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Are secondary markets beneficial for a virtual world operator?

Economics

Master's thesis

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2016

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Abstract

Selling virtual goods for real money has become the dominant business model for virtual worlds in the past decade. As the amount of money involved in virtual goods sales increases, market performance questions gain relevance. In this thesis, we examine the effects of secondary markets on the profitability of a virtual world service provider operating under a virtual goods sales model. More specifically, we ask whether the service provider should tolerate secondary markets or seek to kill them off.

The structure of this thesis is as follows: we first review how virtual worlds operate as businesses and provide an analysis of the market conditions faced by a virtual world operator to provide sufficient context for the reader. We then examine the inner workings of virtual economies and review structures commonly encountered within them. Next, we conduct a literature review on real world secondary market models and analyses. Finally, we evaluate the implications of real world secondary market results on secondary markets for virtual goods. In the final section, we present conclusions and possible avenues for further study.

We find that recent durable goods research suggests that a profit-maximizing monopolist will not shut down secondary markets, but will choose to reduce durability of goods instead and that these results can apply to virtual worlds as well. However, we also show that the question of allowing or not allowing secondary markets cannot be answered based on profitability alone and that service providers have to also account for externalities brought on by secondary markets.

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1. Introduction

1.1 Background

In recent years, selling virtual goods has become the dominant business model in the games industry. Instead of charging players for the game client or requiring a monthly subscription fee, game publishers allow players to play for free and tempt them to purchase virtual goods for real money within the games. Games operating using a virtual good sales model and requiring no upfront payment the players are commonly known as *free-to-play*, or 'F2P'. On the PC platform alone, free-to-play games monetizing through virtual goods sales earned $16.4 billion in revenue in 2014. They also were the dominant revenue driver in the market with a 67% share of the $24.4 billion total revenues versus the 33% share held by pay-to-play titles (Newzoo, 2014).

As the number of dollars involved in virtual goods business keeps growing, market performance related questions gain relevance. We examine one such question in this thesis: how does the existence of real money secondary markets for virtual goods impact operator profits? In practical terms, should profit-maximizing virtual world operators embrace these secondary markets or seek to eliminate them?

As little research, theoretical or empirical, exists on the effects of secondary markets in virtual environments, we will conduct our analysis based on real world secondary market literature and seek to apply real world secondary market theory towards the special economic structures of virtual environments. Real world theoretical frameworks suitable for this are available thanks to several authors who have examined durable goods and secondary markets in the past decades. As recounted by Waldman (2003), microeconomic theory of durable goods (and the secondary markets that existence of durable goods give rise to) saw several major advances in the 1970s through individual contributions of Peter Swan, Ronald Coase and George Akerlof. Swan examined the question of optimal durability for durable goods, Coase the effects of time inconsistency (in other words, how do sales of durable goods tomorrow affect tomorrow's value of durable goods sold today), and Akerlof asymmetric information and adverse selection on secondary markets. These early fundamental models were later on turned into more realistic models by authors such as Igal Hendel, Alessandro Lizzeri, Michael Waldman, Jeffrey Shulman, Anne Coughlan and others.

When it comes to how secondary markets impact primary market profits, the jury is still out. Different authors have arrived at different outcomes depending on the set of assumptions inherent in their models and arguments for and against allowing secondary markets to exist have been presented. The main argument against allowing secondary markets is that secondary markets eat manufacturer profits because used goods create competition for new goods by acting as close substitutes. Instead of buying a new good, consumers can choose to buy used goods instead; especially so if they offer better value in terms of price. As a result, the existence of a secondary market limits the amount of buyers in the primary market and thus reduces the amount of profit a monopolistic seller can extract (e.g. Miller (1974), Liebowitz (1982) and Rust (1986)). On the other hand, it has been argued that secondary markets may also have beneficial effects on primary market profits. Shulman & Coughlan (2007) find that allowing the existence of a secondary market increases primary market sales by reducing the risk faced by the buyer, as purchased assets can be liquidated in the future. On a similar note, existence of a secondary market also enables investment, as assets that appreciate in value can be traded onwards in the future. We will examine these arguments in detail later on in this thesis.

While widespread adoption of virtual goods sales as a revenue model in online games is a relatively recent development, trading virtual goods for real money has been around for some time. On the primary market side, one of the first companies to pioneer virtual goods sales as a revenue model was *Iron Realms* with their MUD[1] *Achaea* in 1997 (Mihaly, 2009). The model gained further traction in the mid-2000s when adopted by companies such as the Korean social media giant *Cyworld*. Secondary market trading of virtual items for real money first emerged in 1999, when users involved in MMORPGs[2] started selling their in-game possessions to other users for real money on online auction sites. The number one intermediary at the time was eBay, but since then specialized auction sites concentrating on specific games and environments have followed suit. As a change to the initial development trend, the growth of the real money market of virtual goods has more recently been increasingly driven by primary market trade, that is, operators selling virtual assets directly to their users.

It should be noted that the implications of allowing or disallowing the existence of secondary markets for virtual goods is not only limited to virtual worlds and online games, but also hold significance towards other virtual mediums such as social networks. Examples of online services that make use of the virtual goods sales model include the U.S. social networking site *Facebook*, the Chinese instant messaging service *Tencent QQ* and the Korean social networking site *Cyworld*. Items are sold on two levels: by the service provider (e.g. Facebook itself) or by application developers (authors of social games that utilize virtual good sales in their revenue model). While these services are not virtual worlds in the traditional sense, the rules that their internal markets adhere to can be very similar to those inside

[1] MUD is short for “Multi-User Dungeon”, one of the earliest types of a multiplayer real-time virtual world.
[2] Massively multiplayer online roleplaying games, see 1.5 Terms and definitions for a more detailed description.

virtual worlds. For the purposes of scope, however, we will focus the discussion on virtual worlds and leave conclusions regarding other similar mediums for further explorations.

Examples of virtual worlds using the virtual goods sales model

Clash of Clans is a free-to-play city building/strategy game by the Finnish game developer Supercell. It was released on iOS in August 2012 and has since frequented the top position in app stores in over 130 countries, including the biggest markets of Germany, Canada, UK and the USA. In early 2013, *Clash of Clans* had over 8.5 million daily active users and made $2.4 million per day in revenue (Forbes, 2013).

Habbo (previously *Habbo Hotel*) is a colorful, socially oriented virtual community owned and operated by Sulake Corporation. The game features chat rooms in form of virtual hotel rooms viewed from a top-down perspective. When first logging in, users create an avatar that then can be used to explore the hotel. New rooms can be created by all users and they can be decorated and customized to great extent. Sulake's revenue model is based on selling virtual assets: playing the game is free, but should the user for example wish to customize his room, the furniture has to be bought with real money. Sulake maintains a monopoly over the trade of virtual items in the game and secondary market transactions are forbidden, although at the moment of writing there were 51 pending auctions for *Habbo* items in the Finnish auction site *huuto.net*. Since its launch in 2000, *Habbo* has grown to a total of 30 online communities (or "hotels"). As of October 2009 over 148 million avatars have been registered and there are 14 million unique users logging in monthly (Sulake Corporation, 2009).

MapleStory is a free-of-charge, scrolling 2D massive multiuser online role-playing game developed by the South Korean company Wizet. Like most MMORPGs, the gameplay centers on venturing into dungeons, combating monsters and performing various quests, which in turn provide users with experience, items and "Mesos", the in-game currency of *MapleStory*. Mesos make up the other half of the game's two-currency system the other being "Cash Points". Cash Points are obtainable for real money and usable in "Cash Shops" all over the game world. While the game itself is free, the operator earns its revenues from selling virtual assets to users for real money. The items on sale in Cash Shops usually have mainly a decorative function and little effect on the actual gameplay. For example, items that affect performance in a straightforward way are not available. A typical item available in a Cash Shop would be a pet that follows the user around and helps by picking up the loot, thus saving time and extra clicks from the user. The estimated revenue for *MapleStory* in 2008 was $150-$500 million and the game had a worldwide user base of over 100 million (DFC Intelligence, 2009)

1.2 Research problem and objectives

The research questions in thesis are the following:

1. How do real-money secondary markets affect the distribution of surplus between market operators in virtual environments?
2. Should real-money trade of used virtual goods be permitted from the service providers' perspective?
3. If a secondary market exists, are there actions that the service provide can take to enhance profits?

1.3 Scope of study

This thesis examines the implications of allowing secondary market transactions of *real-money* durable goods in a virtual world where the operator mainly earns revenue via the primary market.

While the discussions in this thesis are intended to be applicable to all environments that fit the above definition, free-to-play titles are used as the anchoring point for practical discussions. First, they nearly without exception earn their revenues via the primary market and the implications of enabling secondary market transactions are especially interesting for them. Second, market data is more readily available for free-to-play titles due to the growing popularity of the model among game publishers, developers and the audience.

1.4 Structure of the study

In section two, I review some common terms and concepts to familiarize the reader with the subject and facilitate discussion. In the third part, I examine the real-world models on secondary markets and evaluate their suitability for analyzing virtual economic environment. In the fourth part, I proceed to examine the implications of including a secondary market in a virtual world by adjusting a real-world model to the presumptions prevalent in a virtual economy. In the final part, I conclude and briefly list topics and areas not addressed in this document that should be considered for future research.

1.5 Terms and definitions

The following key terms need to be defined for the purposes of this study:

Virtual worlds: Virtual worlds are computer-mediated social environments that allow thousands of users to participate simultaneously. The moniker *massively multiplayer online* (or 'MMO') is often used interchangeably when talking about virtual worlds. Virtual worlds come in many flavors and depending on the nature of the world, the users can take on different activities. These range from gameplay (fighting monsters, searching for treasure, combating other users etc.) to social activities (community building with other users, making friends, shopping for virtual items etc.). As virtual worlds are artificial, the rules, boundaries and mechanics that define the world are created and managed by the service provider. Consequently, the activities available in a certain world are only limited by technology or creativity.

This degree of freedom has allowed operators to create virtual worlds that cater for different niches of users with very different preferences when it comes to features and gameplay. One of the most popular genres in the past two decades has been *massively multiuser online role-playing games*[3] (or 'MMORPGs'). The genre includes titles such as *Ultima Online* (figure below), a game launched in 1997 that can be credited for first popularizing MMORPGs and *World of Warcraft*, a record-breaking online role-playing game launched in 2004 that had over 12 million monthly subscribers in its heyday (Blizzard Entertainment, 2008). As their name suggests, MMORPGs are role-playing games, where the user generally quests to develop his avatar through various challenges in a large fantasy world. In *World of Warcraft* for example, this includes completing quests, defeating monsters and exploring new areas, usually together with other users.

[3] In this thesis, MMOs are included in the definition of a virtual world.

Figure 1: Users interacting in Ultima Online, a massively multiplayer online role-playing game released in 1997

In contrast to intensive gameplay environments of MMORPGs, some virtual worlds are concentrated mainly on social interaction. As an example, *Habbo* (www.habbo.com) by Sulake Corporation is very much geared towards social mechanics and has no built-in gameplay elements at all. In *Habbo*, common activities include obtaining virtual furniture, decorating your own virtual room and hanging out with other users.

When talking about virtual worlds, I generally refer to third-party online gaming services. Although some critique has been put forward concerning the use of term “virtual world” to describe most of the online environments, I will use the term in this thesis as it is probably the most familiar to readers. The largest argument seems to be that the term is somewhat artificial and gives a false preconception of many online environments. More specifically, it refers strongly to a technological concept (an electronic replica of the real world), which in many cases online habitats is very untrue – online environments come in various types, some of which are conceptually very far from the real world. We can sidestep this critique for the purposes of this thesis, as the discussion mainly focuses on the economic framework of virtual worlds. While economic design choices might differ between different virtual worlds, the economic fundamentals they face remain the same.

Virtual goods: Virtual goods refer to digital items and services encountered inside virtual worlds. Goods available vary from decorative accessories to functional items that boost performance to time-savers that expedite access to locked content, depending on the design of the game or service they exist in. As Hamari (2009) succinctly points out, virtual goods are tied to the virtual world they exist in and value is commonly defined by that context – by virtual economy and other rules and structures of the virtual world. This creates the important distinction between virtual goods and information goods such as MP3 files bought from *iTunes.* The latter are not included in the definition of virtual goods. While virtual goods do possess similarities with other information goods (such as intangibility), there are critical differences in their attributes and how they function. As an example, a set of virtual clothes can only be worn by one person at a time – just like clothes in real world. In contrast, information goods are not rivalrous: an MP3 file may be copied to someone else while keeping the original, too. The differences between virtual and digital goods are elaborated on in the Appendix, section 6.1.

Virtual goods sales/Free-to-play

When discussing either the virtual goods sales model or free-to-play model, the intention is always to refer to business model in which the primary revenue driver is sales of virtual goods. Thus, the terms 'virtual goods sales model' and 'free-to-play model' are used interchangeably throughout the thesis. While this is not fully accurate, it matches the purposes of the thesis quite well: the effects of secondary markets on primary market profits are most relevant to titles use the primary market as the main revenue source, and this true for most free-to-play games.

Virtual world operator/publisher/service provider: Virtual world operator refers to a company that is in the business of running a virtual world. In most (if not all) cases the same company is the developer of the virtual world, responsible for maintaining the world and developing it further. In this thesis, I use the terms *virtual world operator, virtual world publisher* and *service provider* interchangeably.

Primary market: Primary market refers to virtual world operator selling new goods to users for the first time. When discussing virtual primary markets, the intention is to always refer to markets where virtual goods that are bought for real money, or more commonly, a virtual currency obtained using real money. While value transfers of currencies and items earned through gameplay are highly interesting, they are not the focus of this thesis.

Secondary market: Secondary market refers to the trading of used, second-hand goods between users. When discussing virtual secondary markets, the intention is to always refer to markets where virtual goods that are bought for real money, or more commonly, a virtual currency obtained using real money.

2. Business of virtual goods sales

The purpose of the section is to give the reader a general overview of the current market involving virtual goods sales in games. We will review the general business structures that virtual world operators work under and the market conditions they encounter.

For numbers, we will use free-to-play titles as the representative sample. Majority of the revenue earned via virtual item sales is earned through them, and reliable data regarding the market is more readily available due to the prevalence of the free-to-play model. While this choice omits some titles working with hybrid revenue models, it is should provide a representative overview of the market.

2.1 Review of prevalent revenue models

While this thesis primarily focuses on analyzing the impact of secondary markets on the profits of services earning their revenue through virtual goods sales, we will briefly go through the other established revenue models below. They will provide useful context for the discussions regarding hybrid models near the end of the paper.

Virtual world businesses have used a mix of revenue models in the past. Before the rise of free-to-play games, the dominant revenue model among online games was hourly, daily, weekly or monthly subscriptions. When *Legends of Future Past* (the first commercial text-based MMORPG) was launched in 1992 via CompuServe, it required users to pay a fee of $6.00 per hour. Using an hourly fee was well established at the time, as most of the users used dial-up modems and thus were accustomed on paying by the minute anyway. Five years later in 1997, *Ultima Online* was offered at its launch for a monthly fee of $10.00. In recent years, payment infrastructure development and the tightening competition among MMOs has encouraged operators to think up new revenue models to challenge the old ones and better adapt to the usage patterns users. New ways of collecting payments have been introduced, such as paying to unlock content as the game progresses or charging users for items bought from the operator in an otherwise free-of-charge environment.

In academia, virtual world revenue models have been explored by several authors. Hamari (2009) provides a comprehensive review on the available literature. The taxonomy by Lehdonvirta (2005) provides a useful framework for further discussion. Lehdonvirta in his literature review divides the virtual world revenue models into five categories: *charge for access, charge for the client program, charge for services, advertising and virtual asset sales*. For purposes of the discussion below, I have merged charge for services and virtual asset sales models under “virtual goods sales”. When talking about virtual goods sales, I am referring to both sales of virtual items as well as services.

It should be noted again that the revenue models below are not intrinsically exclusive. Combinatory models are common and examples of services using a combination of several different revenue models can be found in abundance. For example, *Second Life* famously engages in advertising collaboration with real-world brands while also monetizing its users through virtual goods sales and optional subscriptions. *World of Warcraft* started out with a pure subscription-based revenue model, but has since added optional value-added virtual goods that players can opt to purchase for real money.

Charge for access

Charge for access refers to charging a one-time or recurring fee for access to a service. In the Western market many virtual world operators traditionally required the player to pay an upfront subscription fee before they can access the service. Early variations of charge for access models included pay-per-minute models, but subscriptions later became the prevalent model as internet connections became cheaper and more available. Typically, the virtual world operators would charge a monthly subscription fee, with some operators providing discounts for customers who subscribed for longer periods at a time.

In Asia, "gaming cafés" provide a variation of the charge for access model, where customers pay the cafés for the usage of a seat, and the cafés purchase access from the virtual world operators at wholesale prices.

Charge for the client program

Charging a one-time fee for the client program is sometimes used by the virtual world operators to augment their revenue streams. The practice borrows from the traditional retail model for video games, where the primary revenue is generated from sales of the game client through physical retail channels. Physical retail channels are also used by virtual world operators. However, digital sales and distribution through online channels has become increasingly prevalent through the proliferation of digital distribution platforms such as Steam[4]. Digital distribution channels do away with requiring a customer to purchase a physical product. In case of Steam, customers receive a permanent right to download the game they bought.

[4] **Steam** is a digital distribution, digital rights management, multiplayer and communications platform developed by Valve Corporation. It is used to distribute games and related media online, from small independent developers to larger software houses.

In the context of virtual worlds, charging for the client program is commonly used in combination with other revenue models such as *charge for access* or *virtual goods sales*. This appears to be especially so for titles with high development cost and high perceived customer value: as the perceived valuation of the product is high, the operator can attempt to offset the development cost by charging an upfront fee.

Advertising

Advertising is a typical revenue model for smaller online games. There are Browser-based services can easily integrate advertisements into their revenue model without complex integration, as several third-party services offer plug-in functionality. Advertising is sometimes also used by larger titles as a complementary source of revenue.

Virtual goods sales

In the virtual goods sales model, the virtual world operator seeks to generate revenue by selling virtual goods to users.

Virtual goods sales differ fundamentally from the other presented revenue models due to its close integration with the rules and mechanics of the virtual worlds. Revenue models such as subscriptions or advertising do not usually directly interact with the internal mechanics such as gameplay. Rather, they often act as a separate revenue generation layer around the service that gates access or promotes products of external partners. Subscriptions commonly sell time-restricted access to the service (or parts of it) and advertising harvests earnings from directing users to external partners who then share revenues with the virtual world operator. In both cases, interaction with the internal workings of the virtual economy is limited.

The opposite applies to virtual goods sales, where the earnings model is very integrated and dependent on the laws of the virtual world. How a virtual world is designed and what kind of gameplay it offers has a large effect on the desirability of different types of virtual goods. Due to the intimate connection of virtual goods sales to the design of gameplay and achievement hierarchies inside of the worlds, game designers have been faced with new challenges when designing virtual worlds. Traditionally, virtual world designers have been seeking to provide entertaining and engaging experiences to the users. While this paradigm works well for revenue models that are geared around acquisition or retention of customers, does not remain entirely intact in virtual worlds feature virtual goods sales as their primary revenue model. While providing an engaging experience to the users is still a necessary condition that has to be met in order to have a sustainable business, designers have to also factor in monetization requirements to fulfill the needs of the revenue model. Successful monetization entails creation of user “needs” via gameplay mechanics to facilitate virtual goods sales. From an economic standpoint, virtual worlds are at a rather unique position where they are responsible for both generating demand for virtual goods as well as supply to cater to it.

As outlined in the introduction, the virtual goods sales model is the key revenue model in terms of the focus of this thesis. Since the revenues of an operator using a virtual goods sales model directly depends on the sales of new virtual goods, any effects that secondary markets might have also directly impact revenues. Should an aggregate negative effect from allowing trade of used goods between players exist, it can have a direct impact on the service providers’ profit. Other revenue models are not similarly exposed to the effects of secondary markets.

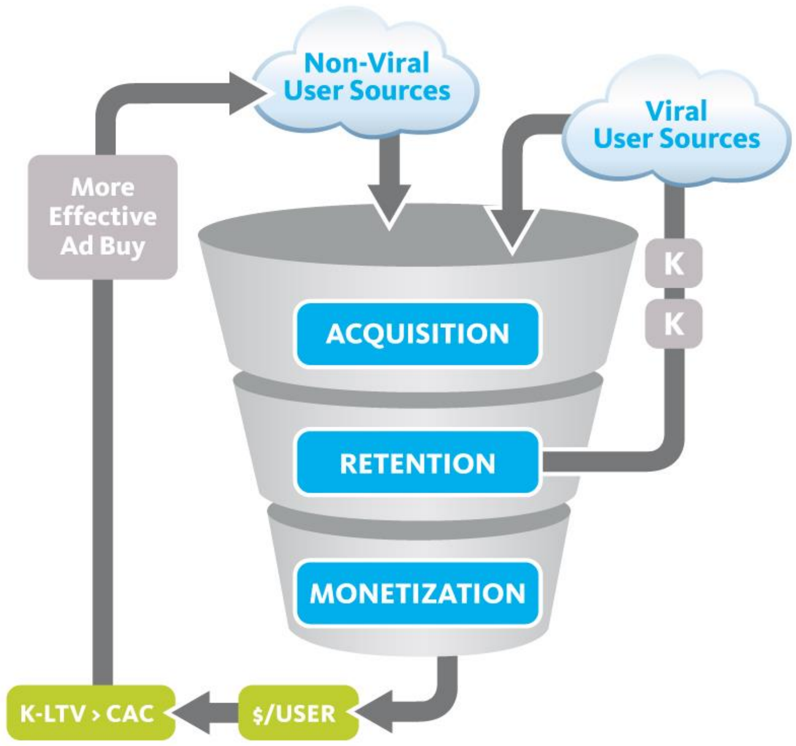
2.2 Virtual goods sales revenue model

The typical virtual goods sales value chain includes five distinct actors: developers, publishers, retailers, network service providers and customers (Pilawski, 2004). Developers are responsible for designing and creating the virtual world to retain and monetize customers and usually also are responsible for operating the virtual world after it has been opened up to the audience. Publishers have a similar role as their counterparts in book or movie publishing: they are responsible for marketing and market research and sometimes also handle distribution of the product. Retailers are responsible for merchandising and sales. Network service providers provide the operational infrastructure needed for virtual worlds: as some worlds may have millions of users, co-operation between the operator and the network service provider is sometimes very close. Finally, customers are the end-users of the virtual worlds and the source of revenue for the earlier parts of the value chain.

In some cases, two or more roles are combined. Development and publishing are sometimes handled by the same company, combining the two steps in the value chain. *CCP Games*, an independent developer and operator of *EVE Online* initially started working together with an external publishing company, but later bought the publishing rights back and currently handles publishing internally. On the flipside, large publishers such as *Electronic Arts* or *Sony* on the other hand may have multiple internal development studios that work exclusively to develop products for them.

As with traditional service industries, virtual goods sales businesses have developed models to evaluate business performance on an operations level. One of the more established models is the ARM funnel, where ARM stands for Acquisition, Retention and Monetization.

Figure 3. The Acquisition-Retention-Monetization Funnel (Kontagent, 2009)[5]



Each step is a layer of business: *acquisition* measures success in obtaining new customers, *retention* success in keeping them using the service, and *monetization* success in getting them to spend money within the service. The model is referred to as a funnel due to the fact that customers are lost on each step: not all acquired customers stay, and not all customers who end up staying actually pay.

The model is an adaptation from the models used in traditional service industry: a similar model was proposed by Blattberg and Deighton in 1996. They divided customer relationships into three stages: acquisition, retention and add-on selling. Hamari (2009) in his paper adapted the model of Blattberg and Deighton to better fit the context of virtual worlds: instead of selling add-ons, virtual world operators *monetize* their customers through virtual goods sales. Further layers that add onto the ARM-funnel have been proposed as well: additions that have gained traction among some businesses include

[5] In Figure 3, "K" refers to K-Factor which is a metric that measures how many new users each user brings into the virtual world. "CAC" is short for customer acquisition cost and "K-LTV" refers to social network lifetime value per user, a metric that measures how much revenue a user generates within its full lifecycle.

for example *activation* and *engagement.* Before customers become retained, they have to be activated, and before they can be monetized, they must be engaged.

The ARM-funnel also offers a way of breaking down the business of operating virtual worlds into two distinct layers: the outer layer and the inner layer. On the outer layer, virtual world operators compete against each other for acquisition of customers. On the inner layer, the virtual world operators seek to retain and monetize the customers they have managed to acquire.

2.3 Market analysis of the free-to-play market

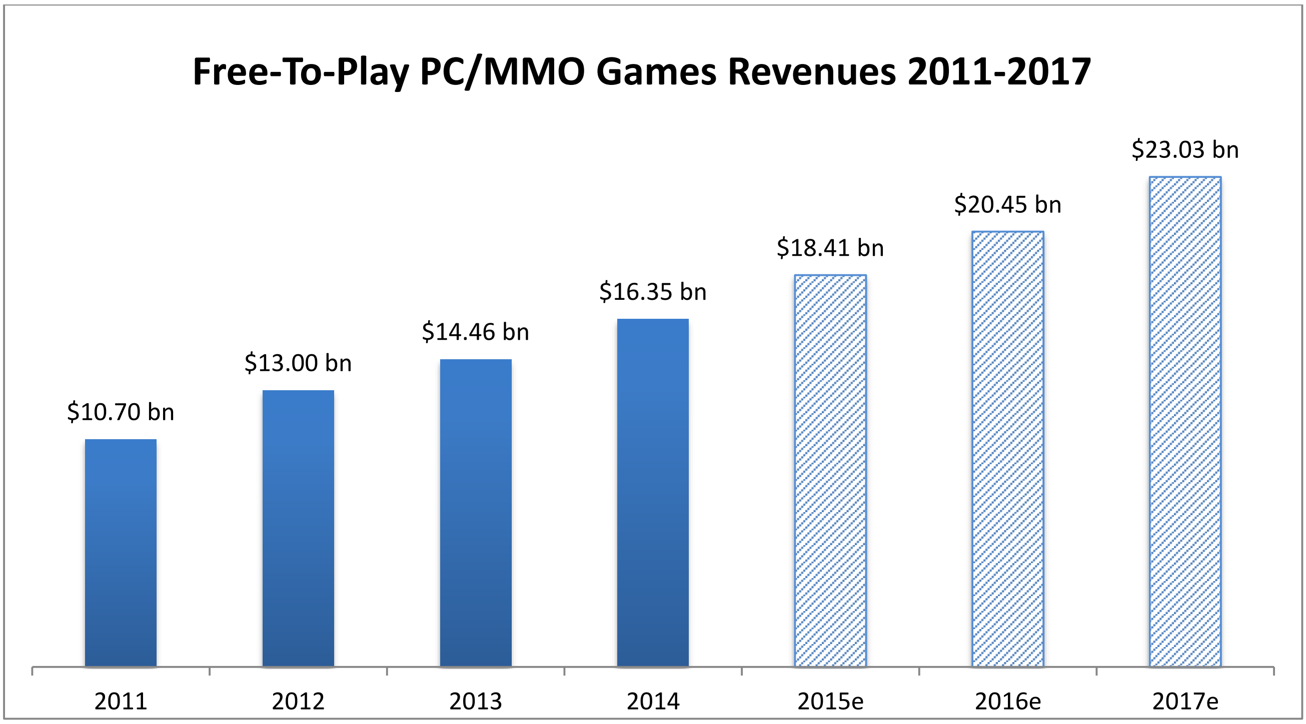
Market size

As can be seen in the figure below, the overall global games market grew from $70.4 billion in 2012 to an estimated $81.4 billion in 2014, with further growth expected to reach $102.9 billion in 2017.

Figure 2: Global Games Market Revenues 2012-2017 (Newzoo, 2014)

Free-to-play games contribute significantly to this trend: on PC, the F2P market has grown in terms of revenues at a yearly average rate of 15.3% between 2011 and 2014. The estimated total revenue rose from $10.70 billion in 2011 to $16.35 billion in 2014, with the expected revenues reaching $23.03 billion in 2017. (Newzoo, 2012), (Newzoo, 2014).

Figure 3: Free-To-Play PC/MMO Games Revenues 2011-2017 (Newzoo 2012, 2014)



Mobile games' market share has grown from 18% percent in 2012 to 27% in 2014. Mobile games are expected to hold a 34% market share by 2017 (GlobalCollect, 2013).

Growth in the free-to-play market is facilitated by several factors. First, market penetration in devices that enable playing free-to-play games such as computers, smartphones and tablets has continuously grown, enabling a larger audience to participate in free-to-play games and online virtual worlds. Year-on-year shipment growth for smartphones was estimated to be at 11.3% in 2015, with shipment volumes at 1.4 billion smartphones per year (IDC, 2015). Much of this growth is focused around emerging markets such as China and India. While the year-on-year growth tablet shipment has recently declined to an estimated -8.0%, much of the slowdown has been attributed to an already saturated market. Around 212 million tablets are shipped each year. Additionally, growth is expected turn positive again in the future, up to 3.1% by 2019 (IDC, 2015).

Second, as free-to-play games and virtual worlds are inherently online experiences and require internet connectivity, growth in both fixed and mobile broadband penetration has opened up new audiences. Mobile broadband penetration has grown globally from a few percent in 2007 to an estimated 47.2% in 2015. Highest concentrations can be found in Europe and United States, with 78.2% and 77.6% penetration, respectively. Fixed-broadband penetration has been growing at slower annual rate of 7% and is estimated to reach 11% by the end of 2015. In terms of regions, fixed-broadband penetration is highest in Europe with 29.6% of households having a fixed-broadband connection, with United States coming second with 18.0%. All in all, the number of people using the internet has grown from 400 million in 2000 to 3.2 billion in 2015 (ITU, 2015).

Third, developments in distribution infrastructure have made games more easily accessible to wider audiences than before. While previously you had to visit a physical store to obtain a game, you can now in most cases obtain the same game through online distribution channels. Some notable examples of these channels are Steam (PC), AppStore (iOS), Google Play (Android), Playstation Store (PlayStation) and Xbox Live (Xbox). Content available through digital distribution channels is often preliminary curated for quality by the service provider, lessening the risk of obtaining malware or compromised software. The channels also often provide features such as search functionality, curated recommendations, user reviews, rankings and other services that reduce friction for the user in terms of finding and obtaining games.

Finally, it could be argued that the free-to-play business model itself is enabling new audiences to engage with online games. While traditional business models always require an upfront charge before allowing gameplay, the free-to-play model (as indicated by name) allows players to play without charge. This removes the monetary barrier for entry and maximizes the number of players who potentially would play.

Threat of new entrants

Barriers to entry vary significantly depending on the platform. Initial capital requirements for developing an old-fashioned, content-heavy virtual world are steep, generally amounting to tens of millions of dollars. Prospective entrants to the market face high upfront fixed costs in form of research and development outlays as well as substantial on-going operating costs during the game development process, which can span over several years. The development of the most popular MMORPG to date, *World of Warcraft*, was stated to have cost $63 million dollars[6] and taken over 4 years to complete[7] and such figures do not seem like a fluke: as an extreme example, more than 800 people spent over six years and $200 million creating Electronic Arts' large-scale MMO *Star Wars: The Old Republic* (Los Angeles Times, 2012).

Free-to-play game companies face increased development complexity and through it higher risk, both in terms of production and operational cost. While in the past game companies could exclusively focus on design, production and testing and then release the finished product over to publishers and

[6] http://digitalbattle.com/2006/06/15/world-of-warcraft-cost-63-million/
[7] http://en.wikipedia.org/wiki/World_of_Warcraft

distributors, free-to-play games are commonly operated by the developer as an on-going service. This comes with an increased number of competencies a developer has to possess. Developers (or sometimes publishers, depending on the division of responsibilities) building a free-to-play product have to be competent in not just in creating fun, enjoyable experiences, but also have to ensure that their experiences are designed to provide attractive purchase options, have robust internal economies and contain sufficient depth overall to keep customers retained for months and years to generate revenue over long periods of time. Having long-term customers means investing in and operating a customer support department that answers to any problems or complaints the customers might have. In the games where users are able to interact with each other through the game, developers might find it important to have dedicated personnel to manage their player communities and foster positive interactions within them. As free-to-play games are often in operation 24 hours a day, 7 days a week, developers must know how to run operations to keep game servers alive and healthy as well as deliver updates and expansions to their product. Games operated worldwide might need to host servers in various regions and contract with third-parties. Billing solutions have to be in place to be able to charge players that wish to make purchases and these solutions need so support currencies and payment methods for every country the game is operated in, and so on.

Finally, development costs have been increasing overall due to hardware becoming more powerful and capable of higher fidelity, heightening customer expectations and consequently pushing developers to continuously raise the quality bar.

While development costs are high among top-end titles for PC and console platforms, the market has in the recent years evolved to new platforms such as mobile. On mobile, development teams are generally smaller and development costs lower. The cost of developing a mobile game are estimated to range between $10 thousand and $300 thousand[8], depending on the size of the project, which is still drastically lower compared to the millions in development spending on high-end PC and console titles.

Not all titles are equally resource intensive on PC and console platforms, however. Smaller developers have been shown to enter the market by focusing on innovative core features rather than on high fidelity and polish. On the other end of the development cost spectrum is *Minecraft*, an isometric 3D sandbox-building game somewhat reminiscent of lego building. *Minecraft* was independently developed by Markus Persson from May 2009 to September 2010. Estimating how much *Minecraft* cost to develop is difficult due to the nature of development (a single person working on the product without compensation), but it is probably safe to assert that it pales in comparison to titles requiring

[8] http://teamcooper.co.uk/blog/how-much-does-a-mobile-game-cost-to-develop/

several hundreds of people to develop. *Minecraft* has been available since in September 2010 and had at the time of writing sold nearly 23 million copies[9].

Achieving success with a low cost structure by focusing innovative core features and lighter distribution channels such as mobile or browser may be possible in terms of virtual worlds as well, and has already been demonstrated to a degree through success stories such as *Realm of the Mad God*, a browser-based MMO shooter game that was initially developed by two people and released in 2011. The game has since been acquired by Kabam.

If the product strategy chosen by the developer allows for it, the level of development cost can be influenced by adjusting the development inputs, such as the number of features or the quality of graphics. These development inputs are key factors in product differentiation and quality, however, and determining them should be part of a comprehensive strategy rather than purely driven from a cost management perspective.

Another aspect that could be discouraging entry is the virtual world operators' power over users due to the switching costs that users encounter. There are at least three identifiable sources of switching costs for the virtual world users. First, there are sometimes monetary costs for switching between virtual worlds, as entry to new virtual worlds sometimes comes with a price tag. This price tag is often fairly low, usually at the retail price of a new game or in the case of free-to-play games, zero. Second, users face switching costs due time and money they have already invested. Most virtual worlds are fully isolated from each other and do not offer any possibility to migrate characters or assets from one world to the other. This is because compatibility does not exist by default and is something that would have to be specifically engineered into existence. Since few companies creating virtual worlds have strong enough incentives to build such links to other worlds, time and money spent by users effectively becomes locked in. This results users developing degrees of commitment to the worlds they participate in. They may become victim to the sunk-cost fallacy (Kahneman & Tversky, 1979), where effort expended on participating in a virtual world makes them reluctant to discontinue their participation in it. Virtual worlds users might feel like they are forfeiting all previous time, effort and money spent on that world. A shrewd operator of a newly launched virtual world could attempt to mitigate users' switching costs by offering migration services to the players of a competing virtual world, allowing players to benefit from time and money spent in the competitor's virtual world when they migrate to the operator's world. Third, social relationships formed with others residing in the virtual world could

[9] https://minecraft.net/stats

potentially carry switching costs for the users. Virtual worlds are fundamentally social places, and users participating in them commonly make friends and acquaintances in the worlds they inhabit. The potential for loss could discourage users from migrating freely between worlds, as doing so would end in a loss of established social structures and rituals. It is therefore likely that social bonds to other residents of a virtual world contribute to switching costs, unless the whole social group is willing to move as a whole: there are examples of the social bonds overcoming the appeal of the product itself, with whole communities migrating from one service to another.

Assuming that switching costs exist, it is also logical to assume that they affect the elasticity of demand by making it more rigid. The monopolistic virtual world operator could thus optimize its profits after gaining a sufficient user population by hiking prices. As a counterargument, however, as the user population in virtual worlds is dynamic, raising prices could effectively cause new users not to join the world, as they would not be subject to the switching costs in the choosing phase. The adverse publicity associated with price hikes also serves as a deterrent for the virtual world operator, who has to also maintain the acquisition and retention of new users due to natural churn.

Network effects might also be a contributing factor to high barriers of entry, as users of a virtual world provide content for other users. As the number of users in a virtual world grows, the amount of content available for a single user grows as well. New entrants to the market may find themselves at a disadvantage to established market players prior to being able to accrue a 'critical mass' of users.

Threat of substitute products

As a form of entertainment, the virtual world and gaming industry faces a threat of substitution from other players in the entertainment industry, such as other television, movies, magazines, other online entertainment and so on. It would seem, however, that virtual worlds have some advantages that guard them against the threat of substitutes. First, consumers participating in virtual worlds might encounter switching costs that derive from their investment into the virtual world(s) they are part of. Progression achieved through time, money or social favors is a common core element in many virtual worlds. It is usually non-transferable: should a player choose to leave a world for good, progression gained through investment is rendered valueless until the player returns. Second, the free-to-play business model commonly encountered in many modern virtual worlds seems quite robust against substitutes that compete through price. In the free-to-play model, consumers can participate in a virtual world for free and can later choose to spend on virtual goods made available by the service operator. As participation is free, virtual worlds utilizing the free-to-play model enjoy a strong position against substitute services that charge fees for participation.

As traditional entertainment industries have been losing ground in the recent years to the emerging online entertainment segments, it would seem plausible that substitute threats for virtual worlds and online gaming would arise from within the online entertainment industry. Industry players offering on-demand entertainment options that are geared towards the digital age might pose the largest competition for people’s time and money. Examples of such services are Netflix, Spotify, Hulu and the like.

Bargaining power of buyers

The primary buyers for virtual worlds are the users. Not every user is a buyer, however: typically the percentage of users who purchase virtual goods ranges between 1%-30%[10] of the total user population, varying by the title in question and how enticing its virtual goods offering is to the users. This seemingly low percentage is due to the nature of free-to-play games: purchases are not required to play and thus some users never convert to paying customers. Similarly, estimated monthly spend per user is relatively low. According to a report by Newzoo (2012), the worldwide revenues of MMO games in 2012 were estimated to be $13 billion. Overall, there were estimated to be 400 million users and 180 million paying users. The figures include both subscription and free-to-play titles. Derived from the numbers in the report, the monthly spend per paying user was $6.01.

Overall, the bargaining power of buyers, or the leverage that the buyers have to influence the virtual world operators, is limited in the case of virtual worlds. Factors that lend some bargaining power to buyers include intense competition in the free-to-play marketplace and capability to share information. Competition in the free-to-play market is intense and there are many rivalrous products to choose from. Players who dislike a game can easily find another one to play without much difficulty, especially since information on the style and quality of different products is readily available online. Similarly, information regarding products that are of low quality, contain unpopular design features or feature prices that are considered too high is shared between players online. The risk of being negatively framed in the public eye applies some pressure on developers and publishers to stay within to implicitly accepted guidelines. For example, developer might be hesitant to experiment with higher than usual pricing due to potential backlash from the players.

[10] http://www.gamesbrief.com/2011/11/conversion-rate/

On the other hand, several factors also limit the bargaining power of buyers in virtual worlds. First, buyers act individually and are not concentrated. Second, only a small percentage of buyers ever make high volume purchases and even then, the volume purchased by a single buyer usually remains insignificant in terms of the total sales volume. High-volume purchases are primarily motivated by personal consumption preferences as in most virtual worlds the users reside at the end of the value chain. Virtual world operator usually acts as the manufacturer and the retailer, and holds a monopoly over primary market sales making profitable resale of virtual goods difficult or impossible. Third, spend per buyer is generally small in terms of total volume. Operators of virtual worlds might sometimes pay special attention to the wishes and needs of their top-spending customer segment, generally known as “whales”.

Bargaining power of suppliers

The suppliers to virtual worlds include for example the labor force (e.g. artists, designers, programmers, quality assurance), network and hosting service providers, distribution channels, marketing agencies, e-commerce and billing platform providers, distributors as well as companies offering development platforms and tools.

Overall, the bargaining power of suppliers has decreased over the past decade due to increased competition in each supply channel. While in the past developers had little choice when choosing platform, distribution channels, game engines, middleware or hosting services, nowadays most facets of supply has several competitive options to choose from. One exception to this is platform choice: while developers can choose a platform for which to develop their product, certain platforms require them to negotiate terms with the platform owner before their product can be sold and distributed.

While brick and mortar retail channels where games are sold on store shelves in shrink-wrapped boxes have historically been the predominant method for video game distribution, they have in recent years been challenged by digital distribution channels as they have been growing in importance with the proliferation of broadband connections and increasing data transfer speeds. Proliferation of digital distribution allows smaller entities to have larger negotiation power over brick-and-mortar retailers or bypass them entirely. Digital sales and distribution are the current industry standard in the mobile sphere, and are gaining traction on the PC and console platforms as well. As with traditional distribution channels, the largest digital distribution channels are controlled by a few operators per platform and companies wishing to take advantage have to seek approval to access the channel. Console publishers have their own digital distribution channels (Playstation Store for Sony, Xbox

Marketplace for Microsoft) to which their consoles are locked to. In personal computers, the digital distribution channel is dominated by Valve Corporation's digital distribution service, Steam. Reliable estimates are hard to find, but an analysis conducted from traffic and ad data in 2011 suggested that Steam controlled 51% of the digital distribution channel for PCs and Macs. The remaining 49% breaks down to several smaller players, including Amazon (11%), Gamestop (10%) and Microsoft (9%), Electronic Arts (5%) and Direct2Drive (5%). On certain platforms such as PC, publishers can also choose to distribute their product through proprietary channels. Titles such as *World of Tanks, League of Legends* and *EVE Online* all offer digitally downloadable clients via their websites.

If deemed strategic, it is possible for virtual world operators to integrate forward and internalize some parts of the supply. Forward integration has the potential to lower marginal costs in long term as the operator can do away with recurring 3rd party costs, but generally can also be resource intensive, require upfront investment from the company and divert focus from the core product. Difficulty and cost of integration varies with some portions of supply being easier to integrate than others. For example, it might be difficult for a virtual world operator to serve itself as a network service provider due to high barriers of entry involved in the network service industry. On the other hand, there are several examples several virtual world operators (especially those under major publishers) having developed internal marketing capabilities, development tools, distribution methods and billing solutions.

At any given moment, virtual worlds have a limited base of potential customers that they can tap into. For one, choice of platform (e.g. PC, console, etc.) by the developer places a hard limitation on who can access the world. The audience of any given world is limited to those who own the needed peripherals to access the world.

Intensity of competitive rivalry

The level of rivalry within the industry is high, with some variance depending on the platform. This is especially true for the mobile segment as the number of competing products has exploded in the past few years. The high and growing number of competing companies in the market has maintained a high level of competition even though the market is also growing in size. PC and console markets are less crowded due to higher barriers of entry, but still competed. To stand out in the crowd, product differentiation seems to play a critical role: as customers can develop loyalty to companies, products and genres, some companies have been able to secure a niche segment on the virtual world market. One of them is the Icelandic developer CCP that operates the second-largest MMORPG in the U.S., *EVE Online*. Testament to its niche appeal, *EVE Online* has been growing yearly since its release in

2003, reaching over 400.000 subscribers worldwide in 2012[11]. Highly differentiated product niches act as insulation against competitive warfare (Porter, 1980).

Market profitability

All in all, the market for free-to-play games could be characterized as having high risk and high rewards. Market conditions differ for companies developing on PC or console versus those developing their worlds in the mobile or browser spaces, however, and the risks faced seem to stem from different factors. Risks for PC or console projects include long development times and high capital requirements, while intense competition in a crowded marketplace is a challenge for companies attempting to enter the mobile or browser space.

Companies that successfully overcome the high risks can generate high revenues and profits: *League of Legends,* a MOBA-style[12] free-to-play game released by Riot Entertainment on PC in 2009, was reported to be earning $123 million a month in 2015 (SuperData Research, 2015). Similar examples of success can be found in the mobile space: *Clash of Clans,* a strategy game released by Supercell in 2012, was initially developed with a core team of 5 people and reported revenues of €519 million and profits of €242.2 million in 2013. In 2014, they nearly tripled their profits to €1.55 billion (The Guardian, 2015).

The above examples do not paint a clear picture of the industry's profitability as a whole, however, as it singles out a few success stories and does not tell us how many unsuccessful companies exist for each successful one. This question is more interesting from a market analysis standpoint: how profitable the games industry is as a whole and how high a risk does the average company face? While comprehensive profitability data that covers the largest markets such as the United States is not readily obtainable as most game companies do not publically disclose their financials, some smaller samples have been published. According to data gathered from Finnish game companies, the number of breakout successes is small relative to the total number of companies operating in the industry. Out of the 260 game companies operating in Finland, two companies (Rovio and Supercell) generate 99% of the profits. The average Finnish game company does not make money, but makes a 6% yearly loss (Balance Consulting, 2014).

In the next section, we move from discussing the market landscape and conditions faced by game publishers to examining the economic rules and frameworks that the virtual economies of free-to-play

[11] http://www.pcworld.com/article/252940/inside_eve_onlines_fanfest_2012.html
[12] MOBA stands for Multiplayer Online Battle Arena

games operate under. The intention is to give the reader a rudimentary understanding of how virtual economies function and thus facilitate later discussions where we analyze virtual secondary markets in the light of real-world secondary market research.

Laws & regulation

As the virtual goods sales industry itself is still relatively young, its regulatory landscape is still evolving. Legislative and regulatory questions pertaining to virtual worlds have been examined by a few authors so far. Lastowka & Hunter (2004) offer a thorough review virtual property rights and Duranske (2008) provides an comprehensive examination of the general legal landscape of virtual worlds. We will provide a short summary of the key legal questions that have emerged thus far. First set of questions involves property rights of virtual goods, namely if users have ownership over the virtual goods they possess in-game or if they are simply allowed usage rights over goods owned by the service provider. Many service providers attempt to navigate around this question by including ownership clauses (that usually hand ownership squarely to the service provider) in their End User License Agreements. Second set of questions deals with taxation and revenue recognition of virtual goods sales. Is revenue recognized when players purchase hard currency with real money, when they spend real money derivative currencies in-game, when an item they purchased is consumed or in installments while the purchased items are being used. Virtual worlds that feature both durable and consumable goods often have the use separate methods for recognizing revenue, depending on the type of good in question. Other questions that are being examined by legislators include whether virtual economies can be used for money laundering and how they should be monitored, as well as what sales tactics should be curtailed for being overly aggressive and abusive (for example, targeting children who have access to their parents' credit card details).

3. Markets in virtual environments

3.1 Overview of virtual economies

> *"A dupe bug renders money useless overnight. In an interesting economic development, the users almost immediately fall upon Dark Angel Feathers as a replacement currency until things return to normal. DAFs are valuable because they are rare-dropped yet stackable items and required to cast user-killing spells. Pkers have an interest in getting them, and non-pkers have an interest in keeping them out of pker's hands."*
>
> **Damion 'Ubiq' Schubert, Lead Designer *Meridian 59*, March 18, 1997**

Simplistically, the term economy refers to a system of production, allocation, distribution and consumption of goods and services in a given country or region. Individuals, households and companies that take part in the economy are called economic agents. Resources are normally scarce, meaning that everyone cannot have everything, so the economy has to decide who gets to have what. A popular solution is to use markets to allocate resources.

While virtual economies resemble their real-world counterparts in many ways, there are crucial differences. Most importantly, transactional efficiency is not an overriding objective in virtual economy design, but entertainment. As virtual environments and therefore economies can be adjusted freely by the operator, it would be easy to eliminate all inefficiencies, such as search costs. This would, however, probably make the economy resemble a spreadsheet and thus make it less interesting towards the users.

Secondly, in a national economy many things can be taken as a given, while in a virtual economy nothing exists unless it is explicitly created. The first question when creating a virtual economy is what goods, agents, production processes and consumption methods exist in the economy. Designers are not limited to virtual versions of real-world goods and processes, although familiar metaphors make the system easier to learn and understand. Currencies are not bound by real world conventions, either: while national economies typically have one national currency and foreign currencies that can usually be exchanged freely, virtual economy designers can experiment with multiple currencies and place restrictions on which goods can be traded with which currencies.

Finally, the ultimate purpose of a virtual economy is to generate revenues to the company operating it. Often the virtual economy is not a self-contained bubble, but has links to the outside in the form of items or currency units purchasable with real money. All the design elements and parameters of the economy are ultimately designed with the aim of generating value to the customers and allowing the operator to capture as much of that value as possible. As the operators' needs vary across service there is no single set of virtual economy characteristics that would apply in all situations.

The core aspects of a virtual economy can be expressed in the following five questions that represent the dimensions of the design space:

1. Who are the agents taking part in virtual economies?
2. What goods are available in virtual economies, and who produces them?
3. What currencies are available in virtual economies, and who issues them?
4. What markets are there, and how do they work in relation to each good and currency?
5. When, if ever, are goods and currencies consumed, expended or destroyed?

I will go through the above dimensions in detail below.

3.2 Agents in virtual economies

The two most common agents in virtual economies are the users and the operator. The operator takes part in the economy through primary market sales, among other things. Moreover, many virtual economies also involve third-party commercial participants, such as Toyota in Second Life or Burger King in Habbo. The difference between companies in Second Life and companies in Habbo is that the former are independent third parties that do not necessarily have any agreement with the operator, while the latter are acting in partnership with the operator. Independent commercial third parties use whatever means are available to establish their presence in the service, while commercial partners receive help such as bespoke content development from the operator.

3.3 Goods in virtual economies

As defined in section 1, virtual goods refer to digital items and services encountered inside virtual worlds. Items available vary from decorative accessories (such as apparel) to functional items that boost performance (such as better weapons) to expedited access to content, depending on the design of the game or service they exist in. Virtual goods are most commonly designed and produced by the game operator who then sells them to players on the primary market within the game. Some alternatives exist: for example, some operators have established channels for accepting and integrating user generated content. In this case, the users participate in creation of virtual goods and the operator oversees the channel, reviews virtual goods submitted by users and integrates approved content into the virtual world.

Goods that exist within virtual worlds are governed by the rules set in the virtual worlds. Due to the manufactured nature of virtual worlds and economies, virtual goods can closely resemble real world goods or be nothing like them. Properties associated with real world goods such as rivalry, non-rivalry, excludability and non-excludability are also present in virtual environments, but how they apply to different virtual goods is determined by the design of the goods and of the economy. Most virtual items are designed to be rivalrous from the players' point of view: a good being used by one player usually cannot be used by another at the same time. This applies especially to virtual items. Excludable and non-excludable virtual goods commonly exist side by side in virtual economies: some goods are commonly available only for paying players while others can be accessed through spending time and effort rather than money. Some successful free-to-play titles only feature non-exclusive goods, but monetize by require non-paying players to invest considerable time and effort to obtain them while allowing paying players to get them faster. Substitute and complementary relationships between virtual goods can exist, but are often purposefully produced by the creator of the virtual economy. Many virtual worlds offer various styles of play and often these styles are mutually exclusive: should a player choose to play a sorcerer, then she cannot play a knight. If a virtual economy for any reason allows players to obtain goods fitting a specific playstyle more cost efficiently than others, then players contemplating their playstyle choice might opt to choose the most cost efficient playstyle. From this perspective, goods that service different, mutually exclusive playstyles can be considered to be substitutes to one another.

Virtual goods can also have properties that real world goods either cannot have or that would be impossible to enforce for them. For example, durability of a virtual good can be arbitrarily and perfectly controlled. Virtual items do not suffer from wear and tear unless such behavior has been programmed into the virtual world. As such, the durability of a virtual good can range anywhere between infinitely durable (always provides the same utility and never needs to be replaced) to one-time use (becomes unusable after a single use). An inventive virtual economy designer might tie the durability of an item to an interesting parameter within the world and create goods that, for example, lose durability and degrade with each social interaction that takes place within the virtual world. The durability function might even be inverted for some items: instead of breaking, a sword might become more and more powerful the more monsters it has been used to slay. Tradability of virtual goods can be controlled on a per-good basis. Players might be able to freely transfer ownership of some goods from one player to another, while other goods might be tied to the player who first obtains them. It is also possible for the operator of the virtual world to set hard inventory limitations on virtual goods, allowing individual players to only possess a limited number of goods at a time. These limitations can apply to distinct goods or all goods, depending on what the operator seeks to achieve.

Virtual goods are also dissimilar to other digital goods such as information goods (for example, video and audio files. As pointed out by Lehdonvirta (2009), the key differences between information good and virtual goods were perhaps most concisely presented by Fairfield (2005) in his examination of virtual property. According to Fairfield, the main difference between information and virtual goods is that virtual goods resemble real world goods in that they are *rivalrous.* As an example, a set of virtual clothes can only be worn by one person at a time – just like clothes in real world. In contrast, information goods are not rivalrous: an MP3 file may be copied to someone else while keeping the original, too. Fairfield (2005) also identifies out two additional attributes for virtual items: *persistent* and *interconnected*. *Persistence* refers to the idea that an object must exist for a length of time in order to be considered an asset. For example, objects that disappear when the computer is shut down do not have significant value and cannot be considered virtual goods. *Interconnectedness* means that in order to be considered a virtual good, an object has to be linked to other people, objects or systems: objects that only exist on one's personal computer are not virtual goods. Fairfield's definition of virtual goods is technology agnostic and applies to everything from *Habbo*'s virtual furniture to the *World of Warcraft* gold coins. It indicates that virtual goods have a role as rivalrous goods in the online environment where few other goods are rivalrous.

Lehdonvirta (2009) also points out that, from a sociological point of view, users' perception of virtual assets are transformed from mere media representations into objects of a "thing-like" nature in a process that resembles theories of objectification and reification. As a result, the user may begin to apply mental models associated with commodity consumption instead of models associated with media consumption. This is a significant difference from a business point of view, similar to that between selling photographs of *Gucci* bags and selling the actual *Gucci* bags. He attempts to characterize this distinction by defining the relationship between virtual and real-world goods as follows: virtual goods could be thought as an independent category of goods: goods that are sometimes "inspired" by certain commonplace objects, but are not "virtual versions" of them.

In his article, Lehdonvirta also provides a helpful illustration (Figure 2, below) of where virtual goods lie in comparison to ordinary material goods and information goods such as mp3-files.

Figure 2. Comparing information goods, virtual goods and material goods (Lehdonvirta, Virtual Item Sales as a Revenue Model: Identifying Attributes That Drive Purchase Decisions, 2009)

Information goods could also exist in virtual worlds – it is just that the designers choose not to include such items, as they would most likely turn out to be worthless due to abundance.

3.4 Currencies in virtual economies

The European Banking Authority defines virtual currency as "a digital representation of value that is neither issued by a central bank or a public authority, nor necessarily attached to a fiat currency, but is accepted by natural or legal persons as a means of payment and can be transferred, stored or traded electronically" (EBA, 2014). In practice, virtual currencies fulfill similar roles to their real-world counterparts: they function as a medium of exchange, as a way to store value and as a measure of value.

Virtual currencies are commonly both issued and controlled by the operator of the service they are used in. Similarly, the total set of goods and currencies payable with virtual currencies are usually (though not always) confined to the service that the currency exists in as well. Since virtual currencies are created and issued by service providers, the number of currencies available is usually dictated by the requirements of game mechanics and ranges from zero to several. New currencies are also often added during the lifecycle of the game. A common reason for minting a new currency in a live product is that with them, the service operator can ensure that everyone starts from zero. Using existing currencies in new features might create, for example, a pricing problem: some players would have large reserves of an existing currency and pricing for them (in other words, setting prices high to compensate for their wealth) would effectively prevent poorer players from taking part. On the other hand, pricing for poor players would potentially make the feature uninteresting for rich players. Virtual economies only stay interesting as long as players have goals to strive towards and having rich players afford to exhaust a feature as soon as it is released would be inefficient. Using a newly minted currency solves the problem by leveling the playing field: as everyone starts from zero, it is much easier for the service operator to balance prices and earning rates to provide entertainment for all involved. As such, the number of currencies vary from title to title. For example, the very first iteration of *Habbo* did not have any virtual currency at all. The primary market purchases in the world were direct premium SMS payments, e.g. customers sent SMS messages with a fixed cost in order to obtain furniture in-game. As currency did not exist, player-to-player trade was based on bartering and eventually led to the emerging of de-facto currencies that varied from server to server (plastyk –chairs in Finland, club sofas in the UK).

As with other aspects of virtual economies, the properties and usage of virtual currencies are perfectly adjustable by the service provider. The usual properties of 'good' currencies such as fungibility, divisibility, countability, recognizability, ease of storage, transportability, durability, resistance to theft and privacy are not always desirable properties for virtual currencies that exist in games. This is because the goal of virtual economies is not transactional efficiency, but creating challenges, social interaction and fun for the players. A bank account that can only contain 10 units of currency might be an unsustainable proposition in the real world, but be a key spending driver in a virtual one. Lehdonvirta (2012) offers discussion on how currencies and their properties can be used to provide interesting gameplay as well as contribute to revenues of the service provider. Lehdonvirta & Castronova (2014) provide an in-depth view into virtual currencies and their design overall for those interested in further reading.

3.5 Markets in virtual economies

3.5.1 Primary markets

On the primary market, the virtual world operator engages in sales of new virtual goods to users. Virtual worlds using the virtual goods sales model always feature a real money primary market, while subscription based worlds may or may not have one. The primary market channel inside a virtual world regularly consists of two parties, the virtual world operator and the users. In contrast to many real world businesses, there are no separate retailers. The operator is usually responsible for the whole supply side, from designing the virtual goods to selling them in a governed marketplace.

At the time of writing, most virtual goods sales driven games feature a primary market such as described above. The operator is the only instance that manufactures and sells items with no possibility for competition on the new goods side.

Depending on the configuration chosen for the supply side of market, there are several different alternatives to how prices will be determined in the market. Lehdonvirta (2005 I) provides an overview of the possibilities.

Figure 3: Market structures and price controls in virtual asset markets (Lehdonvirta V. , 2005 I)

		Buyers			
		All parties	Non-operator	Operator	None
Sellers	All parties	**Price window**	**Price ceiling**		
	Non-operator	**Price floor**	**Perfect competition**	**Monopsony**	
	Operator		**Monopoly**		
	None				**No market**

Virtual goods sales businesses typically operate under an operator monopoly, where the operator acts as the sole manufacturer of virtual goods and sells them to the users. Another less common configuration is with a secondary market, where the operator sells goods on the primary market and users are able to sell them on the secondary market. In this case the primary market price set by the operator becomes a price ceiling for the secondary market transactions, provided that there are no mechanisms in place that allow for used goods to appreciate in value. In a similar fashion, the price ceiling effect also depends on the availability of goods on the primary market: should the operator remove certain goods from the primary market catalog, the price ceiling ceases to exist for those items and the price adjusts freely based on secondary market demand.

In virtual worlds where a real money primary market for virtual goods exists, the virtual world operator typically holds a complete monopoly over it with no possibility for competitors to enter the market. As for the existence of secondary markets, there are examples demonstrating that a real money secondary market for virtual items is quickly established regardless of the existence of a primary market, should the game mechanics allow item transactions to take place. As the environment is absolutely monopolistic, the only possible source of competition would be from the secondary market sales, as used goods perform as substitutes for new goods. A few games such as *Team Fortress 2* and *Dota 2* feature a gated approach where users can submit virtual items (usually visual customization options) they created to the operator, who makes the final decision on which items make it to the primary market. In both cases, the operator takes 75% of revenues while the original creator receives 25%. *Second Life* comes close to having a free market between the operator and the users, as users can create virtual items and have them sold on the primary market.

The operator can seek to augment in-game sales through marketing and merchandising in the primary market channel. For example, many modern virtual worlds feature an elaborate storefront that displays the items on sale in an attractive fashion. The digital environment that online games operate in allows for far greater gathering of information about the customer than conventionally possible. The operator can potentially track everything that the customer does while inside the world. Large social game developers such as Zynga are already using behavioral data for a wide array of purposes; from fine-tuning addictiveness of their games to optimizing their storefront offers to yield maximum returns.

Virtual world operators can also do more to spur demand besides traditional marketing and merchandising. As mentioned in section 1.5, the service provider can efficiently fabricate player needs through the design of the virtual world. Hamari & Lehdonvirta (2010) provide a comprehensive review on how game design is used as a marketing tool in virtual worlds and draw parallels between virtual world design and traditional marketing theory. First, virtual world operators can use mechanisms to segment the market. Many virtual worlds feature stratified content, where player needs change as they progress within the world. This creates natural user segments that enable differentiation and incentivize repeat purchases as old items become obsolete. Perhaps the most common example of stratified content can be found in MMORPGs, where the player's avatar starts at level 1 and gradually gains further levels through gameplay. As players progress through a game, their preference for different items changes. Early items outlive their usefulness for players as they progress in game. For example, a starting player might value a basic iron sword very highly, but such a weapon would have little use for an advanced player preferring magical weaponry. Segmentation through stratified content is often enforced through restricting item usage based on player status. Status restricted items refer to items that become usable or unusable based on the player's status. A common scheme is one where items have level requirements: certain items can only be used by low level players, while some can only be used by high level ones. For example, new players might not be able to wield magical weapons at all before progressing to a certain level. Another way to achieve segmentation is by providing increasingly challenging content as the user progresses. Constantly increasing level of challenge can incentivize players to purchase new, better items to compensate for the increased difficulty. Finally, segmentation can be achieved through offering multidimensional gameplay and varying avatar types. Multidimensional gameplay means offering several modes of play within a single virtual world and having specific items that cater to each mode of play. Segmenting by avatar types refers to segmentation based on profession or class (e.g. merchant, warrior, sorcerer) that the player avatar belongs to. The operator can design each profession to require different items to be effective and thus segment based on them. The table below summarizes the segmentation tools available for a virtual world operator.

Table 1: Segmentation-related game mechanics that promote virtual goods purchases (Hamari & Lehdonvirta, 2010)

Design pattern	***In marketing terms***	***Towards***	***Aims to***
Stratified content	Segmentation, differentiation	Rules, environment	Create segmentation, enable differentiation and generate incentives for repeated purchases
Status restricted items	Differentiation, planned obsolescence	Items	Enforce segmentation and generate incentives for repeated purchases
Increasingly challenging content	Segmentation, differentiation, planned obsolescence	Rules, environment	Enforce segmentation and generate incentives for repeated purchases
Multidimensional gameplay	Segmentation, differentiation	Gameplay	Create segmentation and enable differentiation and create differentiated additional settings for virtual goods
Avatar types	Segmentation, differentiation	Avatar	Create segmentation

In addition to greater possibilities for segmenting the market, Hamari & Lehdonvirta also discuss other mechanisms to promote purchase behavior are not viable in the real world. As discussed in section 3.3, operators can exert precise control over durability of goods and control their degradation, allowing them to optimize durability of goods for revenue purposes. This will be discussed in detail in later sections. They can also intentionally make the gameplay experience inconvenient by offering, for example, only a basic user interface at start and selling additional features for money. Another tool is scarcity, which can be controlled by the operator, and can be employed to make certain goods more desirable by limiting the number that are seeded into the economy. Limited inventory space is often used as a pressure mechanic to drive activity. Finally, the operator can also make adjustments to already sold content and change, for example, desirability of items post-purchase. The below table summarizes the mechanics available for service providers to promote purchase behavior.

Table 2: Other game mechanics that promote virtual goods purchases (Hamari & Lehdonvirta, 2010)

Design	***In marketing terms***	***Towards***	***Aims to***
Item degradation	Planned obsolescence	Items, rules, environment	Create incentives for repeated purchases
Inconvenient gameplay elements	Core product -> Augmented product	User interface, gameplay	Create settings for additional virtual goods and services
Currency as medium	Psychological pricing	-	Create incentives for (repeated) purchases
Inventory mechanics	-	Items, avatar	Create incentives for repeated purchases
Special occasions	Promotional	Environment, items	Benefit from cultural patterns that encourage buying behaviour and create settings for additional virtual goods
Artificial scarcity	Exclusiveness	Items, environment, rules	Make selected virtual goods more desirable
Alterations to existing content	-	Environment, items, rules, gameplay	Create new settings for virtual goods to have value

Willingness spend real money on virtual items might seem strange to those not familiar with virtual worlds. It could be argued, however, that many of the things we consume in daily are 'virtual' as well: in this sense it would be similar to ask why are people willing to pay more for a *Gucci* bag compared to generic, functionally similar alternatives.

The prevalent argument at the moment is that consumption of many goods is based on goods acting as social markers, e.g. as a symbolic means to express status, class, group membership, difference or self-identity. When buying a *Gucci* bag, most of the time you are not just looking for a functional tool to use to carry your items. Along with the bag, you're also buying e.g. a marker of wealth, self-identity, class or status. While virtual goods are “not real” in the sense that they are not “things”, they do seem to have very relevant perceived value in their social contexts.

Instead of looking at goods either as “real” or “virtual”, Featherstone (2007) addresses the problem by dividing the consumption drivers of goods into three distinct categories: the functional aspects of goods, the emotional aspects of goods, and the use of goods as markers for drawing social distinctions. Functional aspects refer to the attributes that allow the good to be used as instruments towards fulfilling, usually, a tangible material objective that is seen as related to some fundamental human need. Emotional aspects refer to the hedonistic, pleasure inducing aspects of goods, e.g. aesthetics or taste. Finally, the use of goods as markers refers to the example above, using goods as symbolic means to express status, class, group membership, difference or self-identity. From the perspective set by Featherstone, consumption of virtual goods does not seem so extraordinary: virtual goods can have functional, emotional and social meaning for the users of the virtual world they are set in.

Adding on Featherstone’s model, Lehdonvirta (Virtual Item Sales as a Revenue Model: Identifying Attributes That Drive Purchase Decisions, 2009) in his study attempts to identify factors that drive purchase decisions regarding virtual commodities using a case study method. In his model, individual purchase decision drivers are classified into ones promoted by commodity attributes and ones shaped by social structures present in computer-mediated environments. The individual drivers are presented and briefly explained in the table below.

Table 3. Virtual item attributes acting as purchase drivers (Lehdonvirta, Virtual Item Sales as a Revenue Model: Identifying Attributes That Drive Purchase Decisions, 2009)

	Attribute	Explanation
Functional attributes	Performance	How an item performs in comparison to similar items
	Functionality	Items providing convenience, new functionality or new gameplay options
Hedonic attributes	Visual appearance and sounds	On-screen visual representation, animation and sounds associated with an item
	Background fiction	Items linked to the background fiction of the respective world
	Provenance	Items with a notable background are more desirable than conventional items.
	Customisability	Items that can be modified by the users can be more desirable
	Cultural references	Seasonal items (e.g. Christmas), items that refer to real world franchises can be more desirable, as they can be used to communicate things such as fandom, identity and values to others.
	Branding	Items promoting real world brands can be more desirable, as they can be used to communicate things such as fandom, identity and values to others.
Social attributes	Rarity	The value and desirability of an item increases with scarcity

Summary of characteristics of markets encountered in virtual worlds:

- Monopolistic primary market[13]
- Availability of information depends on how marketplaces are set up and varies widely
- Nearly non-existent marginal cost for producing additional goods
- Nearly perfectly competition in the secondary market (comparable to stocks trading in the real world)
- Consumers have heterogeneous preferences
- Transaction costs close to zero

[13] As noticeable from Figure 4., some virtual worlds feature user-produced virtual items that are sold for real money. It is worth underlining that this is too always by design. *Team Fortress 2* is a successful example of a model where users create hats that they can then sell through the operator controlled marketplace to other players. Revenue generated from the sales of user-created hats is shared with the creators.

3.5.2 Secondary markets

Once a virtual good has been sold in the primary market, any further trading done with it is considered to be secondary market trading. In virtual worlds, secondary markets users buy and sell virtual assets between each other, often exchanging them for real money or in-game currencies. Prices are set by users and are influenced by supply and demand. Prerequisites for secondary markets to exist in virtual worlds include that goods are durable (i.e. they keep providing utility after a single use) and the operator enables ownership transfers of goods. For in-game currencies to be usable in second-hand trading, the operator also needs to enable transfers of currency between player wallets.

If the above prerequisites are met, trading of used goods is technically possible and secondary markets are able to form. In services where the operator endorses second-hand trading, marketplaces are commonly provided by the operator and often exist within the service itself. Facilitated secondary markets are often integrated into and accessible from within the worlds, while some operate via gaming platforms (such as Valve Software's Steam) or web portals (such as Sony Entertainment Online's Station Exchange for their fantasy MMORPG title *Everquest 2*). Steam is likely to be the largest operator-facilitated secondary market for virtual goods in existence. It also represents a unique case study, as it enables users to trade goods originating from different titles and acts as a commerce hub between various titles. Any developer with a published game on Steam can choose to integrate the secondary market functionality provided by Valve and allow their virtual goods to be traded on the secondary market.

In services where trading is not officially endorsed but nevertheless enabled by the operator, marketplaces commonly emerge organically through the efforts of players. Unofficial secondary market activity often initially takes place in social meeting points such as chat channels. In *Ultima Online*, the bank building in the middle of a major city served as a trading hub on most servers.

Figure 4: Players announcing the goods they have available for trade at a popular meeting spot in Ultima Online

As supply and demand for used goods grow, secondary activity often relocates to more efficient environments such as online auction houses and specialized web portals run by 3rd parties that allow users to list the items they have available for trade, set list prices, make sales and arrange meetings with buyers in game to exchange the items. Some virtual world operators have chosen to take active steps to curtail secondary market trading. These include actions such as monitoring exchanges between users and harshly penalizing users who are caught engaging in the secondary market trade. Virtual worlds looking for curtail secondary market trade often include an anti-trading clause in their end-user license agreements stating that users do not own their virtual possessions but are merely renting them from the operator, rendering ownership transactions of virtual items legally impossible. This has not, however, stopped users from trading. Efforts to completely eliminate secondary markets have been unsuccessful, possibly because sufficient monitoring is too costly and because the operators are reluctant to completely prevent item exchanges between users altogether as it would seriously damage gameplay in their economies.

While some services feature integrated internal secondary markets, it is very common for service providers governing virtual worlds to take a prohibitory stance towards trading goods for real money outside of the service. Many operators actively enforce the rules set in their end-user license agreements and take measures against those who break them. There are several reasons for this. First, many virtual worlds that allow secondary market transactions are susceptible to 'botting', automated computer programs pretending to be real players (‘bots’) playing the game and earning currency and items that can be traded onwards for real money. The reason for different operators taking varying stances depending may be that unsanctioned real money trading has different impact on different kinds of services. In the case of games where the most valuable items are commonly earned through increasingly complex and challenging gameplay, other users will be upset if someone buys their way to the top with real money. Explicitly allowing trading items for real money in such scenarios could lead to users losing their interest in the game. At the same time, the problem is not so pronounced in socially-geared worlds, as they are not so dependent on achievement hierarchies. Some design and marketing measures can, however, be taken to alleviate the possible adverse effect should an operator allow secondary market trading. Sony Online Entertainment provides two kinds of servers in their EverQuest 2: non-real money trade servers for those who consider real money trading to be undesirable and real money trade servers for those who consider it to provide added value.

Secondary markets arise for the same reasons as their real life counterparts: there are consumers who value the used goods more than their current owner. Beyond goods, user accounts are commonly traded as well. Users planning to end their subscription to the service might consider cashing in their assets on the secondary market, especially if they do not intend to return later on.

3.6 Consumption in virtual economies

Consumption is a natural part of many virtual economies. No single model exists: some economies only feature consumable items (that is, items with zero durability), while some economies do not feature consumable goods at all, but have only durable goods.

In contrast to consumable goods such as bandages or magic potions that disappear when used once, durable goods yield services or utility over time. They do not quickly wear out or might even maintain their perfect condition indefinitely, in which case they can be identified as perfect durable goods. As items in virtual worlds are not inherently subjected to wearing due to laws of nature, it completely is left to the developer to decide whether items are worn out or not. If yes, it is again up to the developer to choose what set of rules determine how items deteriorate.

Durability of goods plays a key role in secondary markets as having durable goods is a requirement for used goods markets to exist. With zero durability, items are consumed after use. This makes secondary market trading untenable – there’s nothing left to trade with. In the real world, durable of goods are commonly defined as goods that yield utility over time rather than being completely consumed in one use. Durability of goods is a continuous rather than a discrete variable that ranges from perfectly durable to non-durable. Perfectly durable goods refer to goods that never wear out. Non-durable goods include consumables such as cosmetics, food and fuel. Purchases of non-durable goods can be interpreted as consumption, while purchases of durable goods can be considered investment. Similarly, durable goods are compatible with a rental model, where the good is leased to a user against payment for a time. This is generally not applicable for non-durable goods. Implications of rental models in virtual worlds are briefly discussed in the conclusions.

As with other aspects of virtual worlds, the decisions to make goods of varying durability depend on the type of economy that the operator intends to create. In virtual worlds, durability of goods does not result from the quality of the materials a good is produced from or the craftsmanship put into producing the good. In virtual environments, durability is simulated. The operator can choose the durability of virtual items, thereby deciding how close a substitute the used good is going to be for future units of the new good. Mechanics used to wear down virtual goods often resemble those of the real world: you can only wear clothes for a certain amount of time before they are reduced to tatters, you can only hit an enemy with your sword so many times before it breaks or you can only walk so many miles in your boots before they become unusable. In theory, virtual goods could be infinitely durable, but in practice, virtual world operators find it advantageous to artificially limit item durability.

In consumer electronics, a strategy similar to artificially limited durability is known as planned obsolescence. Goods can become obsolete because of physical breakdown, but also because they fall out of fashion. Both outcomes are precipitated by the vendor. Likewise in virtual goods the fact that an item is technically durable does not have to mean that its social life is indefinitely long. Through marketing coordinated with content release cycles it is possible to create fashion cycles. Online community Habbo stands as a good example of this. It even provides virtual recycling bins where items that lose their allure can be dumped. Virtual goods can also depreciate through change of players' needs. Often as players progress in the game, old items they obtained earlier become obsolete: the sword you had when you started might not be useful after a few hours of play. Such depreciation is another tool that game developers use to drive economic activity in games. As old items become less useful as the players progress, they are incentivized to purchase new, better equipment on the primary market provided by the operator, usually using one of the currencies available in the game.

4. Real world secondary markets

The question most relevant to this thesis -- how secondary markets affect the profits of a monopolistic seller and whether the monopolist should interfere with them -- has been a topic of controversy in the secondary market literature. Several authors have studied the dynamics of used goods markets over the years and reached a variety different conclusions on their effects depending on their initial assumptions. In this section, we will review results from past research on the effects of secondary markets on distribution of value chain profits. I will focus on the case where the supplier maintains a monopoly over the market and leave situations of oligopolistic competition outside the analysis. As such, the scope will still be sufficient for the case of secondary markets in virtual worlds, as virtual environments are inherently monopolistic.

4.1 Review of secondary market literature

Secondary markets and their dynamics belong to the branch of microeconomic theory of durable goods. Durability of goods is intertwined with secondary markets for a few reasons. First, it is key requirement for secondary markets' existence: if goods have no durability, secondary markets cannot by definition exist as goods are destroyed before they can be traded onwards. Second, durability matters for second hand value of goods. The more durable an item, the better it retains its value over time. Used goods that retain their value well are better substitutes for new goods and thus command a higher price on the secondary market.

Theory on durable goods and secondary markets saw major advances starting in the 1970s on several fronts, with different authors exploring different sets of questions involving durable goods and secondary markets. First, Swan (1970) contemplated durability choices made by producers of goods and whether they are incentivized to produce goods that break down quicker than would be fully efficient, and whether producers have incentives to introduce new versions of goods to make the old versions obsolete. Prior to Swan's work, the general theme of preceding durable goods literature was that a profit-maximizing monopolist would choose less durability than would competitive producers or in other words, an inefficiently low level of durability. In his series of papers, Swan showed that this result was incorrect and that a monopolist would choose the same level of durability as would competitive industry and efficiently extract consumer surplus through sales price alone (Waldman, 2003). Swan's result has since been challenged by several authors, as we will review below. Second, Coase (1972) examined timing issues faced by the durable goods producer and how sales of durable goods tomorrow affect tomorrow's value of durable goods sold today. Finally, Akerlof (1970) dealt with availability of information within the durable goods market and the ability of secondary market buyers to evaluate the quality of units offered for sale. The fundamental theoretical frameworks established in these early models were later amalgamated into more realistic secondary market models by authors such as Waldman (1997), Hendel & Lizzeri (1999), Waldman (2003), Shulman & Coughlan (2007), among others. Waldman (2003) provides an exhaustive overview to the early microeconomic analysis on durable goods, as well as a review of the later work based on the early theories.

In our review, we will focus on the later models as they are more representative of real world secondary markets. As pointed out by Waldman (2003), certain key assumptions made by earlier authors do not emulate real world conditions very well. For instance, Swan's assumption that some number of used goods are a perfect substitute for a new good does not hold in several real world secondary markets, such as the market for used cars. For example, it would be very costly to take a car that has lost half of its value and restore it to mint condition by purchasing half of a new automobile. Hendel & Lizzeri (1999) also point out that since Swan assumes different vintages of goods to be perfect substitutes for each other, used markets do not play an allocative role – there is no room for trade even if used markets would be open. These assumptions are unrealistic for most used goods markets. In addition to focusing on the newer literature on secondary markets, we will also specifically focus on the theory on the monopolist's durability choice and potential motivations to interfere with secondary markets. We will leave out discussion on Coase's analysis on timing issues and the information asymmetry issues brought up by Akerlof. While interesting, their implications on virtual secondary markets are not strictly within the scope of this thesisand are best left for future studies.

4.2 Results from recent secondary market literature

As outlined above, recent secondary market literature includes work by authors such as Waldman (1997), Hendel & Lizzeri (1999), Waldman (2003) and Shulman & Coughlan (2007). Key differences to the early models include more realistic assumptions that better reflect the conditions a monopolist faces on real world secondary markets. Contrary to Swan, Waldman (1997) and Hendel & Lizzeri (1999) assume that new and used units are imperfect substitutes that vary in terms of quality. They model durability as the speed at which the quality of a unit deteriorates. They also assume that consumers have heterogeneous preferences for quality and that this drives the formation of secondary markets. Finally, Hendel & Lizzeri (1999) assume that durability of goods is endogenous as opposed to the exogenous durability featured in some earlier models and in Shulman & Coughlan (2007).

On closing down secondary markets

A question of fundamental interest for this thesis is whether a monopolist should permit the existence of secondary markets. Hendel & Lizzeri (1999) and Shulman & Coughlan (2007) both examine this question from slightly different viewpoints. Key differences between the two models are that Hendel & Lizzeri treat durability endogenously in their model and assume the highly durable goods are costlier to produce, consider consumer population to be static and focus on the manufacturer's point of view. Meanwhile, Shulman & Coughlan examine a variation where the monopolist controls the entire market channel and acts both as the producer and retailer of goods. In their model, the monopolist also operates the secondary market through its role as the retailer. Like Hendel & Lizzeri, Shulman & Coughlan work with a two-period model, although their model does not feature an infinite horizon nor do they comment on the possible implications of having one. Also, as opposed to Hendel & Lizzeri, Shulman & Coughlan assume exogenous durability and that a renewable population of consumers so that each period new consumers enter the market.

In their analysis, Hendel & Lizzeri show that the monopolist prefers not to shut down secondary markets despite the substitution effects brought on by used goods. Instead shutting down the secondary market, the monopolist would rather reduce durability of new goods and thus reduce substitutability between new and used goods. The monopolist benefits from a smoothly functioning secondary market due to improved market segmentation it entails. While killing off the secondary market would eliminate any substitution effects, it would also cause the monopolist to forfeit the market segmentation advantages.

In general, Shulman & Coughlan's results are in line with those of Hendel & Lizzeri's: the presence of a retailer-operated secondary market serves as a price discrimination mechanism and expands total sales. Additionally, they note that the retailer-operated secondary market generates higher valuations for new goods due to consumers' ability to re-sell goods they no longer value. Shulman & Coughlan show that a clever monopolist can capture extra value by running the secondary market through its role as the retailer. Acting as the retailer is not a precondition for benefitting from a healthy secondary market, however: their conclusion is that the monopolist would not have an incentive to shut down the secondary market even if it does not control the entirety of the market channel. According to their model, profits are strictly higher when a secondary market exists as opposed to when one does not. Their proposition is that, specifically, sales of new goods unambiguously increase in period 1 with the existence of a secondary market; sales of new goods in period 2 decrease; and total new-good sales across the two periods may increase or decrease with a secondary market. If the total new-good sales across the two periods decrease with a secondary market, incremental unit sales of used goods in period 2 more than compensate for the loss in new-good unit sales.

On optimal durability choice

Monopolist's durability choice has been widely examined in secondary market literature after Swan published his results in the 1970s. The specific question that most authors have focused on is whether the monopolist has an incentive to reduce durability of goods to increase profits. While Hendel & Lizzeri and Shulman & Coughlan show that a monopolist would not kill off the market for used goods, they conclude so assuming the monopolist can take other measures to protect its primary market profits.

Hendel & Lizzeri (1999) show that a durable goods monopolist underinvests in durability with the result that the quality of used units is less than the efficient level. This is due to the substitution effect between new goods and used goods. Since used goods are substitutes for new goods, their value on the second hand market places pressure on the value and price of new goods. By underinvesting in durability, the monopolist seeks to reduce substitutability between used and new units and thus allows the monopolist to raise the price of new units. The general conclusion is that a durable goods monopolist wants to lower the quality of used goods because this translates to higher prices for new goods.

On new versions of goods

Introducing new versions of goods is another tool the monopolist can utilize to protect primary market profits against the substitution effect. According to Waldman (2003), Fudenberg & Tirole (1998) offer the most thorough examination of the topic. They assume a two-period model where the goods produced are perfectly durable, but the goods produced in the second period are of higher quality than the first-period goods. They also assume, like Hendel & Lizzeri (1999), that consumers have varying valuations for quality. Results of their analysis are closely related to those of optimal durability choice discussed above. They find that a similar effect to reduced durability can be achieved through releasing new, improved versions of new goods. As the quality of newly released goods improves with each period, a quality gap develops between new and used goods. Since used goods are of lesser quality and thus imperfect substitutes to new goods, primary market prices for new goods are higher than they would be otherwise and result in higher profits for the monopolist.

On leasing and buying back goods

Finally, the monopolist can seek to limit availability of used goods instead of reducing their comparative value. The mechanism here is again closely related to the ones above: due to the substitution effect, the availability of used goods lowers the monopolist's price for new goods. Durable goods literature offers two ways to for the monopolist to limit availability of used goods. First, the monopolist can lease its products instead of selling them. Second, the monopolist can commit to buying back used goods from the consumers and scrap them. Implications of leasing is examined by Hendel & Lizzeri (1999) and Waldman (2003). Hendel & Lizzeri show that the monopolist does not provide socially optimal durability even when it leases and that sometimes the monopolist wishes to lease to gain additional market power. Waldman discusses the differences between leasing and buybacks combined with scrappage, and concludes that while their effects are very similar, the buyback strategy is prone to time inconsistency problems.

To summarize, findings from real world secondary market literature suggest that the service provider wants to lower the quality of used units as it reduces substitutability between new and used goods and thus translates into higher prices for new units. One way to achieve this is to reduce the quality of used units by reducing the built-in durability of new units. Another is to introduce frequent style changes to decrease the perceived quality of used units (Waldman, 2003). The virtual world operator is positioned better to do this than its real world counterparts due to its extensive control over the rules of the environment, such as durability and item degradation. As an alternative to reducing substitutability between new goods and used goods, the monopolist can also seek to achieve a higher price for new units by limiting the overall availability of used goods. There are three identified ways to achieve this: through leasing, by eliminating the secondary market or by the service provider purchasing back all sold units and scrapping them. The below table provides a summary of the policies a monopolist can use to combat substitution effects in its secondary market.

Table 4: Summary of methods used to interfere with secondary markets

Method	Mechanism of action
Reduce durability of new goods	Reduces substitutability between new and used goods
Introduce new versions of new goods	Reduces substitutability between new and used goods
Lease goods instead of selling them	Reduces availability of used goods
Prevent secondary market trading	Reduces availability of used goods
Buy back used goods and scrap them	Reduces availability of used goods

5. Implications on virtual environments

As can be seen in the previous section, results from durable goods literature suggest that a profit-maximizing monopolist would not choose to shut down secondary markets. Instead, it would is more advantageous for the monopolist to mitigate the substitution effect used goods have on new goods using methods outlined in the previous section. In this section, we will evaluate the applicability of the real world analyses to virtual environments and review options available to a virtual world operator for dealing with secondary markets. We suggest that secondary markets can be both beneficial and harmful for the virtual world operator, depending on the circumstances. At the end of this section, we briefly review leasing as a potential option for virtual world operators as well as explore the transaction tax model presented by Shulman & Coughlan (2007).

Conditions for a virtual monopolist differ from ones faced by a real world monopolist in certain important ways. First, the cost structure of producing virtual goods is differs from the one associated with real world goods production. While producing a virtual good carries fixed production costs that includes development expenses such as design, engineering and testing, marginal costs for creating additional copies is close to zero due to the digital nature of virtual goods. The operator still faces certain on-going costs such as server upkeep and bandwidth fees, which add to cost of operations, but are not directly related to goods production. Additionally, durability has no impact on production costs in virtual worlds. The cost of producing a perfectly durable good is the same as producing a zero-durability good. While interesting, it would appear that lack of marginal production costs does not drastically alter the results presented by Hendel & Lizzeri (1999). More specifically, the incentives for the operator to mitigate the substitution effect and maintain secondary markets seem to remain unaffected. Lack of recurring production cost would simply allow the monopolist to reach a higher level of profit than previously possible. To confirm this result, we propose a potential avenue of future research at the end of this thesis.

Second, channel structure in virtual worlds differs from traditional channel structures encountered in the real world. In most real world secondary market models there usually are two parties operating on the supply side, the manufacturer and the retailer, who most of the time have nonaligned incentives. From the manufacturer's point of view, higher first-period sales generate higher first-period profits, but also result in a greater quantity of used goods to compete with future new good sales, thus diminishing subsequent manufacturer sales. For the retailer, on the other hand, higher first period sales lead to a cheaper supply of used goods and less reliance on the manufacturer as a source of future profits (Shulman & Coughlan, 2007). In virtual worlds the operator acts simultaneously as both the manufacturer and the retailer. The operator governing the virtual world designs and creates new items and then proceeds to sell them in a virtual marketplace that resides within the world. As opposed to its real world counterpart, the virtual world operator is able to harvest the whole supply side-profit. Another curiosity is that the market channel for virtual worlds is completely protected from potential competitors, as described in section 3.5. Again, it would seem that increased control over the market channel does not contradict any assumptions made by Hendel & Lizzeri (1999) or Shulman & Coughlan (2007). If anything, it affords more control to the operator and opens up certain supplementary options, such as implementing a transaction tax proposed by Shulman & Coughlan (2007).

Finally, a key assumption that drives much of the results presented by Hendel & Lizzeri (1999) and Shulman & Coughlan (2007) is that consumers have heterogeneous preferences. There is evidence that this assumption also prevails in virtual worlds. As detailed in section 3.5, virtual world operators purposefully utilize numerous design tools to create various consumer segments and needs in their worlds. For example, use stratified content results in development of heterogeneous preferences as they are defined by Hendel & Lizzeri (1999). As players progress within the virtual world, old items become less valuable to them, yet might still be very valuable to less advanced players. Status restricted goods and progressively challenging content similarly create heterogeneous valuations. A virtual world that would not feature heterogeneous valuations would have to be very simplistic and only feature goods that remain perfectly substitutable when worn (akin to light bulbs). As pointed out by Hendel & Lizzeri (1999) however, secondary markets would not serve any purpose in such an environment.

Based on the above, it is possible to tentatively assume that results from real world durable goods analyses may also apply to virtual environments, including the market segmentation benefits endowed by secondary markets, the substitution effect of used goods and the methods that the monopolist can alleviate its impact.

The virtual world operator can interfere with secondary markets much in the same ways as a real world monopolist. First, the operator can seek to shut down secondary markets altogether. While a tricky proposition for a real world monopolist, virtual world operators have sufficient control over their economies to kill off secondary markets. In essence, the operator can prevent secondary markets from forming by restricting ownership transfers of its virtual goods. If ownership of goods cannot be transferred from one player to another, trading of used goods is not possible. The only exception to this are user accounts[14], trade of which can be difficult to eradicate completely.

Second, the operator can choose to not shut down secondary markets and instead seek to reduce substitutability between new and used goods or reduce availability of used goods by moving to leasing (examined briefly at the end of this section). Operators that choose to mitigate the substitution of effect brought on by used goods can either reduce durability of new goods (and thus reduce the value of used goods) or create conditions under which used goods lose their appeal over time. One example of a service with secondary markets that utilizes new goods releases is Valve Software's *Dota 2*. In *Dota 2*, the main goods sold on the primary market are character outfits. Instead of producing all outfits internally, Valve leverages the player community to design and produce outfits. It then sells them on its primary market and then shares revenue with the creators. This bears several advantage for Valve: its production costs for new goods are lower, it can tap into a wider pool of talent than it otherwise could and it has a larger production capacity than it would otherwise. This allows Valve to release new goods onto the primary market at steady rate. The continuous cadence at which goods are released coupled with naturally emergent competition among producers (as Valve also controls which outfits make it to the market, with quality being one deciding factor) ensures that new goods are usually among the most desired items in the economy. In addition to introducing new goods that constantly introduce new "styles", *Dota 2* also limits second hand trade of some new items to shield them against substitution effects. Combined, these two measures do well to protect primary market sales by protecting the value of newly released items. Once the items mature and enthusiasm for them wanes, trading bans are lifted and consumer value is increased by opening up secondary market trading.

The impact of secondary markets for an individual virtual world is not limited to their effects on primary market profits. Virtual secondary markets also give rise to several externalities that virtual world operators have to take into account. First, enabling used goods trade adds a layer of complexity to the design of the virtual world and increases both development and operational risk. As with all other aspects of virtual worlds, the ability to transfer ownership of an item from one player to another is something that has to be purposefully implemented by the operator and thus competes in priority with other features the operator could be working on. In essence, the operator has to consider whether secondary markets are a good investment of time and effort compared to other available development

[14] User accounts here refer to accounts created by users when they sign up for a virtual world. Typically, all of the players' achievements and virtual possessions are stored under their accounts. Transferring ownership of an account is nearly always prohibited by the End User License Agreements of virtual worlds. However, as accounts are typically controlled via user names and passwords, trading their credentials for real money has been a known practice since the early virtual worlds.

goals. To mitigate implementation and operational costs, the operator can take advantage services such as Valve's *Steam*, which features an integrated secondary market platform that operators can adopt with reduced cost and effort. Second, allowing trade may in some cases damage information value of items. For example, if an item can only be obtained by high level players from a very difficult mission, ownership of the item acts as proof of social status. If items can be traded, this information value gets lost and it becomes impossible to say for certain who has "earned" the items they possess and who has simply bought them. In cases where preserving such information value is critical for the value proposition of the virtual world, the operator can seek to mitigate drawbacks by only allowing trade of non-critical items and locking key items to the player characters that earned them. An example of such a practice includes Blizzard's popular MMORPG, *World of Warcraft*, where certain items become "soulbound" when obtained. The soulbound status locks the item to the character that first picked it up, preventing trading it forward to other players. Third, introducing a secondary market opens up a window of opportunity for "farming" virtual goods and currency for real-world returns. If trading is not possible, the sellers have no way to transfer their goods to the buyer. Gold farmers perform often repetitive in-game activities (sometimes with the help of macros and programs that allow them to automate in-game actions) that maximize the amount of virtual currency earned over time. This "farmed" currency is then sold on to regular players for real money, usually advertised through the game's in-game chat system. If farming of virtual goods becomes extremely prevalent within a service, it can have negative externalities on the gameplay experience of regular players. These usually include loss of immersion and farmers monopolizing resources (Heeks, 2008). In extreme cases, gold farming can undermine stratified content structures designed by the operator by releasing vast amounts of virtual currency into the economy, allowing players to have more purchase power than the operator originally intended. It is possible to mitigate the drawbacks of farming through design (such as making earning currency require actions that are difficult to automate) and technological investment (such as sophisticated monitoring to trace flows of items or currency from farming accounts to seller accounts), but costs of doing so can be high. Alternatively, the operator can also attempt to drive out gold sellers by introducing a more trustworthy, operator-controlled primary market for currency sales. Fourth, allowing trade between players opens up the possibility for players to defraud one another and requires the operator to develop policies on how to handle cases of fraud and provide customer support. As might be expected, defrauding other players is forbidden in most virtual worlds, though there are some exceptions. One such exception is *EVE Online*, operated by CCP Games, which is famous for allowing players to scam other players as long as the fraud stays within the constraints of the virtual world. Ways to mitigate the impact of fraud includes forbidding it and then banning users who engage in it, warning players and designing trading systems that make defrauding other players difficult (for example by including a grace period during which either side can review the trade and withdraw their contribution should something be amiss).

Secondary markets also feature positive externalities. First, existence of secondary markets reduces the risk for buyers of new goods, as assets can be liquidated later on. This also allows for higher primary market prices (Shulman & Coughlan, 2007). Second, secondary markets enable investment, as goods that appreciate in value can be traded onwards. Third, secondary markets can act as sources of entertainment for players. Certain player types can be less interested in consuming actual game content and more inclined to monitor the used goods market for good deals and finds. Fourth, secondary markets can help create intrigue and stories around the game. For example, *EVE Online* has an economist on staff who is regularly interviewed by game and mainstream media (PC Gamer, Washington Post, BBC). *EVE Online* itself is regularly covered in media as well. News outlets who have covered it include Businessweek, Forbes and New York Times, among others. Finally, secondary markets can alleviate perceived problems of unfairness relating to the use of real-money puchases giving gameplay advantages, as they allow “time-rich” and “money-rich” players to access all goods through exchange (Hamari & Lehdonvirta, 2010).

All in all, an operator considering whether to allow or prohibit secondary markets should weigh the effect on primary market profit, the externalities involved and efficiency with which its virtual world mitigates negative externalities to determine overall net impact.

Leasing in virtual worlds

An alternative to selling durable goods is leasing them. Leasing solves time inconsistency issues as well eliminates drawbacks associated with used good acting as substitutes to new goods (Waldman, 2003). Hendel & Lizzeri (1999) point out that monopolist may sometime choose to lease instead of selling due to the increased market power it affords: a monopolist that leases has more control over the prices of used goods. In virtual environments, leasing confers some benefits and some drawbacks. One advantage of leasing is that it functions as a safeguard against inventory gluts: as virtual economies mature, durable goods can in some cases cause a situation where durable goods become obsolete but have no way out of the economy. This obsolescence is often caused by changes in player needs: an item was useful in the early stages of a players’ progression becomes worthless as the player advances. As a result, obsolete items can get stockpiled in players’ inventories and cause congestion. Leasing solves this by constantly eliminating expiring items from the economy. Other ways to address the problem include having features that consume durable goods, such as selling them back to the operator for virtual currency. To solve a similar issue in their economy, *Habbo* introduced an in-game machine that consumes old items and gives out a random new item for every 10 items fed into it. Other advantages of leasing include an opportunity for easy price segmentation (the operator can offer quantity discounts through different lease lengths) and simpler accounting of revenue. When the operator leases, revenue can be recognized when goods expire opposed to arbitrarily determined write-off durations that are used with durable goods. On the downside, leasing does not provide the same sense of ownership as owning goods does. Furthermore, leasing forces players to continuously experience loss as the leases end. All in all, it is a viable alternative to traditional virtual goods sales and there are examples of virtual worlds that employ leasing instead of durable goods sales. One such world, *APB: All Points Bulletin* by Realtime Worlds, started with a leasing-only model for its weapons and later started also selling permanent weapons in addition to its offering of leased goods.

Creating a transaction tax

Due to its control over the entire market channel, the virtual world operator would be in an advantageous position to introduce a Pigouvian transaction tax similar to one proposed by Shulman & Coughlan (2007). Upon opening a secondary market, buying propensity from the primary market decreases due to the substitution effect. At the same time, the trade-in value of the commodities improves, thus reducing risk as users can then liquidate their assets. Also, if the market is introduced inside the game environment, it reduces transaction costs for the user by making trading faster and more convenient. The user does not have to exit the virtual world to buy the desired goods and delivery of the purchased goods can be instantaneous due to the operator being the middle man. Furthermore, associating in the operator provided secondary market is safer for the user as the transaction are supervised and controlled by the operator. In cases where the transacting parties have disagreements, the operator can step in and mediate. Should it be necessary, the operator would also be able to revert transactions. Due to these benefits, we can assume that the user would be willing to pay a transaction cost when using operator sanctioned secondary market.

An operator controlled used goods marketplace would feature the following benefits. First, users would face a reduced risk of losing money or assets due to fraud, as the operator can act as an intermediary. Second, trading would be faster with the operator as an intermediary, as there would be no need to make additional arrangements (such as meeting up within the virtual world to perform the exchange). Third, search costs would be lower due to ease of access and the marketplace being tailored to the needs of the virtual world in question.

From here, we can assume the following: if the operator charges buyers a transaction tax in the operator sanctioned market, users are willing to utilize the market as long as tax does not exceed than the perceived benefits that using the operator sanctioned market provides. It could also be argued that users benefit more from using the operator sanctioned marketplace when trading in more expensive items, as avoiding risks is then worth more to them. Because of this, it might be reasonable for the operator to use a tax rate instead of a fixed tax amount per transaction.

As an expansion to the model, one might want to take into account the amount of users in the economy and their growth rate, whether it is positive or negative. Logic is as follows: if the amount of users in a virtual world is rapidly growing, it should be safe to assume that there is more demand for virtual assets in the secondary market. In contrast, should a world be dying, there should be less demand for virtual assets in the secondary market as users would not be enthusiastic to invest when the future looks dismal. Also, quitting users might be eager to undercut the average prices wanting to cash in their possessions.

All in all, further analysis would be necessary to determine the full implications of adding a transaction tax to an operator controlled secondary market. For example, operators might choose not to add a transaction cost to the secondary market transactions as doing so might have detrimental effects to market volume as the transaction cost would act as a disincentive for users to participate. Determining whether this would be the case is an interesting question to pursue in future research.

6. Conclusions and discussion

In the previous sections, we examined how secondary markets affect a virtual world operator's profits, basing our analysis on durable goods literature on real world secondary markets. Three primary research objectives were posed: we sought to find out whether how real money secondary markets for virtual goods affect the primary market profits of the virtual world operator, whether they should be permitted from the operator's point of view and whether the operator can undertake certain actions to enhance profitability of its secondary markets. For the first question, we found it likely that the existence of secondary markets has a positive effect on primary market profits provided that the virtual world operator takes measures to mitigate the substitution effect caused by used goods either by reducing their substitutability or by reducing the availability of used goods.

The second question, whether secondary markets should be allowed by the virtual world operator, is more complex in nature. While secondary markets may have a positive effect on primary market profits, their net effect may or may not be positive for any given virtual economy. Much depends on the design of the virtual world they exist for and how the design of the world handles negative externalities arising from secondary markets. If integrated and managed well, secondary markets can have few harmful effects overall and provide multiple benefits to the operator. If integrated and managed poorly, they can compromise the overall economy of a virtual world and lead to problems for the operator. Overall, it appears that secondary markets can best serve virtual world operators that anticipate their existence and design their virtual world with compatibility in mind. Carefully designed and managed secondary markets can act as a source of entertainment for the players and profit for the operator, as can be seen in the cases of *EVE Online* or *Dota 2*. On the other hand, virtual worlds that have not been designed to accommodate for secondary markets might find allowing them to be harmful, as secondary markets can potentially undermine an unprepared economy. In some cases, ill-prepared operators have been caught off guard by unexpected economical interactions involving secondary markets. In case of *Diablo 3*, the operator-controlled secondary market contributed to the hyperinflation that ravaged the virtual economy and eventually forced the operator to kill off the secondary market. The unfortunate chain of events started with unexpected player behavior: instead of spending virtual currency at the blacksmith (which was intended by the economy designers to be a major currency sink), players chose to purchase goods from other players on the secondary market instead. Primary reason for this was that the secondary market offered better value for money. Since secondary market transactions did not function as efficient currency sinks and currency faucets were creating new currency at normal rates, the amount of currency in circulation kept growing. The problem was exacerbated by gold farmers, who quickly arrived in number after the game launched and started producing vast amounts of virtual currency and selling it to players. Some players reported secondary market prices doubling every few days. After several months and multiple failed attempts to address the issues, the operator was forced to close down the secondary market to restore stability to the economy. Earle (2013) provides an anecdotal account of the whole sequence of events for those interested in reading further about it. The disaster could perhaps have been avoided had the operator had better knowledge of the dynamics of virtual secondary markets and taken stricter measures to alleviate risks.

To answer the third question, we concluded that the operator can optimize secondary market profitability by taking actions to mitigate negative externalities and amplify positive ones. To mitigate investment required in introducing secondary markets, the operator can utilize third party services such as Steam. To preserve information value of goods, operators can impose status restrictions on key items. To prevent gold farming, the operator can design earning mechanics that are robust against automation, provide a more reliable channel of in-game currency sales themselves or invest in analytical solutions that identify transactional patterns typical to gold farmers. To prevent fraud, operators can invest in educating the player community on how to avoid fraud and design trade systems that offer protection against fraud by allowing traders to give feedback on reliable trading partners, by offering escrow services and so on. On the other hand, the operators can seek to amplify the benefits caused positive externalities. Virtual worlds with vibrant secondary markets can utilize secondary markets to generate interesting stories and provide content for marketing, as CCP does with *EVE Online*. Operators can also design virtual goods that utilize secondary markets to tap into demand that would be otherwise unavailable for them. *EVE Online* features a monthly subscription cost, but also allows players to pay for it by consuming in an in-game item called “PLEX”. Units of PLEX are sold to players by the operator for real money. However, since they can be traded on the secondary market, “time-rich” players who play more and possess more virtual currency can trade with “money-rich” players that own little virtual currency, but can buy PLEX with real money. Through this dynamic, both player types can get what they want: money-rich players get virtual currency which they don’t have time to earn, and time-rich players get PLEX which they don’t have money to buy. At the same time, the operator benefits by being able to serve the whole audience instead of just serving the money-rich players.

It is straightforward to predict that measures virtual world operators can utilize to successfully interfere with secondary markets range beyond those available to the real world monopolist. While the real world monopolist is limited adjusting durability of new goods or choosing different strategies for how it sells or rents its products, the virtual world operator enjoys much greater control over all aspects of the market. Strategies employed by Valve with *Dota 2* are an example of this: a real world monopolist would not be capable of first perfectly enforcing trading restrictions for new goods and then efficiently removing them on an arbitrarily defined date. Further mapping the ways a virtual world operator could optimize primary and secondary market profits using its unique control over market conditons would be an interesting avenue of future study.

Another potential avenue for future exploration would be better adapting real world secondary market models to virtual environments. As pointed out earlier in this thesis, some assumptions made in the real-world models of secondary markets hold poorly for virtual economies: in virtual environments, producing a good with infinite durability carries no extra cost. Durability is an attribute of the good that can be adjusted perfectly and without cost. Furthermore, producing additional copies of a virtual good after the first good is virtually costless.

Adopting these new assumptions and integrating them into the previous research might provide additional insights into the effects of secondary markets in virtual environments. Take the model of Hendel & Lizzeri (1999) as an example. In their model, the monopolist's objective is to maximize the following:

$$\Pi = \sum_{t=0}^{\infty} \delta^{\mathrm{t}}\, y_t \left\{ \overbrace{\Theta(y_t)v}^{New\ good\ profit} - \overbrace{w\big(\Theta(y_t) - \Theta(y_t + y_{t-1}) - \delta\Theta(y_t + y_{t+1})\big)}^{Used\ good\ substitution\ effect} - \overbrace{c(w)}^{Production\ cost} \right\}$$

$$subject\ to \quad w \geq 0, \qquad y_t \geq 0 \ \ \forall\, t,$$

with initial conditions (starting values at $t = 0$) $y_{-1} = \hat{y}$ and $w_{-1} = \hat{w}$. Hendel & Lizzeri assume an infinite horizon, discrete time, heterogeneous consumer preferences and that there is a unit mass of consumers who live forever (meaning that no new generations of consumers arise). The variables involved in the target function are defined as follows: v is the quality of a new good, w is the quality of a used good, y_t is output in period t, Θ denotes the consumer type and δ is discount factor.

Following from the monopolist's target function, Hendel & Lizzeri present the following optimality conditions for the monopolist:

$$\frac{\partial \Pi}{\partial w} = \sum_{t=0}^{\infty} \delta^{\mathrm{t}}\, y_t\{\Theta(y_t + y_{t-1}) + \delta\Theta(y_t + y_{t+1}) - \Theta(y_t) - c'(w)\} + y_0(\delta\Theta(y_0 + y_1) - c'(w))$$

and

$$\begin{aligned}\frac{\partial \Pi}{\partial y_t} = \delta^t\big\{&\Theta(y_t)v - w\big(\Theta(y_t) - \Theta(y_t + y_{t-1}) - \delta\Theta(y_t + y_{t+1})\big) - c(w) + y_t[\Theta'(y_t)v \\ &- w\big(\Theta'(y_t) - \Theta'(y_t + y_{t-1}) - \delta\Theta'(y_t + y_{t+1})\big)] + wy_{t-1}\Theta'(y_t + y_{t-1}) \\ &+ w\delta y_{t+1}\Theta'(y_t + y_{t+1})\big\}\end{aligned}$$

Using their optimality conditions, Hendel & Lizzeri posit the following steady state where $y_t = y \;\forall\; t$, assuming that $\hat{y} = y$:

$$\delta[2\Theta(2y^m) - \Theta(y^m)] = c'(w^m) \quad (1)$$

$$\big(\Theta(y^m) + y^m\Theta'(y^m)\big)(v - w^m) + w^m(1 + \delta)[\Theta(2y^m) + 2y^m\Theta'(2y^m)] = c(w^m) \quad (2)$$

Or, at a corner solution,

$$w^m = 0, \qquad \delta[2\Theta(2y^m) - \Theta(y^m)] \leq c'(0), \qquad \Theta(y^m) + y^m\Theta'(y^m))v = c(0).$$

Possibly the most obvious incompatibility relating to virtual environments in the objective function above is the recurring nature of production cost and its dependence on durability. In the model, the cost of durability follows constant returns to scale and the cost of producing output y of durability w is $C(y,w) = yc(w)$, where $c(.)$ is assumed to be differentiable, increasing and convex. They also assume that $c'(0) = 0$ and $c(v) = \infty$ meaning that the marginal cost of durability at zero is zero, but it is infinitely costly to produce a good that does not depreciate at all. Such assumptions hold poorly in a virtual context. First, in virtual environments durability of goods can be perfectly controlled by the operator and increasing or decreasing it does not have a direct effect on cost. Producing a good that never deteriorates is just as cheap (or expensive) as making a good that vanishes after a single use. Second, once the operator has spent the necessary resources to produce a virtual good, producing more goods of the same kind is virtually costless.

To better reflect the conditions monopolists face in virtual environments, we modify the objective function by considering the production cost to be a fixed cost instead of marginal cost. This yields the following function:

$$\Pi = \sum_{t=0}^{\infty} \delta^{\mathrm{t}} y_t \left\{ \overbrace{\Theta(y_t)v}^{New\ good\ profit} - \overbrace{w\big(\Theta(y_t) - \Theta(y_t + y_{t-1}) - \delta\Theta(y_t + y_{t+1})\big)}^{Used\ good\ substitution\ effect} \right\} - \overset{Production\ cost}{\delta^0 c}$$

Deriving the optimality conditions again from the *modified* target function above, we get:

$$\frac{\partial \Pi}{\partial w} = \sum_{t=0}^{\infty} \delta^{\mathrm{t}} y_t \{\Theta(y_t + y_{t-1}) + \delta\Theta(y_t + y_{t+1}) - \Theta(y_t)\} + y_0(\delta\Theta(y_0 + y_1))$$

and

$$\frac{\partial \Pi}{\partial y_t} = \delta^t \{ \Theta(y_t)v - w\big(\Theta(y_t) - \Theta(y_t + y_{t-1}) - \delta\Theta(y_t + y_{t+1})\big) + y_t[\Theta'(y_t)v - w\big(\Theta'(y_t) - \Theta'(y_t + y_{t-1}) - \delta\Theta'(y_t + y_{t+1})\big)] + w y_{t-1}\Theta'(y_t + y_{t-1}) + w\delta y_{t+1}\Theta'(y_t + y_{t+1}) \}$$

Since the production cost of goods is a fixed one-time expense in virtual environments, it ceases to exist in the optimality conditions. Consequently, the new steady state equations are:

$$\delta[2\Theta(2y^m) - \Theta(y^m)] = 0 \quad (3)$$

$$\big(\Theta(y^m) + y^m\Theta'(y^m)\big)(v - w^m) + w^m(1+\delta)[\Theta(2y^m) + 2y^m\Theta'(2y^m)] = 0 \quad (4)$$

This new steady state could be analyzed further for theoretical insights into how virtual secondary markets differ from those encountered in the real world.

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