argues that 60 USD represents a psychological price that the publishers do not dare to cross. Additionally, as stressed by Nair (2007), video games are very weak substitutes for each other because of their relatively unique characteristics, so price competition in the video game industry does not exist in an equally extensive form compared to many other industries.

Though not directly providing answers, the contribution of Nair's (2007) study and model helps to understand the relatively fixed prices of new video games and the decline in prices as time passes.

Another factor affecting the prices and intertemporal price discrimination choices of video game producers is the fact that the durable goods market has a unique feature of producers facing competition of an existing stock of used goods. Ding et al. (2018) study the impact on quality and pricing decisions that the secondary markets have in video game industry. They show that firms producing different generations of their game (‘game series’) compete with their own products in the secondary market and have to choose the extent to which they compete with prices and with quality improvements between generations. The producers can choose to make significant quality improvements to kill off the competition and thus raise R&D costs, or they can adopt lower prices. Considering the empirical regularity that many of the successful video games are made into series, this finding can also be kept as an explanatory factor on why the video game market prices have remained rather stabile.

As a summary to this chapter, it can be said that video game pricing strategies and nominal prices during the traditional era of video games have stayed rather constant. Intertemporal price discrimination is undoubtedly still the prevalent pricing policy for ‘the normal good’ of console video games, especially with the ‘AAA’ games. The technological development and demand for more complex games as complicating factors to the evolution of the industry, however, have emerged rising costs that have not been offset by rising prices of the games. This disrupting development, along with the rise of online gaming, mobile gaming and digital markets, have both opened up and enforced publishers and developers to look for new streams of revenues in the 2000s. (Zackariasson & Wilson, 2014). This is where the economics and pricing strategies of information goods have entered the industry.

4 PRICING THEORY

In previous chapter, terms like price discrimination and two-part pricing were mentioned. In this chapter, these terms are looked more into. More specifically, this chapter introduces us to the economic theory behind advanced pricing models, or as Baye (2009) refers to as “strategies that yield even greater profits” than classical profit-maximization conditions, to give background to the change that has happened in the video game industry. First, the basic theory of price discrimination is reviewed before introducing the economics and pricing theory of information goods that video games are.

4.1 Price discrimination

For a firm with market power and thus control over the price, there are additional ways to gain even greater profits than following the simple monopoly pricing rule. These pricing strategies enable the firm to extract additional surplus from consumers, but require the firm to have different types of information about consumers, as well as to avoid potential arbitrage practiced by buyers.

4.1.1 First-, second-, and third-degree price discrimination

There are three basic types of price discrimination introduced by Pigou (1920): first-, second- and third-degree price discrimination and their usage depends on the information the producer has on the consumers, their preferences, and the ultimate demand. First-degree price discrimination, also called perfect price discrimination enables the firm to extract all consumer surplus by charging each consumer the maximum price they are willing to pay. Hence, the prices follow the demand curve perfectly, but the producer must have perfect information about the willingness to pay. (Baye, 2009; Pigou, 1920).

Second-degree price discrimination involves charging different prices for the amount of quantity consumed. This allows the producer to extract consumer surplus by giving discounts for higher quantities without having the perfect information. (Baye, 2009; Pigou, 1920).

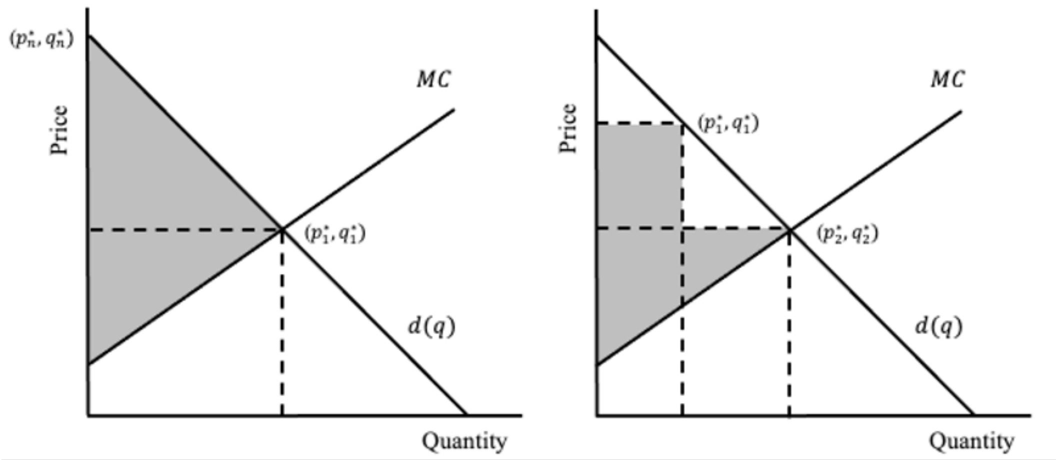

Figure 4. First- and second-degree price discrimination. (Adapted from Baye, 2009).

Figure 4 illustrates the first- and second-degree price discriminations. Compared to the classical profit maximization pricing rule, the consumer surpluses are captured to producer surpluses, with producer surpluses being the grey areas. In first-degree price discrimination, instead of charging the monopoly profit-maximizing price (p_1^*, q_1^*) from all customers, the firm charges customers perfectly according to their willingness to pay all the way from (p_n^*, q_n^*) to (p_1^*, q_1^*). In second-degree price discrimination, the firm offers discounts on consumers consuming more (p_2^*, q_2^*).

The last of the three basic price discrimination types is the third-degree price discrimination, also known as group pricing. It is practiced by producers who can identify different demand revealed by different demographic groups, and then charge different prices for these different groups. More specifically, in order for the firm to benefit from third-degree price discrimination, elasticities of demand must vary between different precisely distinguishable groups. (Baye, 2009; Pigou, 1920).

4.1.2 Two-part pricing

Another type of pricing strategy that can yield higher profits for a firm with market power is the two-part pricing, or two-part tariff. In it, the producer charges a fixed price: an “access fee”, or a right to purchase its goods, and a per-unit fee for each unit consumed. If the fees are same for all customers, this pricing strategy is not generally thought of as price discrimination, where the producer charges different prices for the same product. Depending on the author, however, it is sometimes presented as a way of practicing first-degree price discrimination, as like first-degree price discrimination, two-part pricing allows the producer to extract all consumer surplus. (Baye, 2009; Oi, 1971). More specifically, Oi (1971) shows that this is achieved by setting per unit price to equal marginal cost, and the access fee, or tariff, according to the consumers' willingness to pay.

The two-part tariff or two-part pricing model is usually used in the context of a monopolistic market. Two-part tariffs, however, may also exist in competitive markets when consumers are uncertain about their ultimate demand. Harrison and Kline (2001) show that the ability of firms to extract consumer surplus with an access fee decreases as the number of firms in competition increases, which also shows that two-part prices are not exclusive to monopolies. In addition to this, it also reasonable to assume that video game firms have monopoly power to some extent, as the products differ a lot from each other. (Meagher & Teo, 2005).

4.2 Price discrimination of information goods

Neoclassical pricing theory works as a basic guideline framework for all pricing economics. The information economy, including video games, however, have some distinctive economic characteristics that differ from the economics of normal goods.

4.2.1 Information goods

Information goods refer to as any good that can be digitized. (Shapiro & Varian, 1998). They have the characteristic of having high fixed costs but very low to zero marginal costs. In this sense, producing a large amount of the same information good costs about the same as producing one and hence the neoclassical pricing framework with cost-based pricing cannot be directly applied to information goods. Instead, producers in the information industries use value-based pricing, where goods are priced with the base of the value consumers attach to them and not by their production costs. (Belleflamme, 2005).

4.2.2 Versioning of information goods

Shapiro and Varian (1999) describe second-degree price discrimination in the context of information goods as versioning. This implies that (at least) two versions of the same good are sold, which does not fit to the standard definition of price discrimination, since classical Pigou (1920) price discrimination involves selling the exact same good with different prices. Phlips (1983), however, argues that often it is not the same product that is sold at different prices, but differentiated products. This is also the viewpoint of Belleflamme (2005), who stresses that information goods are usually versioned through the dimension of quality, and not by price.

In versioning of information goods, two or more versioned information products are offered with some combination of price and product characteristics, which then induces consumers to use self-selection to reveal the value they attach to the product. As these valuations differ across the set of consumers, versioning is bound to extract more surplus than selling a single quality product. (Belleflamme, 2005).

According to Belleflamme (2005), there are at least three specific strategies of versioning. These are bundling, functional degradation, and conditioning prices on purchase history. Bundling forces consumers to acquire a good they would not have purchased otherwise by bundling them with goods they are willing to purchase. Functional degradation is the purposeful removing of features of a product and selling the degraded version at a lower or zero price in order to incentivize the consumers to purchase the non-degraded version at a positive price. This damaged good strategy is particularly used in the video game industry as will be seen in the next chapter. Conditioning prices based on purchase history is exactly what the name suggests, and in theory when practiced correctly, it allows the seller to perfectly price discriminate.

Belleflamme (2005) argues that as information goods’ valuation by consumers differ widely, versioning is not only well-suited for information goods, but also facilitated by the use of information technology. He provides three main driving forces for the increased usage of versioning: rapid quality improvement and sharp price declines in information technology, the convergence in communication and computing technologies, and the growth of network computing intensified by the internet.

As Belleflamme's (2005) driving factors point out, it is clear that the generalization of the internet and online stores, along with the collection of big data, can facilitate the process of price discrimination by firms attending online markets. Included within these firms are those within the video game industry, which have started to develop new business models and use the versioning models of information goods in the 21st century. (Dey & Lahiri, 2016; OECD, 2005).

5 ECONOMICS OF THE CHANGED VIDEO GAME INDUSTRY

In this chapter, the current pricing economics of the video game industry are looked into. As pointed out in chapter 4, video games have lately adopted second-degree price discrimination generally used in the software industry (Dey & Lahiri, 2016), commonly known as versioning in this context. (Shapiro & Varian, 1999). From free-to-play games to 'ultimate' editions of premium games, price discrimination with versioning enables producers to reach out to consumers with different willingness to pay. Next, the different forms of versioning in video games are reviewed.

5.1 Versioning in video games

Zackariasson and Wilson (2014) state that traditional model of retail unit sales is being replaced and complemented with new business models and revenue streams, including monthly subscription-based models, advertising-based models and the sales of virtual items known as microtransactions. Rayna and Striukova (2014) stress that the new business model paradigm of the industry is not replacing the old one, but the product offering of the industry has evolved to a greater mix of products and services.

According to Hart et al. (2017), additional monetization of video games can be traced back already to the 1990s with subscription fees, expansion packs and shareware. Subscription fees, however, can be seen as two-part tariffs rather than versioning, like Meagher and Teo (2005) show. Dey and Lahiri (2016) note that by 2016, one of the innovations in marketing and product placement of the video game industry has taken the form of downloadable content, in which the producer of the game initially only offers a subset of features in the retail version of the game, and the rest as incremental and complementary downloadable content (henceforth DLC).

By 2016, almost all games offered varying amounts of DLCs. Included among these are zero-day DLCs which become available the day the game is released, meaning the additional contents were already fully developed before the releasing of the game, but the producers purposely hold them back to sell them separately. This implies damaged good-type versioning. (Dey & Lahiri, 2016).

Versioning, the DLCs, in video games take many forms. Generally, DLC is used as a catch-all term for all additional content. Next, the terminology of these various forms of DLCs and other pricing strategies of the changed video game industry is explored.

5.1.1 Subscription model

Subscription fees were first introduced on PC by multiplayer online games (MPOGs) in the 1990s, powered by the innovation of online distribution. Though being the oldest form of additional monetization practiced by the industry, subscription model is still being used by some games, but the shift with these games has moved towards the freemium model. In the subscription model, producers combine the traditional one-time purchase with monthly subscription fees. (Hart et al., 2017). As shown by Meagher and Teo (2005), these access fees and subscription fees are a classic form of two-part pricing aimed to extract consumer surplus. Meagher and Teo (2005), however, also show that network externalities have strong effect and thus in subscription model, it is not always optimal to follow classic Oi (1971) two-part tariff, which is a significant contribution leading towards freemium model. This is further explored in part 5.2.

5.1.2 Expansion packs

Expansion packs are a large form of DLCs that build on the original game and extend its playability. Expansion packs differ from other DLCs in the sense that they were already practiced in the industry before the internet-age, through cartridge and disc form. Expansion packs have, however, also become more common in the 21st century. Specifically, *Valve*'s Steam platform's launch in 2003 was the first platform offering fully digital sales and distribution of games, leading to the generalization of expansion packs due to them being more easily accessible by consumers, and having lower distribution costs. (Hart et al., 2017).

5.1.3 Microtransactions

As a concept, microtransactions can be tracked all the way to the days of coin-op games, where all arcade games were pay-to-play with small fees. (Peckham, 2013). As seen in previous chapters of this thesis, after the shift from arcades to console gaming, the prevalent model of the industry shifted towards large payments for initial access, but there was no investment after the initial purchase until the utilization of internet connectivity. Since then, the industry has shifted back to an economic model that utilizes microtransactions. (Hart et al., 2017).

Nowadays, most microtransactions are low-amount payments of virtual items, but they are primarily determined by purpose and not by the amount of payment. Generally, the purpose of microtransactions is to bring cosmetical changes to a game, additional content, improve the player's position under existing conditions, buy time or subscribe to access otherwise unavailable game modes. (Tomić, 2019).

The following are the most used forms of microtransactions:

Cosmetic microtransactions are microtransactions that are purely aesthetic and offer no in-game advantages to players, meaning they have no effect on the particular game's mechanisms. (Zendle et al., 2020). According to Tomić (2019), cosmetic microtransactions are the only form of microtransactions towards which the gaming community has a positive attitude, because they consider all other forms to create an imbalance among players.

Pay to win microtransactions are a form of microtransactions that offer the player a chance to increase their in-game success through purchase of virtual items. This means that a player who pays for a pay to win microtransaction has a bigger chance to win under the same conditions than the player who does not pay. (Tomić, 2017). According to Zendle et al. (2020), pay to win microtransactions have raised controversy among gamers and academics, because they give 'unfair' advantages to players that have higher willingness to pay.

Loot boxes are microtransactions that offer randomized rewards of uncertain value. They can contain either only cosmetical content, or only pay to win contents, or both. (Zendle et al., 2020). Some (e.g., Drummond & Sauer, 2018) have concerns that loot boxes have considerable similarities with gambling. Though the causal relationship is still unclear, this has been debated to possibly lead to increases in gambling amongst players. (Zendle & Cairns, 2019). As a result, at least Belgium has banned the usage of loot boxes. (BBC, 2018).

Zendle et al. (2020) study the generalization of these three main forms of microtransaction in video games distributed in Steam platform through 2010 to 2019. They analyse 463 most played Steam desktop games during the time period and produces three joinpoint regression analyses that show the rapid growth of cosmetic microtransactions and loot boxes. The results are shown in figure 5.

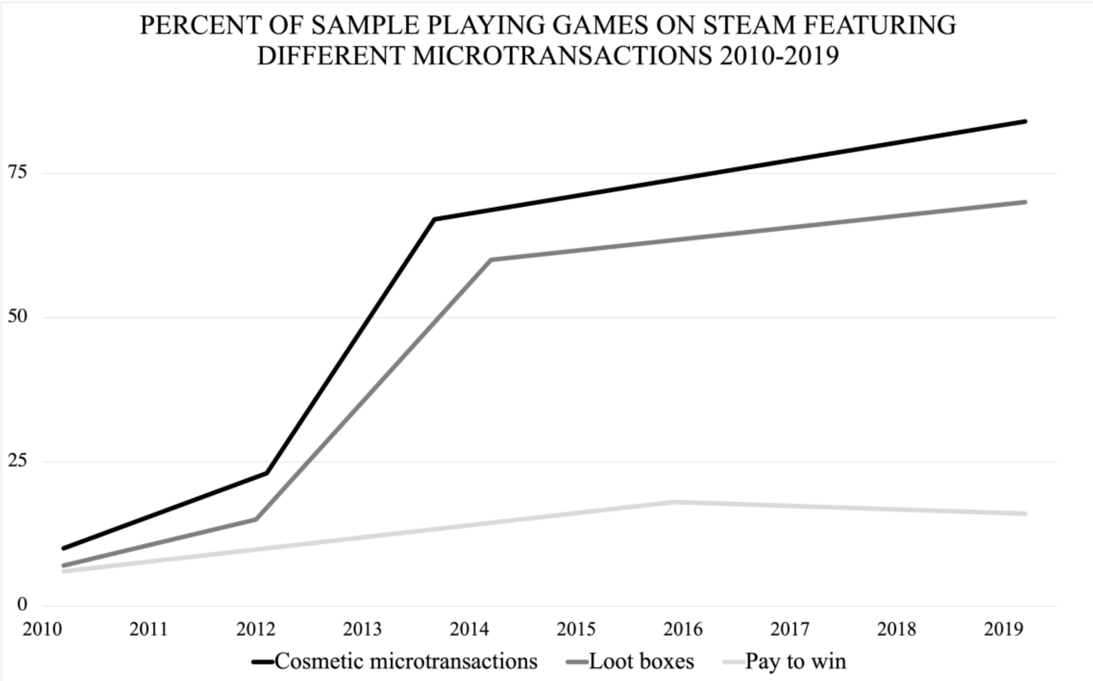

Figure 5. Time series graph showing the percent of the sample playing games that feature different microtransactions. (Adapted from Zendle et al., 2020).

As can be seen from figure 5, microtransactions became a more common business practice for the most played Steam games between 2012 and 2014 and have continued their popularity since. A notable detail is, however, the declining trend of players playing games featuring pay to win microtransactions since November 2015. This is possibly due to the negative feedback the industry has had towards pay to win elements in games.

5.1.4 Freemium

Freemium model, according to Oxford English Dictionary, is derived from the words *free* and *premium*, and is described as a business model where the basic service is provided free of charge, but more advanced features are offered and must be paid for. According to Runge et al. (2019), the profitability of the model depends on its ability to convert free users to paying ones.

During the last decade, freemium, also known as free-to-play in the context of video games, has become a business model for many games and other services. It has been particularly popular in mobile games, but lately it has also become a significant model for traditional console and PC games.

Hamari et al. (2020) define freemium model as creating “demand through inconvenience”, finding support to the hypothesis that the higher the customer enjoyment of a freemium service, the lower their intentions to purchase premium content, but the higher their intentions to continue using the service. This implies that it is in producers’ favour to use Belleflamme’s (2005) damaged good strategy, or as Hamari et al. (2020) describe this, designated inconveniences to reduce the enjoyment in order to encourage premium purchases.

Hamari et al. (2020) also note that while the retail model collects the same value from all customer and subscription model collects value periodically, the freemium model is able to capture value even from non-paying customers in the form of increased network effects. As free-to-play games offer different microtransactions with different prices, often including several or all of the three previously mentioned forms of microtransactions, they are also able to quality discriminate to capture the consumer surpluses of consumers with different willingness to pay.

5.1.5 Games as a service

As a generalized concept of offering variable in-app purchases and doing this to extend the life cycle of a game, games as a service (GaaS) include all the previously mentioned monetization methods. The name is a variation of the older and more known business model software as a service (SaaS). Lehdonvirta (2009) describes games as a service as a broad class of online games that provide in-game content on a continuing revenue model. The focus is on the word continuing, with the firms and games that utilize the model being able to significantly prolong their life cycle and escape the superseding of the game with continuous updates and improvements that are then monetized with microtransactions, expansion packs and subscription model, as well as advertising.

5.2 Meagher and Teo's Model

Meagher and Teo (2005) build a formal model to analyse the two-part tariff price discrimination choice of a monopolist under network externalities and creative destruction. The monopolist is an online game maker who experiences market power until the game is superseded. The monopoly model is used for simplicity, but also for the games' likeliness to be heterogenous and thus possess monopoly power to a certain point. The network externalities are positive, as more people playing the game, the more there are opponents to play with, and the negative externalities being the technical and reputational problems arising during the game's lifespan. As will be seen, the model is applicable not only to two-part tariffs with subscription fees, but to free-to-play games as well.

The model involves a quadratic utility function for consumers, with N players playing the game in total:

$$u(N) = \alpha_1 N - \frac{\alpha_2}{k} N^2 \tag{1}$$

where u is utility per consumer, α_1 is the coefficient for the positive network externality that is the utility gained for having other people play the game, α_2 the coefficient for the negative network externality called congestion, and k the capacity choice the firm has made before making the video game. Initially, k is taken as fixed and exogenous. N is an assumed positive integer. When N increases, $u(N)$ is increasing to the point of congestion where it starts to decrease.

Now, with the representative firm using two-part pricing and utility being quasi-linear in income, Meagher and Teo (2005) express the indirect utility function as follows:

$$V(N,A,p) = E\left[U(N) - A - \sum_{t=1}^{\infty} \delta^t p\right] = \frac{\left[\alpha_1 N - \frac{\alpha_2}{k} N^2\right]}{(1-\delta)} - \left[A + \frac{\delta p}{(1-\delta)}\right] \tag{2}$$

where $U(N)$ is the sum of the utility function $u(n)$ in continuous time (infinite number of periods) given a fixed number of players N. A is the access fee part of the price, p is the subscription part of the price and δ is the pseudo-discount factor consisting of $\delta = dq$, where d is the common discount rate and q is the random fixed and constant probability that the consumer continues to play the game in the next period. In other words, q is the rate of creative destruction, adapted from the creative destruction model by Aghion and Howitt (1992). This means that the consumers are assumed to be homogenous in the model with homogenous preferences. Consumers can choose to either buy or not to buy the game, which makes the demand function discontinuous at the individual level. The utility from not consuming is normalized to zero and the number of consumers buying the game determine the industry (aggregate) demand function.

The representative firm's profit in Meagher and Teo's (2005) model is:

$$\Pi(N,A,p) = [N(A-c)] + \frac{\delta[N(p-c]}{(1-\delta)} = N\left[\left(A + \frac{\delta p}{(1-\delta)}\right) - \frac{c}{(1-\delta)}\right] \tag{3}$$

with c being the constant marginal cost and the fixed cost being normalized to zero. As the firm is profit maximizing, they choose to sell to the maximum number N of players willing to buy the game. This is done by setting the indirect utility function $V(N,A,p)$ to zero and solving the greater root:

$$N^{max}(A,p) = \frac{\alpha_1 k + \sqrt{\alpha_1^2 k^2 + 4\alpha_2 k((\delta - 1)A - \delta p)}}{2\alpha_2} \tag{4}$$

Now, for the representative firm to make positive profits, the marginal costs must fulfil the condition:

$$c < \frac{\alpha_1^2 k}{4\alpha_2} \tag{5}$$

If the marginal cost condition is fulfilled, there exists an equilibrium for the two-part tariff prices A^* and $p^*(A)$, and quantity N^* so that given (5), for each

$$A^* \in \left[0, \frac{\alpha_1(\alpha_1 k + G) + 3\alpha_2 c}{9\alpha_2(1 - \delta)}\right] \tag{6}$$

there is an equilibrium two-part tariff and quota $(A^*, p^*(A), N^*)$ where

$$G = \sqrt{\alpha_1^2 k^2 - 3\alpha_2 kc}, \tag{7}$$

$$p^*(A) = \frac{\alpha_1(\alpha_1 k + G) + \alpha_2(9\delta A^* - 9A^* + 3c)}{9\alpha_2 \delta}, \tag{8}$$

and

$$N^* = \frac{\alpha_1 k + G}{3\alpha_2} \tag{9}$$

Each of these equilibria produce the same expected profits:

$$\Pi^* = \frac{\alpha_1^2(2kG + 2\alpha_1 k^2) - \alpha_2(9\alpha_1 kc + 6cG)}{27\alpha_2^2(1-\delta)} \tag{10}$$

According to Meagher and Teo (2005), this model with externalities differs from classical two-part pricing models such as Oi (1971) so that the second period price can differ from marginal cost. The model and its parametric set of prices accounts for the fact that firms in (multiplayer) video game industry use different sets of prices.

Though the model by Meagher and Teo (2005) is used to explain multiplayer online games at the beginning of the millennium, when more of the industry's firms practiced 'pure' forms of two-part pricing with access fees and subscription prices, both being obligatory to play the game, it contains some interesting features that can be used to explain the video game industry today and the rise of the freemium model.

Firstly, Meagher and Teo (2005) note that if the firm knows that their game is of high quality and the consumers' expectations differ in that they do not expect the game to be of high quality, the firm's choice should be to set the access fee low. This leads to the consumers playing the game for more periods than expected, and making the subscription fee correspondingly higher leads to higher levels of profits. As the set of feasible access fees (6) contains zero, it can be said that this is a significant cause for the rise of freemium games that are the major workhorses of the industry today.

Secondly, in Meagher and Teo's (2005) model, the effects of externalities on p^*, A^*, N^*, and Π^* are as follows:

$$\frac{\partial p^*}{\partial \alpha_1} > 0, \frac{\partial A^*}{\partial \alpha_1} > 0, \frac{\partial N^*}{\partial \alpha_1} > 0, \frac{\partial \Pi^*}{\partial \alpha_1} > 0, \frac{\partial p^*}{\partial \alpha_2} < 0, \frac{\partial A^*}{\partial \alpha_2} < 0, \frac{\partial N^*}{\partial \alpha_2} < 0, \frac{\partial \Pi^*}{\partial \alpha_2} \tag{11}$$

This means that an increase in the positive network externality allows the firm to produce higher profits by reaching more consumers and charging higher prices. This is also in line with the freemium model, in which the firm can benefit even from non-paying consumers in the form of increased positive network effect. (Hamari &

Järvinen, 2011; Hamari et al., 2020). In Meagher and Teo's (2005) model, this positive effect can of course be offset by the negative network externality, congestion. In real life, this can be for example server capacity issues due to high volume of players.

6 PANEL DATA STUDY ON FACTORS OF VIDEO GAME REVENUE

The video game industry has increasingly drawn the interest of scholars during recent years and though there has been qualitative research on the subject, versioning in the context of video games has been studied very little empirically and quantitatively. It is reasonable to assume that individual companies inside the industry have much more empirically tested scientific information about player behaviour, demands, their elasticities and pricing models that work in practice, but these are kept trade secrets.

Microtransactions in their many forms have been a much-debated subject, but the emphasis on the scholarly work for the subject has been more on the consumer side with focus on psychology and worries about gambling-likeliness. (E.g., King et al., 2019; Zendle & Cairns, 2019). In addition to this, price discrimination in general is a much-discussed subject in economic literature, but rather little empirical evidence has been published on its impact on revenues. (Courty & Pagliero, 2012).

6.1 Research methodology

The aim of this research is to study the contributing factors to annual revenues within firms in the video game industry, with focus on the newly adopted business models, such as versioning. The goal is to show systematic evidence of a relationship between firms using versioning and increasing revenue. The research analysis is based on panel data regression models generated in Stata software.

Though the methodology is influenced by studies such as Cox (2014), in which observable characteristics of video games and their effect on a game becoming a ‘blockbuster’ hit is studied, and Zendle et al. (2020), in which the exposure to different kinds of microtransactions is explored, the approach is rather different than existing literature has used to analyse the video game industry.

This study loosely follows the empirical framework of Courty and Pagliero (2012), who estimate the impact of price discrimination on revenue of pop music concerts with the following general model:

$$ln(R_i) = \gamma_0 + X_i\gamma_1 + PD_i[\gamma_2 + Y_i\gamma_3] + \Phi_i^1\gamma_4 + \varepsilon_i \quad (12)$$

where $ln(R_i)$ is the log of revenue in concert i, γ_0 is a constant and X_i is a vector of concert characteristics. PD_i is an indicator variable that takes the value of 1 if more than one price category is offered and otherwise 0, Y_i is a vector of concert and market characteristics that affect the return to price discrimination, Φ_i^1 is a vector of dummy variables and ε_i is the error term.

Like Courty and Pagliero (2012), this study separates product characteristics to their own variables and vector, and pricing characteristics to their own. On the other hand, this study is a much-simplified version, with a small observation number limiting the variable count. Also, variable observations are annual summaries and not tied to individual products, unlike in Courty and Pagliero (2012).

6.2 Data

The data for this study includes 7 different video game publishers and their revenues from years 2000 to 2020, along with all the games and their characteristics being considered, released during the time period. The included companies are Activision Blizzard, Electronic Arts, Take-Two Interactive, Ubisoft Entertainment SA, Capcom, Square Enix Holdings, and Bandai Namco Entertainment. In total, the companies released 4315 games during the viewing interval that are considered in the dataset. The data sources are presented in part 6.2.3.

6.2.1 Variables

The data is organized in panel data form, which means that the data has both cross-sectional and time-series elements. Each observation has an entity *i* which represents the particular firm and time *t* that represents the year. The dependent variable is the natural logarithm of revenue generated by entity *i* in year *t*, in either nominal billions of USD, or billions conversed to 2020 USD, depending on the model. The descriptions for each variable are shown in table 1.

Table 1. Description of variables.

Variable	Variable description
log_rev_n	Logarithmic revenue for entity i in year t, nominal USD in billions
log_rev_n	Logarithmic revenue for entity i in year t, 2020 USD in billions
titles	Number of released games by entity i in year t
multi	Number of released multi-platform games by entity i in year t
console	Number of released console/pc games by entity i in year t
mobile	Number of released mobile/handheld/other games by entity i in year t
mc_10p	10th percentile Metascore of games released by entity i in year t
mc_med	Median Metascore of games released by entity i in year t
mc_90p	90th percentile Metascore of games released by entity i in year t
sub	share of games using subscription model, released by entity i in year t
f2p	share of games using free-to-play model, released by entity i in year t
dlc	share of games offering DLC content (>10$), released by entity i in year t
mt	share of games offering microtransactions (≤10$)), released by entity i in year t

6.2.2 Variable selection

As addressed in the literature review, the costs of producing video games have risen as the industry has matured. It would be ideal to analyse the relationship between production, production costs and profits, and the adoption of new business models for the firms in the industry, but as these numbers in financial reports are not straightforward and comparable because of different accounting policies and include lots of variation from unspecified shocks and events, it is not meaningful to analyse other quantitative economic information from the financial reports of entities other than revenue. That is why revenue for entity i in year t is taken as the dependent variable.

For most time series that cover 21 years of monetary data, it would obviously be reasonable to adjust the data for inflation. As discussed in chapter 3, however, video game prices are sticky and the prices themselves have not been inflation adjusted for over 10 years, so inflation adjusting the revenues of companies of which main products are video games could overcorrect the data.

On the other hand, four of the seven companies' reporting currency is not USD, and the revenues are converted to USD with the annual reporting day's exchange rate. Thus, it makes sense to inflation adjust the values to control for the possible bias that can occur from exchange rates and different inflation rates, as converting the nominal values to 2020 USD and then using Consumer Price Index to deflate them should take care of this according to the Purchasing Power Parity.

While there are supporting factors for both the usage of nominal revenues and the usage of inflation adjusted revenues, both of these are taken as dependent variables and used in different models.

Next, distributions and kernel density estimates are analysed for skewness in revenue. Figure 6 presents the frequency distribution and kernel density estimates for nominal revenues in billions USD. Figure 7 presents the frequency distribution and kernel density estimates for revenues in billions of 2020 US dollars.

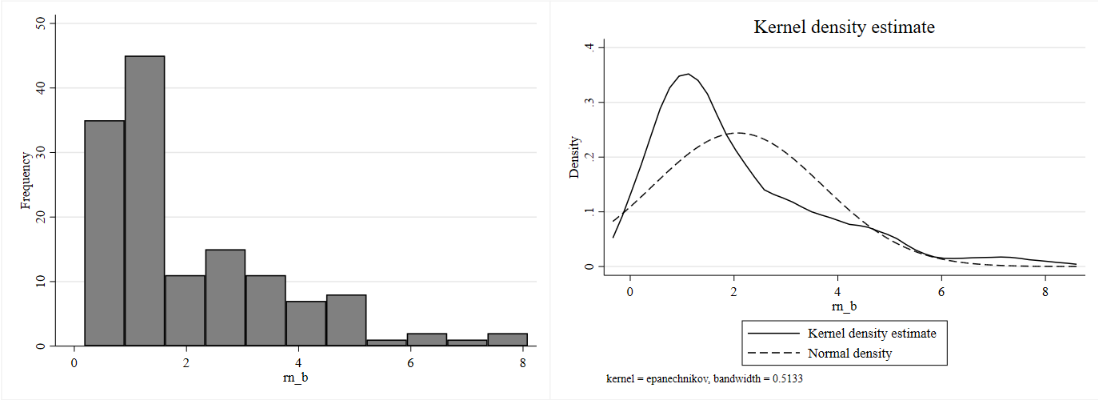

Figure 6. Frequency distributions and kernel density estimates for nominal revenues in billions USD.

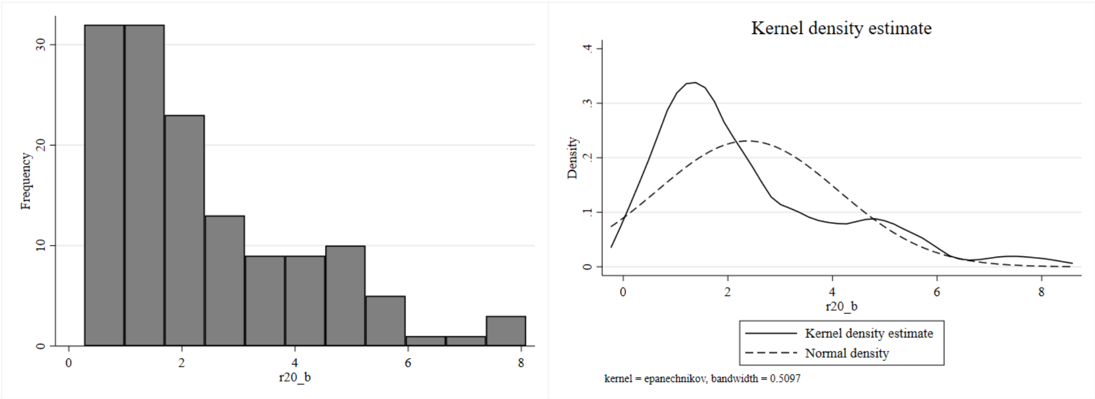

Figure 7. Frequency distributions and kernel density estimates for revenues in billions of 2020 USD.

As can be seen from figures 7 and 8, the nominal revenues are skewed to the right with most of observations being between 0 and 2 billion dollars. Thus, revenues should be log transformed.

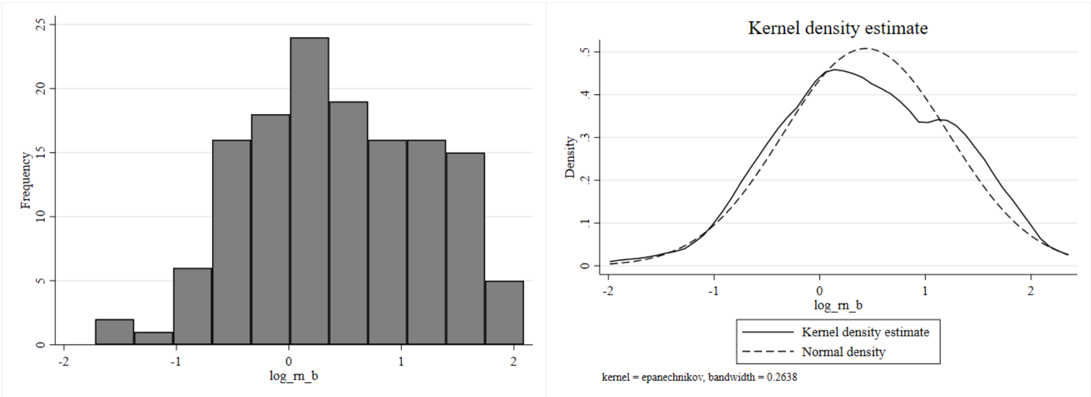

Figure 8. Frequency distributions and kernel density estimates for natural logarithms of nominal revenues in billions USD.

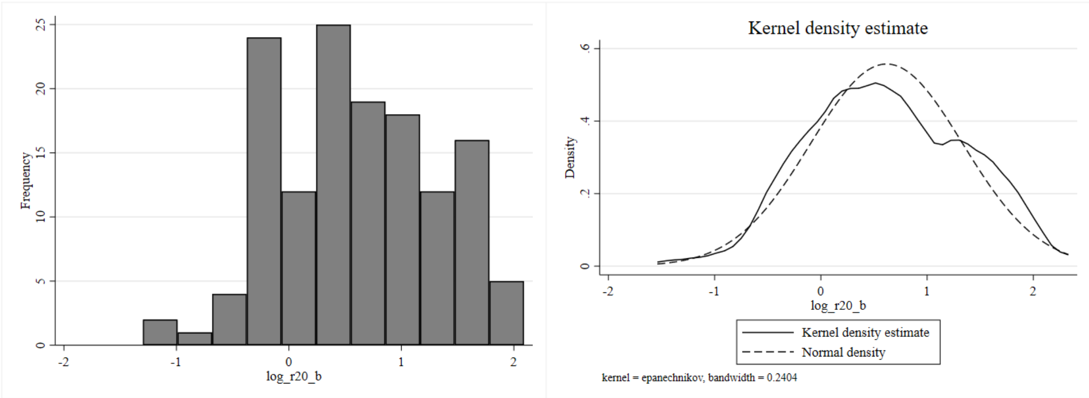

Figure 9. Frequency distributions and kernel density estimates for natural logarithms of revenues in 2020 billion USD.

As can be seen from figure 9, log-transformed nominal revenues are normally distributed, and from figure 10, log-transformed 2020 USD revenues are almost normally distributed.

As for the vector of product characteristics for entity *i* in year *t*, the variable *titles* represents the number of released game titles and is taken as a variable for descriptive statistics and figures, but is not used in the actual models, since it is perfectly collinear with the other variables of product characteristics vector. These platform variables categorize titles to multi-platform, console, and mobile games, with the variable *multi* containing titles that are released on at least one of both platforms contained in the console and mobile categories. The variable *console* includes titles that are released on either a home video game console, a personal computer, or both. The variable *mobile* includes all other platforms, which mainly consist of mobile and handheld games, but also include more niche categories such as VR and arcade games. The aim of these variables is to give quantitative data on the amount and type of products the entity has released in a given year.

The vector of product characteristics also includes variables that are aimed to measure the quality of the products released by the entity in a given year. These variables are based on critic evaluations of games called Metascores, which are highly considered review aggregates for video games, TV shows, music albums and others submitted on Metacritic.com. These scores range from zero to one hundred and the breakdown thereof is shown in table 2.

Table 2. General meaning of Metascore in video games. (Adapted from Metacritic.com).

Description	Score
Universal Acclaim	90 - 100
Generally Favorable Reviews	75 - 89
Mixed or Average Reviews	50 - 74
Generally Unfavorable Reviews	20 - 49
Overwhelming Dislike	0 - 19

In earlier literature, Cox (2014) has shown Metascores to be one of the most statistically significant contributors to sales volume of games, with each unit increase in Metascore contributing to about one and a half percent increase in sales of a game. The results of Cox (2014) suggest that video game unit sales are quality elastic.

In this study, variables *mc_10p*, *mc_med*, *mc_90p* are used to describe the distribution of Metascores for games released by the entity in a given year. The data for these variables, however, is not perfect. For a title to have a Metascore, it has to have been reviewed by at least four well-known news and/or media outlets, which is not the case for a lot of games included in the data. This is a possible cause for bias.

For the vector of price characteristics, it would be ideal to study the prices of core products more thoroughly, but unfortunately there is no data available on the releasing prices for games. Instead, there are four variables to measure the usage of different pricing models for the products the entity has released in a given year. These variables are *sub*, *f2p*, *dlc* and *mt*.

6.2.3 Data sources

As the video game industry has been a subject for very little empirical quantitative research, there is very little readily available reliable data. The data for this study is collected manually from multiple sources. Sources for data are presented in table 3.

Table 3. Sources for variables.

Variable	Variable source
log_rev_n	Annual reports, SEC Filings*
log_rev_20	Annual reports, SEC Filings*
titles	Marketplaces*, Giantbomb.com***, Mobygames.com***
multi	Marketplaces*, Giantbomb.com***, Mobygames.com***
console	Marketplaces*, Giantbomb.com***, Mobygames.com***
mobile	Marketplaces*, Giantbomb.com***, Mobygames.com***
mc_10p	Metacritic.com
mc_med	Metacritic.com
mc_90p	Metacritic.com
sub	Marketplaces**
f2p	Marketplaces**
dlc	Marketplaces**
mt	Marketplaces**

* Revenue is taken with originally reported currency, conversed to USD with reporting day's exchange rate, and in log_rev_20 then transformed to 2020 USD with CPI

** Marketplaces include Xbox Games Store (formerly known as Xbox Marketplace), Microsoft Store, PlayStation Store, Steam Store, Nintendo Games Store, Apple App Store and Google Play Store

*** These sources include user-created lists of games. All data used is manually checked from other online sources as well.

6.2.4 Notes and limitations to data

Out of the seven entities included in the study, the main industry of six is producing and publishing of video games, and their revenues extracted from annual reports have not been corrected for revenue from other ventures than video games, because these ventures have been considered to be minor. Bandai Namco Holdings Inc., however, is a holding company that has other major ventures as well, like toys, music, movies, and amusement parks. Hence, from the integrated annual reports of Bandai Namco Holdings, the revenues of only Bandai Namco Entertainment have been considered in the data.

All the entities included in the data are major publishers in the video game industry. All of them are listed companies. For a larger scale study, it would be in our interest to examine a larger number of companies, both big and small, but the constraint to this again is data availability. Following significant barriers were met when gathering data:

1. Companies that are on the video game industry but have other significant business industries could not be included in the study (excluding Bandai Namco). These companies include, for instance, Tencent, Valve, and Warner Bros.

2. Companies that are on the video game industry but have significant hardware production could not be included in the study, because hardware and software revenues are not specified in their financial reports. These companies include Microsoft, Sony, and Nintendo.

3. Companies that are too new for the reviewed time period of 2000 – 2020 could not be included in the study. Albeit there are missing values in the data for Square Enix and Bandai Namco, these missing values are dealt with Stata.

4. Privately held companies could not be included in the study as they have no obligation to report yearly revenues.

With these constraints, the total amount of companies for analysis is limited to seven, with 138 total observations.

The data for this study includes variables to explain the generated revenue of firms in the video game industry for the financial year. There are no variables, however, to account for continuous revenue gathered from titles released in prior periods. As games as a service is a substantial business model used in the industry at the present time, continuous revenue can be assumed to be an important factor in explaining annual revenues of the firms in the industry. It would be in our interest to account for continuous revenue in the data and models, but public annual revenues do not allocate revenues to their corresponding production and costs, or specify revenue gathered from individual titles. In an ideal scenario, it would be in our interest to specifically study individual products and their characteristics, pricing strategies etc., like in Courty and Pagliero (2012), but because of restricted data availability this is not possible and instead, annual summaries are studied.

One way of addressing continuous revenue would be to add lagged variables, but this did not result in significant outcomes when tested in various models. Another way would be to include ‘GaaS’-variables to measure titles that are expected to produce continuous revenue in the years after their release, but this solution is challenged by limitations to data availability. More specifically, there is sufficient data available on intervals of content dripping, but it can be assumed that most popular titles generate turnover long after their content updates are ended.

As the revenues in annual reports are from fiscal years of the firms in question, all data has been assigned to the equivalent period. For instance, as the fiscal year of Electronic Arts lasts from the beginning of April to the end of March, the titles to be included in the observation for the given year are also released between April and March.

There are, however, two fiscal year changes within the firms of this study that take place during the reviewed time series. These changes have been corrected by including titles of which release date belong to both the old and new accounting periods to both years.

The vector of price characteristics includes shares of games using the subscription model, free-to-play model, expansion-type DLC, and microtransactions. Like Zendle et al. (2020), the presence or absence of these features is coded manually on whether the attribute appeared in the game at the time of analysis. Hence, it is likely that some games that have been coded as featuring microtransactions or others of these characteristics have added or removed these features during this study’s period. It is infeasible to qualify whether these features have been present at the time of the titles’ release, which is also a part of the problem with continuous revenue discussed earlier.

Zendle et al. (2020) had two human coders examine the games in question, and the coding on in-game features, including cosmetic microtransactions, pay to win microtransactions and loot boxes, was based on agreement of the two coders for which Cohen’s Kappa was calculated. This study, however, does not categorize microtransactions by their type and thus relies on raw data taken from multiple marketplaces to examine whether a game uses microtransactions and expansive content. There is no feasible way of categorizing additional content, and hence an add-on, DLC, microtransaction or other in-app purchase that has a price of less than or equal to 10 dollars is regarded as a microtransaction. With price higher than 10 dollars, the additional content is regarded as expansion-type DLC.

6.3 Hypotheses

Based on the economic theory of versioning and economic literature, we make four hypotheses regarding the expected results of the study. First, each variable is analysed for expectations, and then hypotheses are made.

Titles per year is expected to be on decline. This is purely based on observing the data. Though it could have something to do with the rising costs of producing video games, the rise of games as a service model where hit titles live longer, or other reasons, there is no reference for this. But, because of this observation on the data, and respectively for the fact that revenue is on the rise, it is hard to make expectations of titles-variables. An obvious expectation would be that titles-variables are positive and significant, but however not necessarily, as there could be a strong difference between 2000 – 2010 and 2010 – 2020.

For the titles-variables' expectations, the high budget AAA titles that have high expected sales are usually released on multiple if not all possible platforms. Thus, *multi,* is expected to be positive and significant. Mobile games is the fastest growing segment as shown in figure 2, so *mobile* is also expected to be positive and significant. Console/PC games (*console*) could be positive or negative, and significant or insignificant.

As Cox (2014) showed, Metascores are found to have high significance with unit sales of individual titles. In this study, as explained, Metascores are annual summaries of the sample firms' titles and there are three variables to present the annual distribution of Metascores. Because the video game industry is described as a hit-driven industry, the average quality of products can be meaningless if there are blockbusters in the mix. Thus, it is expected that at least the 90^{th} percentile of Metascores, *mc_90p*, is positive and significant. *Mc_10p* and *Mc_med* could be significant or insignificant.

The vector of price characteristics is at the center of this study, and they are expected to be the most significant ones. There seems to be, however, a very limited number of titles using subscription-based model in the data. In addition to this, subscription-based games are a subject for continuous revenue not accounted for in this study, with some subscription-model titles receiving support, updates, and new content even 10+ years after their release. For these reasons, *sub* could be insignificant, or negative and significant.

Though free-to-play is the de facto business model of the video game industry these days, it is unlikely that even the most popular f2p titles break even to equivalent revenue had they been premium titles during their first year. Since continuous revenue is not accounted for in the data, *f2p* is expected to be negative and significant.

Variables *dlc* and *mt* are expected to be highly significant and positive. In addition to this, the sum of their coefficients is expected to be higher than that of the negative *f2p*, which would support the assumption that in-app purchases of free-to-play titles make up for the revenue lost when giving the core products for free.

As a summary of these expectations, the following hypotheses for the study are made:

Hypothesis 1: Microtransactions (*mt*) are the most significant and positive factor for revenue of the companies in the study.

Hypothesis 2: Free-to-play titles are a negative and significant factor for revenue of the companies in the study.

Hypothesis 3: The sum of coefficients of free-to-play games (*f2p*), microtransactions (*mt*) and additional downloadable content (*dlc*) is positive.

Hypothesis 4: 90^{th} percentile of Metascores (*mc_90p*) is positive and significant.

6.4 Descriptive statistics and figures

6.4.1 Descriptive statistics

The descriptive statistics for variables are presented in table 4.

Table 4. Descriptive statistics for variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
log_rev_n	138	0.437	0.785	-1.722	2.090
log_rev_20	138	0.619	0.716	-1.298	2.090
titles	141	30.603	15.657	3	80
multi	141	3.348	4.219	0	25
console	141	17.142	10.414	3	54
mobile	141	10.113	8.895	0	42
mc_10p	141	57.4	9.482	25	79.4
mc_med	141	73.3	5.667	55	84
mc_90p	141	84.6	4.141	71.8	94.2
sub	141	0.0048	0.0136	0	0.0714
f2p	141	0.0781	0.1117	0	0.4615
dlc	141	0.1986	0.2323	0	0.9091
mt	141	0.2967	0.2836	0	1

As can be seen from table 4, logarithmic revenues have rather large standard deviations which underline the need for log transforming. On average, a company in the study makes nominal revenue of 1.548 billion USD, and 1.857 billion in 2020 USD. The company releases 30 games in a year, of which 3 are multiplatform games, 17 console and 10 mobile games.

The mean Metascore of games is 73.3, which is considerably higher than that of Cox's (2014) study, in which the mean for Metascore was 68.43. This, however, is because of the yearly aggregates and the individual mean of the 4315 games included in this study is 70.96, which is still larger than that of Cox (2014) but does not deviate significantly.

As for the pricing variables, there are very few titles using the subscription model, with the annual maximum for the variable being only 7.14% and the mean 0.48%. On average, a company in the study uses free-to-play model on 7.8% of their titles released in a year, downloadable additional content on 19.9% and microtransactions on 29.7% of their titles released in a year.

6.4.2 Descriptive figures

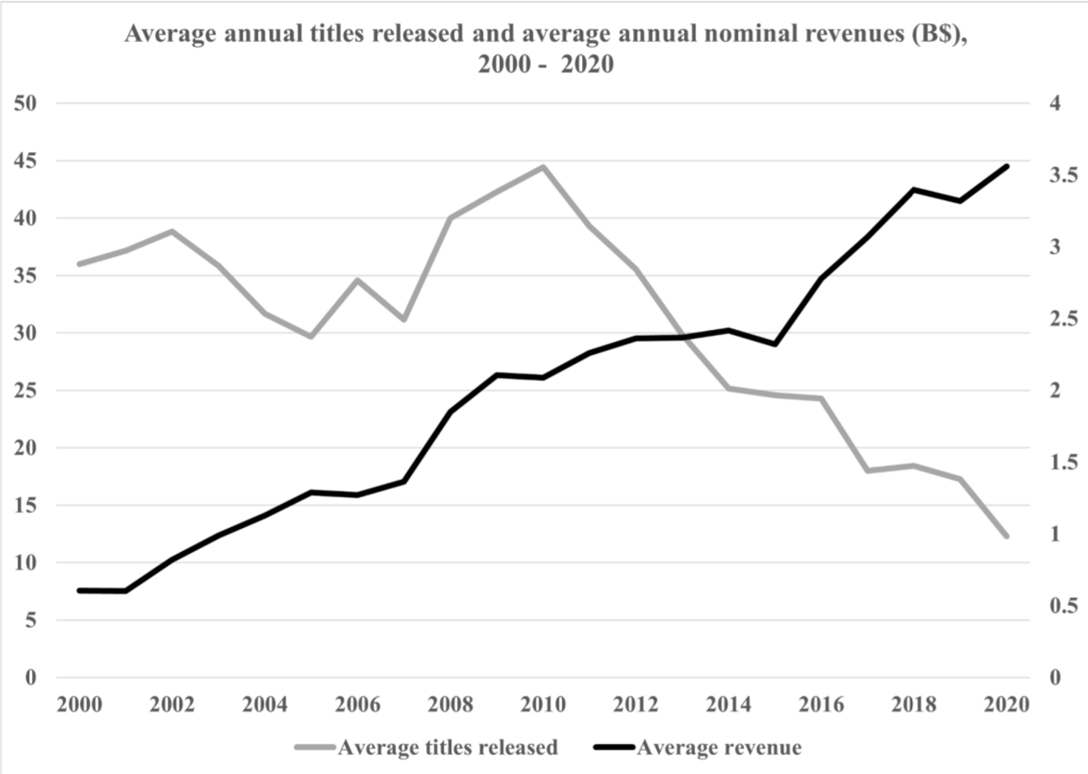

Figure 10. Average annual titles released and average annual nominal revenues, in billions of USD. Data for 7 firms of the study.

As can be seen from figure 10, the assumption of declining titles released per year seems to be correct on average level. There is a clear break point to be seen around 2010. At the same time, average revenue is on the rise, which means that revenue per title is greatly on the rise.

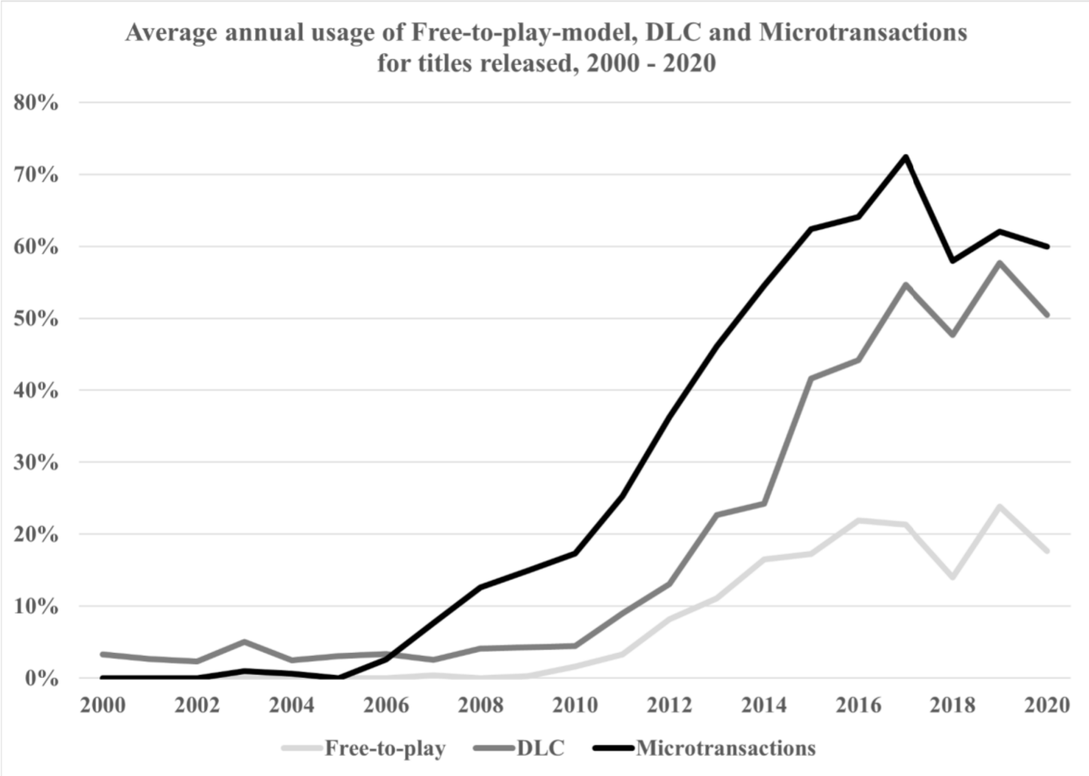

Figure 11. Average annual usage of Free-to-play model, DLC and Microtransactions for titles released. Data for 7 firms of the study.

As can be seen from figure 11, the usage of DLC and microtransactions became more common around 2010, which is the same time as the average titles released started to decline. Regarding microtransactions, the figure shows results almost identical to Zendle et al. (2020) seen on figure 5.

Since 2017, the average usage of microtransactions seems to be on the decline. This could be either coincidence in the sample, or it could have association with the fact that the gaming community has a rather negative attitude towards microtransactions (Tomić, 2019), especially pay to win microtransactions. By withdrawing the usage of microtransaction in a portion of titles, firms could try to diversify their games portfolio for different consumer preferences – to those that okay with microtransactions, and to those that despise them. In addition to this, loot boxes being associated with gambling could have an effect on the total usage of microtransactions.

By comparing figures 11 and 11, it can be seen that there is still significant growth on revenue before 2010 that is hardly entirely explainable with the usage of versioning pricing models. The additional factors for this growth could be the growth to average annual titles released between 2007 and 2010, as well as the emergence of the mobile games segment, and increased general demand for video games due to, for instance, shifting demographics.

6.5 Model selection

As two of the companies included in the study have entered the market over the sample period, we have an unbalanced panel dataset. We assume, however, that the missing values are missing completely at random (MCAR), as the missingness is not caused by the missing values themselves. Thus, Stata is able to handle the unbalanced panel and uses listwise deletion to exclude any observations that have missing values, either in the regressand or regressors. The listwise deletion, however, reduces our observations to 138 and some information is lost.

6.5.1 Unit root test

In order for the two dependent variables to be suitable for regression modelling, they need to be stationary. Stationarity is tested with the Im-Pesaran-Shin unit root test in Stata, which is selected because it is suitable for unbalanced panel data models.

As seen in figure 11, the logs of nominal revenues have upward deterministic trends. This is controlled for by including lags with AIC selection in Im-Pesaran-Shin tests. The information criteria, however, chose 0 lags as the most suitable.

The full results of unit root tests are presented in appendix 1. The results show that the null hypotheses of the observation series containing unit roots are rejected, and the variables are stationary.

6.5.2 F-test and LM test

The next thing to do is to conclude whether Pooled Ordinary Least Squared, Fixed Effect, or Random Effect model is preferred. (Park, 2011). For this, we conduct the F-Test and LM Test.

F-Test for fixed effects is a formal test to examine whether all dummy parameters except for one for the dropped are all zero. (H_0: $\mu_1 = \ldots = \mu_{n-1} = 0$). (Park, 2011). If the null hypothesis is rejected, the Fixed Effects model is preferred over the Pooled OLS. The full results for two F-tests are shown in appendix 2.

F-tests are conducted with both dependent variable models. On both models, the null hypothesis is rejected (p>0.000 and p>0.000, respectively), and the Fixed Effect model is preferred over the Pooled OLS.

Breusch-Pagan's (1980) Lagrange Multiplier (LM) test is a formal test to examine whether the individual or time specific variance components are zero. (H_0: $\sigma_u^2 = 0$). If the null hypothesis is rejected, the Random Effects model is preferred over the Pooled OLS. The full results for two LM tests are shown in appendix 3.

LM tests are conducted with both dependent variable models. As a result, the Chi-squared is 0.00 on both models (p<1.000 and p<1.000, respectively), and the null hypothesis of no random effects is not rejected. Thus, the Pooled OLS is preferred over the Random Effects model.

6.5.3 Models

As the null in the F-test was rejected and not in the LM test, we conclude that Fixed Effects (within) model is preferred. This means analyzing the impact of variables that vary over time and removing the effect of time-invariant characteristics. (Torres-Reyna, 2007). This is in line with the interests of our study. The estimator results in Fixed Effects model are the same as with the Least Square Dummy Variable model (LSDV).

As mentioned, the regression is done with two different dependent variables. The first model, in which the revenues of entities are taken as nominal values, is

$$log\_rev\_n_{it} = \beta_1 multi_{it} + \beta_2 console_{it} + \beta_3 mobile_{it} + \beta_4 mc\_10p_{it} + \beta_5 mc\_med_{it} + \beta_6 mc\_90p_{it} + \beta_7 sub_{it} + \beta_8 f2p_{it} + \beta_9 dlc_{it} + \beta_{10} mt_{it} + \alpha_i + \mu_{it} \quad (13)$$

where $log\_rev\_n_{it}$ is the dependent variable, the right-hand side variables are as explained in table 1, β_1 - β_{10} are the regression coefficients, α_i is the entity-specific intercept, and μ_{it} is the error term.

The second model, in which the revenues of entities are converted to 2020 USD is

$$log\_rev\_20_{it} = \beta_1 multi_{it} + \beta_2 console_{it} + \beta_3 mobile_{it} + \beta_4 mc\_10p_{it} + \beta_5 mc\_med_{it} + \beta_6 mc\_90p_{it} + \beta_7 sub_{it} + \beta_8 f2p_{it} + \beta_9 dlc_{it} + \beta_{10} mt_{it} + \alpha_i + \mu_{it} \quad (14)$$

where $log\_rev\_20_{it}$ is the dependent variable, the right-hand side variables are as explained in table 1, β_1 - β_{10} are the regression coefficients, α_i is the entity-specific intercept, and μ_{it} is the error term.

As tests in Stata point out, there is both heteroskedasticity and autocorrelation in the dataset. Also, microeconomic panel datasets are likely to exhibit complex patterns of mutual dependence between the cross-sectional units. (Hoechle, 2007). Thus, Driscoll-Kraay (1998) standard errors are used, which are modified Newey-West (1987) standard errors that are not only robust to heteroskedasticity and within-unit serial correlation, but also to lagged spatial correlation. This makes Driscoll-Kraay standard errors particularly practical in panel datasets that have longer time dimension *T* than cross-sectional dimension *N*, which is the case in this study.

The maximum lag considered in the autocorrelation structure is chosen with heuristic approach shown by Hoechle (2007):

$$m(T) = floor[4(T/100)^{\frac{2}{9}}] \tag{15}$$

This calculation yields the lag choice of 2 in our study.

6.6 Regression results

Table 5 presents the coefficient values and Driscoll-Kraay standard errors (in parentheses) for the two regressions.

Table 5. Regression results.

	(1) log_rev_n	(2) log_rev_20
multi	.020016** (.007822)	.016775** (.00702)
console	.000744 (.00461)	.003079 (.003937)
mobile	.012125** (.005082)	.010945** (.004561)
mc_10p	.000481 (.005183)	-.000389 (.004752)
mc_med	-.007023 (.00946)	-.006073 (.008369)
mc_90p	.009585 (.012286)	.009133 (.011666)
sub	.253998 (1.535445)	.254006 (1.389511)
f2p	-1.231893** (.490743)	-1.178484** (.441402)
dlc	.638453** (.29436)	.61629** (.279722)
mt	1.522955*** (.331086)	1.171465*** (.283831)
_cons	-.585139 (1.170339)	-.295209 (1.136393)
Observations	138	138
Within R^2	.541532	.448788

*** Significant at 1 % level, ** Significant at 5 % level, * Significant at 10 % level

As can be seen from table 5, the Within R-squared of 0.541532 and 0.448788 tell that the models have significant explanatory power over the revenues of the included companies.

There are no differences on significant variable coefficients between the models, meaning that the exchange rates, currency conversions and inflation did not have significance over the viewing interval.

The interpretation and analysis for the regression results of each variable are presented next. The results are interpreted quantitively with ceteris paribus assumption, as well as qualitatively. In addition to this, the hypotheses of this study are either rejected or confirmed and the second research question is answered.

The constants for both regressions are statistically insignificant, but suggest that with zero output, companies of the study are expected to make revenue of 0.557 billion USD (model 1, $p<.623$) and 0.744 billion USD (model 2, $p<.798$). In case of zero input, all income comes from previously released products, meaning that these are continuous revenue. Standard errors, however, are very large and the constants cannot be seen to have any significance in showing the true values of continuous revenues.

Out of the three titles variables, multiplatform titles released and mobile titles released are statistically significant, while console titles released is statistically insignificant. The signs and significances of *multi* and *mobile* are as expected, with multi having the coefficient of 0.0202 in model 1 with nominal revenues. This means that for every unit increase in multiplatform titles released, revenue is expected to increase by 2.02%, holding other variables constant ($p<.019$). For model 2 with revenues in 2020 USD, the coefficient of multi is 0.0168 ($p<.027$). Releasing an additional mobile game and holding all other variables constant is expected to increase revenue by 1.22% when measured in nominal currency and 1.10% when measured in 2020 USD ($p<.027$ and $p<.026$, respectively).

A 2.02% increase in revenue for developing and releasing of one additional unit of multi-platform games, and a 1.22% increase in revenue for developing and releasing of one additional unit of mobile games, however, can be regarded as a very small growth considering the general costs of developing games, not to mention the very small and insignificant coefficients of console games released. There is likely to be a breakpoint in the data considering the titles-variables around 2010 as suggested by figure 11. This would be in line with the earlier literature: the games as a service model has extended the life cycle of games and the releasing of large amounts of individual games has been substituted to maintaining and updating existing titles. As the revenues have increased at the same time, it is likely that the business model change is shrinking the coefficients.

None of the Metascore variables are significant in either of the models. This is contrary to Cox (2014). Though the coefficients of the variables are as expected; *mc_90p* is positive in both models, its p-values are 0.444 and 0.443 respectively, making it a redundant variable like the other Metascore variables, and thus the fourth hypothesis is rejected.

This result can have multiple interpretations. It indicates that in a medium-long interval, the improvement in game quality is not a significant factor to explain the industry growth, at least with this study's sample. As the qualities of the products have not risen on average, but the revenues of the firms on the study have, the conclusion is that a firm on the market has been able to increase revenue of a same quality product. This underlines this study's focus of presenting versioning as the most significant factor to revenue growth.

On the other hand, Metascores may not be unbiased estimators of product quality in the long run. Versioning may hamper the systematic quality approximation of video games, as the version the valuers play could differ significantly. Cox (2014) used data of games released over a 4-year period at the turn of versioning becoming more common. This is a much shorter viewing interval and thus is likely to have consumer expectations produce less bias on the Metascore values. Over a 21-year period, the true quality of games has undeniably improved, but this does not necessarily show up on Metascores, as the Metascore values are tied to their respective era of releasing and thus prone to expectation bias. Hence, it can be argued that on aggregate, a game released in 2020 that has a Metascore of 80 is of higher quality than a game released in 2000 that has a Metascore of 90.

Also, yearly aggregate distribution of games and their Metascores used in this study are likely not to represent the true qualities as accurately as individual analysis of games and their sales, like in Cox (2014). In addition to this, the missing values of

Metascores in the data of this study can cause the estimated percentiles and medians to be biased, as mentioned earlier.

The variable for subscription-based pricing model is insignificant on both models, as expected, with p-values being 0.870 and 0.857 respectively. This is, as said, most likely due to the models being unable to take continuous revenue into account, as well as subscription-based games being more of an anomaly in the dataset. The insignificance of subscription-based model on revenue, however, is in line with the fact that in recent years, the subscription model has shifted from games to game services, like Xbox Gamepass, PlayStation Now, EA Play and many others, the effect of which is not captured in the models.

The inclusion of free-to-play games has a negative (-1.232 and -1.178) and significant contribution on revenue and the second hypothesis is thus confirmed. This is as expected, as free products do not make revenue, and the revenue gathered by free-to-play games is presented in DLC and microtransaction variables. For a one percent increase in free-to-play model usage in games released in a year, ceteris paribus, revenue for companies in the study is expected to decline by 1.22% in nominal USD (model 1, $p<.021$) and 1.17% in 2020 USD (model 2, $p<.015$), compared to the situation had the company kept the one percent changed as pay-to-play.

The usage of downloadable additional content has a positive and significant effect on revenue in both models. For a one percent increase in DLC usage in games released in a year, ceteris paribus, revenue is expected to increase by 0.64% in nominal USD ($p<.042$) and 0.62% when measured in 2020 USD ($p<0.039$).

The coefficient for microtransactions usage is the largest and most significant (1.523, $p<.000$) when measured in nominal USD (model 1). When measured in 2020 USD (model 2), however, the negative coefficient of free-to-play (-1.178) is larger than that of microtransactions (1.171), but the microtransactions variable is still the most statistically significant ($p>0.001$). Considering the results along with the literature review of versioning, there is enough support for the first hypothesis though not all conditions were met. Microtransactions seem to be the most significant instrument of versioning at least among this study’s companies.

For a one percent increase in microtransactions usage in games released in a year, ceteris paribus, revenue is expected to increase by 1.53% in nominal USD (p<.000) and 1.18% when measured in 2020 USD (p<0.000).

The summed-up coefficients of free-to-play, DLC and microtransactions are 0.930 in model 1 and 0.609 in model 2, which confirm hypothesis three. This means that the regression suggests that for a firm considering versioning through free-to-play model with additional DLC and microtransactions offered (as an alternative for retail model), it is expected that when releasing 10 games in a year, the expected change in revenue for changing one of the games to a free-to-play with versioning monetization (10% change) is 9.51%. This underlines the fact that free-to-play has become the de facto business model in the industry, as in addition to the revenue increase, the firm in question also gets positive network externality as suggested by Hamari et al. (2020).

7 CONCLUSIONS

The video game market has gone through significant changes during the 21st century. Previously a niche leisure industry that could have been described as simple retail business, with project-like products that have high fixed costs and no returns before publishing, is now an industry with market size valued at over 150 billion USD. This makes the video game industry bigger than the movies and music industries combined.

Besides demand side factor changes, business model paradigm evolvements have arguably had their impact on the industry growth. This thesis analysed the relationship between the economic theory of versioning type price discrimination and the video game industry change.

The main findings of literature review on the traditional video game industry (before versioning and exponential growth) were that traditionally, the game makers have relied on rule-of-thumb pricing mechanisms (Nair, 2007) rather than actual profit-maximizing conditions. 60 USD has acted as a psychological price for the products (Tomić, 2019) which few entities have dared to cross. These conditions may have acted as a “pseudo-equilibrium” of the industry for decades, until new business and pricing models were invented. With the internet and digitalization fuelling the contingency for change, the demand for more complex games has also raised the costs of producing games. This has both opened up and enforced game developers to search for new streams of revenues in the 2000s. In addition to this, Zackariasson and Wilson (2014) point out that the industry’s developers have moved more toward professionalism which is also likely to have affected the change to more profitable pricing and business models.

During the 21st century, the video game industry has adopted versioning business models proposed by Shapiro and Varian (1999) to be the smart way to sell information. This type of second-degree price discrimination can also be described as quality discrimination, meaning selling differentiated products with different prices, as already suggested by Phelps (1983). Versioning takes many forms in video games, including microtransactions, expansion packs, and freemium games, while the subscription model can be seen as a classic form of two-part pricing, extracting additional consumer surplus with both access fees and subscription fees.

Microtransactions are a much-debated implementation of low-amount payments for virtual items as in-app purchases within video games. (Tomić, 2019). As shown by Zendle et al. (2020), microtransactions have become a more common practice of the industry between years 2012 and 2014.

Hamari et al. (2020) point out that freemium games are able to collect value even from non-paying customers with the increased network effects, which is also in line with the formal model proposed by Meagher and Teo (2005) in the context of subscription-based games, with the positive network externalities allowing firms to produce higher profits by reaching more consumers and charging higher prices. As the model's set of feasible access fees contains zero, it can be said that this is a significant cause for the rise of freemium games.

The empirical study of this thesis shows that using versioning and its adapted pricing models has considerable explanatory power on the revenue growth within the video game industry. Though there is no coverage on the demand side changes, as influencing factors such as demographic change affecting the demand for video games could not be included in the regressions, it is safe to conclude that business model changes have had their share on the growth regardless of the magnitude of the demand side changes.

Using two fixed-effects panel data regressions to estimate the factors of revenue making within big video game publishers measured in both nominal and 2020 conversed US dollars, we found that the level of microtransactions usage is the most statistically significant contributor to revenue of the included 7 publishers between the years 2000 and 2020. The main hypothesis (1) of the study was thus confirmed.

Other statistically significant contributors to revenue were the level of downloadable additional content usage as well as the number of multiplatform and mobile platform video game titles released. As seen from the data (figure 11), the annual number of released titles has a downwards sloping trend while revenue has an upwards sloping trend. This means that the revenue per released title is on the rise, though no substantial price changes, at least to AAA games sector (figure 5), have been noticed. This further confirms the hypothesis of versioning being the most significant contributor to the growth.

As a controversial perspective for the explosive growth, some point out that versioning in the industry through the usage of different kinds of microtransactions and additional content sold through in-app purchases can have negative welfare effects.

King et al. (2019) argue that some in-game purchasing systems can be regarded as unfair and exploitative, including the exploitative usage of player data to manipulate the prices and availability of in-app purchases to maximize the likelihood of a purchase. This raises the question of whether the industry is heading towards perfect price discrimination? Though no other references for this are available yet, it would seem likely. As limitless amount of data on player behaviour is available to be collected, it is also probable that this data is used to the advantage of the game makers. After some patterns in player behaviour become known, it is possible to implement game mechanics that incentivize and manipulate players to spend more on the game. This combined with the fact that some microtransactions (loot boxes) have already seen to have similarities with gambling, points out that some regulation may be needed to address welfare and prevent the firms of the video game industry from exploiting certain types of players more vulnerable to overspending on in-game purchases.

For further studies, it would be interesting to see larger scale quantitative analysis on factors affecting revenue in the video game industry, with less restrictions on data availability. It would also be interesting to see these studies be controlled for the actual demand increase that has undeniably happened during the last 10 to 20 years, to further analyse the effect that versioning has on the industry compared to the retail model. Future research on the welfare effects of unrestricted in-app purchase producing and selling is also topical. With the well-known negative welfare effects of problem gambling, unrestricted exploitation of players vulnerable to overspending could cause similar social welfare maximization problems on the video game industry as well.

REFERENCES

Aghion, P., & Howitt, P. (1992). A model of growth through creative destruction. *National Bureau of Economic Research Cambridge, Mass., USA,*

ARS Technica. (2020). The return of the $70 video game has been a long time coming. Retrieved from https://arstechnica.com/gaming/2020/07/the-return-of-the-70-video-game-has-been-a-long-time-coming/

Baye, M. R. (2009). *Managerial economics and business strategy.* McGraw-Hill New York, NY.

BBC. (2018). Video game loot boxes declared illegal under Belgium gambling laws. Retrieved from https://www.bbc.com/news/technology-43906306

Belleflamme, P. (2005). Versioning in the information economy: Theory and applications. *CESifo Economic Studies, 51*(2-3), 329-358.

Bloomberg. (2019). Peak video game? top analyst sees industry slumping in 2019. Retrieved from https://www.bloomberg.com/news/articles/2019-01-23/peak-video-game-top-analyst-sees-industry-slumping-in-2019

Bloomberg. (2020). Sony is struggling with PlayStation 5 price due to costly parts. Retrieved from https://www.bloomberg.com/news/articles/2020-02-14/sony-is-struggling-with-playstation-5-price-due-to-costly-parts

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies, 47*(1), 239-253.

Caves, R. E. (2000). *Creative industries: Contracts between art and commerce.* Harvard University Press.

Courty, P., & Pagliero, M. (2012). The impact of price discrimination on revenue: Evidence from the concert industry. *Review of Economics and Statistics, 94*(1), 359-369.

Cox, J. (2014). What makes a blockbuster video game? an empirical analysis of US sales data. *Managerial and Decision Economics, 35*(3), 189-198.

Derdenger, T. (2014). Technological tying and the intensity of price competition: An empirical analysis of the video game industry. *Quantitative Marketing and Economics, 12*(2), 127-165.

Dey, D., & Lahiri, A. (2016). Versioning: Go vertical in a horizontal market? *Journal of Management Information Systems, 33*(2), 546-572.

Ding, Y., Hicks, D., & Ju, J. (2018). The secondary market impact of quality and pricing decisions for new product generations. *Pacific Economic Review, 23*(2), 309-355.

Donovan, T. (2010). *Replay: The history of video games.* Yellow Ant.

Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics, 80*(4), 549-560.

Drummond, A., & Sauer, J. D. (2018). Video game loot boxes are psychologically akin to gambling. *Nature Human Behaviour, 2*(8), 530-532.

Dymek, M. (2010). Industrial phantasmagoria: Subcultural interactive cinema meets mass-cultural media of simulation. *PhD thesis, KTH/Royal Institute of Technology, Stockholm.*

Grand View Research. (2020). Video game market size, share & trends analysis report by device (console, mobile, computer), by type (online, offline), by region, and segment forecasts, 2020 - 2027. Retrieved from https://www.grandviewresearch.com/industry-analysis/video-game-market

Hall, R. L & Hitch, C. J. (1939). Price theory and business behavior. *Oxford Economic Papers, 2*, 12-45.

Hamari, J., Hanner, N., & Koivisto, J. (2020). "Why pay premium in freemium services?" A study on perceived value, continued use and purchase intentions in free-to-play games. *International Journal of Information Management, 51*, 102040.

Hamari, J., & Järvinen, A. (2011). Building customer relationship through game mechanics in social games. *Business, technological, and social dimensions of computer games: Multidisciplinary developments*, 348-365, IGI Global.

Harrison, M., & Kline, J. J. (2001). Quantity competition with access fees. *International Journal of Industrial Organization, 19*(3-4), 345-373.

Hart, C. B., Chou, H. Y., Cruea, M. D., Cuff, S., Kice, B., Liboriussen, B., . . . Wang, S. S. (2017). *The evolution and social impact of video game economics.* Lexington Books.

Hesmondhalgh, D., & Pratt, A. C. (2005). Cultural industries and cultural policy. *International Journal of Cultural Policy, 11*(1), 1-13.

Hoechle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence. *The Stata Journal, 7*(3), 281-312.

Juul, J. (2005). *Half-real: Video games between real rules and fictional worlds.* MIT press.

King, D. L., Delfabbro, P. H., Gainsbury, S. M., Dreier, M., Greer, N., & Billieux, J. (2019). Unfair play? video games as exploitative monetized services: An examination of game patents from a consumer protection perspective. *Computers in Human Behavior, 101*, 131-143.

Lehdonvirta, V. (2009). Virtual item sales as a revenue model: Identifying attributes that drive purchase decisions. *Electronic Commerce Research, 9*(1), 97-113.

Meagher, K., & Teo, E. G. S. (2005). Two-part tariffs in the online gaming industry: The role of creative destruction and network externalities. *Information Economics and Policy, 17*, 457-470.

Nair, H. (2007). Intertemporal price discrimination with forward-looking consumers: Application to the US market for console video-games. *Quantitative Marketing and Economics, 5*(3), 239-292.

Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica Vol. 55, no. 3 (may, 1987),* 703-708,

OECD. (2005). Digital broadband content: The online computer and video game industry. *OECD Publishing, Paris.*

Oi, W. Y. (1971). A Disneyland dilemma: Two-part tariffs for a Mickey Mouse monopoly. *The Quarterly Journal of Economics, 85*(1), 77-96.

Oxford English Dictionary. (a). Freemium. Retrieved from https://www-oed-com.pc124152.oulu.fi:9443/view/Entry/47580612?redirectedFrom=freemium#eid

Oxford English Dictionary. (b). Video game. Retrieved from https://www-oed-com.pc124152.oulu.fi:9443/view/Entry/36448402?redirectedFrom=video+game#eid15555246

Park, H. M. (2011). Practical guides to panel data modeling: A step-by-step analysis using Stata. *Public Management and Policy Analysis Program, Graduate School of International Relations, International University of Japan, 12*, 1-52.

Peckham, M. (2013). Why EA's video game microtransactions do and don't bother me. *Time.* Retrieved from https://techland.time.com/2013/02/28/why-eas-video-game-microtransactions-do-and-dont-bother-me/

Phlips, L. (1983). *The economics of price discrimination.* Cambridge University Press.

Pigou, A. C. (1920). *The economics of welfare.* Macmillan & Co, London.

Rayna, T., & Striukova, L. (2014). 'Few to many': Change of business model paradigm in the video game industry. *Digiworld Economic Journal,* (94), 61.

Runge, J., Nair, H. S., & Levav, J. (2019). Price promotions in "Freemium" settings. *Stanford University Graduate School of Business research paper*, 19.

Shapiro, C., & Varian, H. R. (1998). Versioning: The smart way to sell information. *Harvard Business Review, 6*, 106, 106.

Shapiro, C., & Varian, H. R. (1999). *Information rules: A strategic guide to the network economy.* Harvard Business Press.

Tomić, N. (2017). Effects of micro transactions on video games industry. *Megatrend Revija, 14*(3), 239-257.

Tomić, N. (2019). Economic model of microtransactions in video games. *J.Econ.Sci.Res.Vol, 1*(01).

Torres-Reyna, O. (2007). Panel data analysis fixed and random effects using Stata (v. 4.2). *Data & Statistical Services, Princeton University,* 112.

Zackariasson, P., & Wilson, T. L. (2014). *The video game industry: Formation, present state, and future.* Routledge.

Zendle, D., & Cairns, P. (2019). Loot boxes are again linked to problem gambling: Results of a replication study. *PloS One, 14*(3), e0213194.

Zendle, D., Meyer, R., & Ballou, N. (2020). The changing face of desktop video game monetisation: An exploration of exposure to loot boxes, pay to win, and cosmetic microtransactions in the most-played steam games of 2010-2019. *PloS One, 15*(5).

APPENDICES

Appendix 1. Unit root tests

```
Im-Pesaran-Shin unit-root test for log_rev_n

H0: All panels contain unit roots           Number of panels       =      7
Ha: Some panels are stationary              Avg. number of periods =  19.71

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                       sequentially
Time trend:   Not included

ADF regressions: 0.00 lags average (chosen by AIC)

                     Statistic      p-value

 W-t-bar              -1.6629        0.0482
```

Figure 12. Im-Pesaran-Shin unit-root test with nominal revenues as the dependent variable.

```
Im-Pesaran-Shin unit-root test for log_rev_20

H0: All panels contain unit roots           Number of panels       =      7
Ha: Some panels are stationary              Avg. number of periods =  19.71

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                       sequentially
Time trend:   Not included

ADF regressions: 0.00 lags average (chosen by AIC)

                     Statistic      p-value

 W-t-bar              -2.0946        0.0181
```

Figure 13. Im-Pesaran-Shin unit-root test with revenues conversed to 2020 USD as the dependent variable.

Appendix 2. F-test

```
 ( 1)  multi = 0
 ( 2)  cons = 0
 ( 3)  mob = 0
 ( 4)  mc_10p = 0
 ( 5)  mc_med = 0
 ( 6)  mc_90p = 0
 ( 7)  sub = 0
 ( 8)  f2p = 0
 ( 9)  dlc = 0
 (10)  mt = 0

       F( 10,   127) =   15.92
            Prob > F =    0.0000
```

```
 ( 1)  multi = 0
 ( 2)  cons = 0
 ( 3)  mob = 0
 ( 4)  mc_10p = 0
 ( 5)  mc_med = 0
 ( 6)  mc_90p = 0
 ( 7)  sub = 0
 ( 8)  f2p = 0
 ( 9)  dlc = 0
 (10)  mt = 0

       F( 10,   127) =   12.59
            Prob > F =    0.0000
```

Figure 14. F-tests for both dependent variables.

Appendix 3. LM tests

```
Breusch and Pagan Lagrangian multiplier test for random effects

log_rev_n[id,t] = Xb + u[id] + e[id,t]

Estimated results:
                 |       Var     SD = sqrt(Var)
        ---------+-----------------------------
       log_rev_n |   .6168131       .7853745
               e |   .1664025       .4079246
               u |          0              0

Test: Var(u) = 0
                      chibar2(01) =     0.00
                   Prob > chibar2 =   1.0000

log_rev_20[id,t] = Xb + u[id] + e[id,t]

Estimated results:
                 |       Var     SD = sqrt(Var)
        ---------+-----------------------------
        log_re~20 |   .5120916       .7156058
               e |   .1373718        .370637
               u |          0              0

Test: Var(u) = 0
                      chibar2(01) =     0.00
                   Prob > chibar2 =   1.0000
```

Figure 15. Breusch and Pagan Lagrangian multiplier (LM) tests for Random Effects for both dependent variables.