



**WORLD OF WARCRAFT: A CORRELATION BETWEEN A VIRTUAL
ECONOMY AND REAL ECONOMY**

Lappeenranta–Lahti University of Technology LUT

Software Engineering – Digital Transformation Master’s Thesis

2022

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Examiner(s): Professor Jari Porras

ABSTRACT

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Abstract:

MMORPG genre games have a very similar resemblance to real-life since they are based on a large-scale community of people co-existing in a virtual world. Virtual worlds behave parallel to the real world regarding economic factors, since there is a population that can support elaborate decision making while investigating an economy with a multitude of investment opportunities. This thesis aims to analyse patterns using MMORPG data and compare them to real life economical patterns that already have an established behaviour. The outcome of this thesis is a confirmation of analogous behaviour between the virtual and real-world economy.

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I want to thank all my friends; it feels incredible to be surrounded by such amazing people.

I dedicate this thesis to my grandfather, whose wisdom will live on with me.

SYMBOLS AND ABBREVIATIONS

Abbreviations

API	Application Programming Interface
BI	Business Intelligence
CSV	Comma-Separated Values
EU	Europe
JSON	JavaScript Object Notation
MMORPG	Massively Multiplayer Online Role-Playing Game
NFT	Non-Fungible Token
NPC	Non-Playable Character
RPG	Role-Playing Game
TBC	The Burning Crusade
WoW	World of Warcraft

1	INTRODUCTION.....	5
1.1	AIM OF THE RESEARCH.....	6
1.2	RESEARCH QUESTIONS	6
1.3	OBJECTIVES & LIMITATIONS	8
1.4	STRUCTURE OF THE THESIS	10
2	RELATED WORK.....	11
3	VIRTUAL WORLDS	20
3.1	WORLD OF WARCRAFT.....	21
3.2	ECONOMY IN WORLD OF WARCRAFT	23
4	ECONOMICAL ASPECTS	28
4.1	THE SIMILARITIES	30
4.2	THE DIFFERENCES.....	30
5	ECONOMIC TRENDS AND BEHAVIOURS.....	32
5.1	THE LAW OF SUPPLY AND DEMAND	32
5.2	PRICE ELASTICITY.....	34
5.3	SCARCITY.....	35
5.4	VIRTUAL WORLD REPRESENTATION	36
6	TOOLS & METHODS.....	38
7	ECONOMICAL COMPARISONS	41
8	CONCLUSIONS.....	52
	REFERENCES	54

Figures

Figure 1: Article Elimination

Figure 2: Articles written by year

Figure 3: Articles by categorisation

Figure 4: Articles by type of data

Figure 5: Articles by data collection method

Figure 6: Process of making a firework launcher

Figure 7: Law of Supply and Demand

Figure 8a: Haste potion auction data Alliance

Figure 8b: Haste potion auction data Horde

Figure 9: Firemaw population (Ironforgepro, 2022)

Figure 10: Firemaw population graph (Ironforgepro, 2022)

Figure 11a: Crimson spinel auction data Alliance

Figure 11b: Crimson spinel auction data Horde

Figure 12a: Sunmote auction data Alliance

Figure 12b: Sunmote auction data Horde

Figure 13a: Quick lionseye auction data Alliance

Figure 13b: Quick lionseye auction data Horde

Figure 14a: Peacebloom auction data Alliance

Figure 14b: Peacebloom auction data Horde

Figure 15a: Netherweave cloth auction data Alliance

Figure 15b: Netherweave cloth auction data Horde

Figure 16a: Large prismatic shard auction data Alliance

Figure 16b: Large prismatic shard auction data Horde

Tables

Table 1: Literature Review Steps

Table 2. Similarities between a virtual economy and a real-life economy

1 Introduction

Attempting to predict complex systems has been a difficult venture in many fields, ranging from Chaos theory to ecosystems, climate & weather forecasting to economics. The use of computational models has provided some amount of insight into the phenomena present in these complex fields and has given the ability to make, to some extent, predictions about the behaviour of a system. The ability to make these predictions in the field of economics is referred to as "Economic Forecasting". (Liberto, 2020).

Businesses rely on economic forecasting in order to plan their activities and maximize their profit and growth. Governments will also use economic forecasting in order to shape their fiscal policies and try to avoid or mitigate economic trouble, such as recession. The need for this type of prediction is twofold: eliminating or mitigating the uncertainty of the economic future and revealing the impact of economic decisions. Even though applying economic forecasting has obvious benefits to society, mastering it has been proven difficult due to the complexity of the economic ecosystem. Predictability is directly tied to complexity in the sense that simple systems are easy to predict and complex systems show behaviour that is counterintuitive or not operating by the laws of cause and effect. It would be beneficial to have a system that has similar characteristics to the economy but without its excessive complexity and ambiguity. If such a system would be identified it could be a great value for economic research.

This thesis aims to demonstrate that the economical ecosystem and behaviour of a virtual economy is analogous to real-world economy behaviour to a high degree. If this proves to be true a virtual economy would provide a testing ground with greater transparency, control and a decreased complexity. This virtual testing ground would make it easier to analyse and understand economical patterns and behaviours and as a result increase the ability to successfully employ economic forecasting in the real world. In order to achieve most objective results, transactional data has been used to demonstrate the behaviours of a virtual economy. The aim is to show the reader the market behaviour in a virtual world, and explain the patterns found in the data by using conventional economic knowledge. The degree to which the observed phenomena follow or deviate from the conventional theory will determine how strongly the virtual economy correlates with the real-world economy.

1.1 Aim of the research

The aim of this research is to determine whether the real-life economy can behave similarly to a virtual economy. This research will highlight the characteristics in economy that go hand in hand with a virtual economy and analyse the patterns of comparable behaviour.

In virtual worlds, people behave in a realistic manner as they do in real life, which makes the research conducted in these virtual worlds regarding economic sciences have a great potential. (Bainbridge, 2007).

1.2 Research Questions

The key component this paper aims to shine light is the similarities between the virtual economy and real economy. In order to do that, the similar patterns of behaviours need to be analysed. The research questions got composed specifically to understand if any predictions can be made about the real-life economy using a virtual economy. The data used to conduct this research is also a crucial element to give answers to this research.

Research Question 1: Is there a correlation between a virtual economy and real economy?

Rationale: If there is sufficient proof that a virtual economy displays the same behaviour as the real economy, it can be used as an economical microcosm on which economic studies can be done.

Research Question 2: What kind of data can be used to detect the behaviours that real economy shows in a virtual world?

Rationale: Where can data be collected that fulfils the needs regarding quality, volume, duration, level of detail? Does the chosen source of data fulfil these needs, if not, what are alternative sources for future research?

Research Question 3: What are the ways of measuring various effects in a virtual economy that is also seen in a real economy?

Rationale: There is a need for reliable methods to demonstrate the economical correlation.

Research Question 4: Do the results of the virtual economy behaviour confirm or go against the current understanding of economic behaviour in the real world?

Rationale: If the behaviour observed in the data does not behave in a way that can be explained by conventional economic theory it would undermine the value of the virtual economy as a testing ground.

1.3 Objectives & Limitations

There is a lot of competitiveness among players in videogames and as a result there is a wide array of third-party tools and resources available meant to provide data to players that might give them an advantage. These tools can be used to gather data pertinent to this research.

One commonly used tool is an auction house tracker which collects all the auction listings on a game server to make them available for later review, players could browse through the historical data and review the price movement in order to determine the optimal moment to buy or sell a good. Auction house basically means the market of the virtual world economy. Players sell and buy goods from the auction house, in order to invest or use the goods that are available in the game. These goods, just like in real-life, can benefit the players inside the game. It is almost impossible to play the game without ever using the auction house, since just like in real-life, the goods that can be bought/sold are highly varied (players cannot obtain all kinds of goods to benefit them in the game, they have to work with other players).

Many of these trackers are open source and have a significant data retention period, even though the oldest data might not be accessible directly through the website of these trackers, some will provide an API to query the full range of historical data. One of limitations of the data is that the data that can be queried from the World of Warcraft API can only provide data about the currently listed auctions. (Blizzard Battle.net Developer Portal, 2022).

When querying the auction house for a particular server it will list all current auctions as with the following information ("id", "Itemid", "bid", "buyout", "quantity", "time_left") as such the records of the transaction of the sales themselves are not directly available, only the records of the listings of the items with the aforementioned information.

This does not render the data unusable however, since the smallest found buyout of a particular item can be seen as the “sticker price” or base price for that item, since a buyer will always purchase a good at the lowest price available and a seller, when listing the same item will not want to list far above this sticker price or their good will not sell, they will also not want to sell too far below that price since that will cost them earnings.

As such the lowest detected buyout price for a good should be a precise indicator for its current market value. The objective is to analyse the auction data, this is a daunting task however, a scan performed with the open source addon “Auctionator”. (GitHub, 2022).

On the World of Warcraft – The Burning Crusade EU Firemaw server on April 25th 2022 revealed a total of 10042 distinct types of items and a total of 107801 auctions listed. Querying such a large number of items, importing the resulting data into a BI tool to create a histogram, and investigating the resulting histogram to detect a potential economic phenomenon would require a significant amount of time and not be a feasible task to complete for each of the 10042 item types.

In order to limit the data to items that would be likely to contain evidence of an economic phenomenon, the author relied on her personal experience with the World of Warcraft economy to determine which items would be good candidates for investigation.

1.4 Structure of the thesis

This paper is going to examine how a virtual economy behaves similarly to the real-world economy. The following issues are going to be talked about respectively:

- Related work is going to be discussed about previously done research about this issue.
- Virtual worlds are going to be explained to the viewer in order to give a good understanding of the subject matter.
- Then the game “World of Warcraft” is going to be discussed in terms of game play options and the economy in the game.
- Economical aspects are going to be talked about regarding their similarities and differences between the real world and the virtual world.
- Economic trends and behaviours are going to be explained in order to analyse the examples more clearly.
- Tools & Methods that have been used to conduct this research are going to be discussed.
- Economical comparisons will be made with the visualisation of the graphs created by the supporting data.
- Lastly, conclusions will be made about this research.

2 Related Work

In order to create a well-established Related Work section, several steps have been taken. First, the literature review topic has been defined. Then the literature review protocol has been written and planned. After the protocol has been defined clearly, it was implemented into the conducting stage and the actual literature review has been conducted. Lastly, in the dissemination step, the research article has been written.

Table 1. Literature Review Steps

Stage 1 - Setting the scene
Stage 2 - Planning
Stage 3 - Conducting
Stage 4 - Dissemination

The articles that have been mentioned in this paper were selected considering their specifications about this topic, relevance to this topic and the ability to answer the research questions clearly. The articles which fell under grey literature had been removed. The articles which did not include specific-enough material had been removed. Articles which are fully available, written in English and engaging in various relevant key points have been used. After considering these elements the selected article number was 18 out of 50.

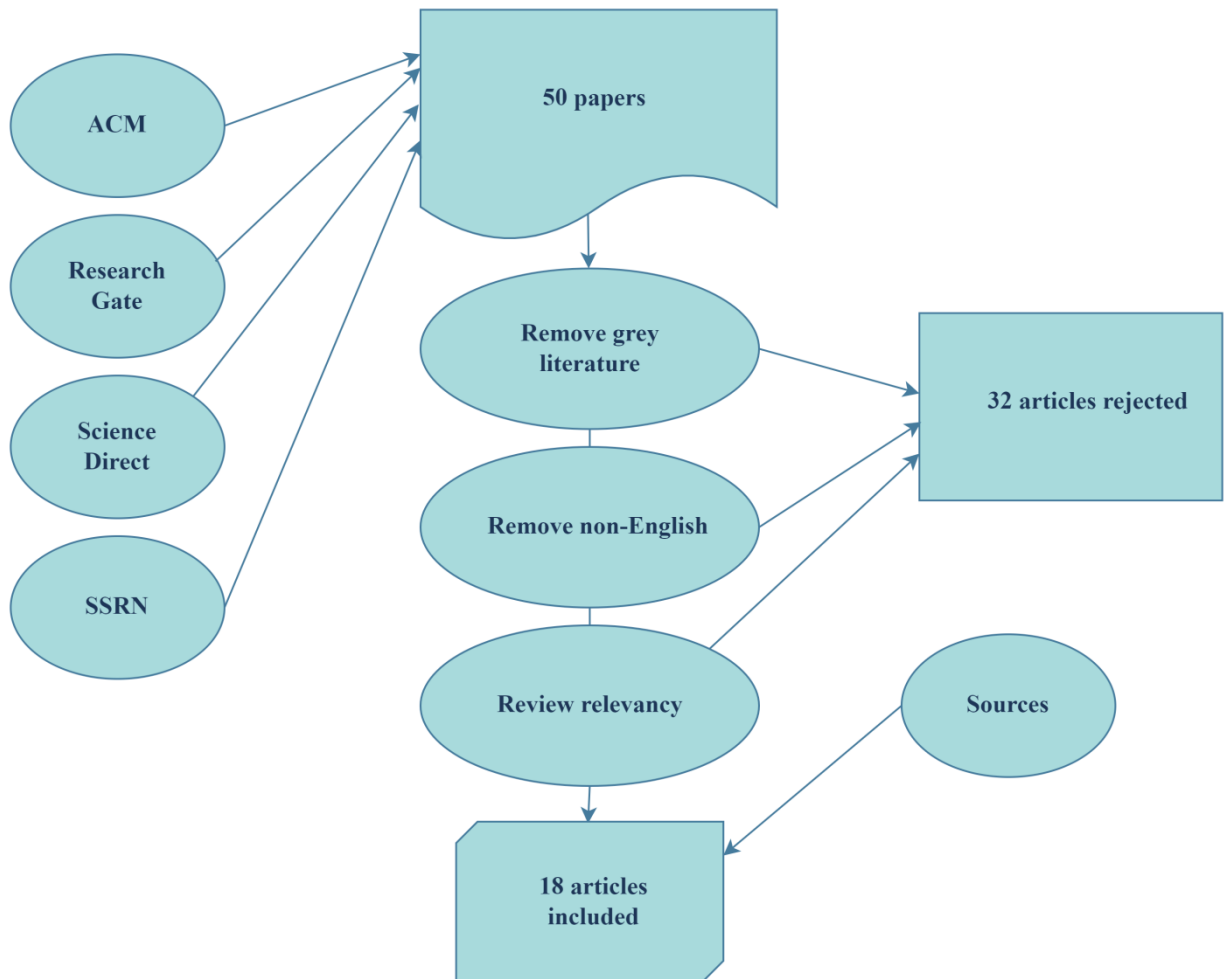


Figure 1. Article Elimination

The figure above shows the literature review process. There were four databases that were used in the search of related articles. Forward snowballing was used after finding the primary articles, after this process, there were 50 articles to look at. For those 50 articles, the ones with grey literature had been removed, the ones that were not written in English language had been removed, and, the irrelevant ones (with further reading done after looking at abstracts) had been removed. At the end, 32 articles were falling into the removed pile, and the remaining 18 articles had been used to conduct this research.

There are few main difficulties in this research. One of the biggest obstacles is that the data presented in the previous studies are not elaborate enough. Datasets not being big enough to draw valid conclusions from are a problem and they might not give solid and/or specific answers.

Figure 2 represents the article numbers that are written parallel to this topic over the years. It is important to understand that the research that has been done about “Virtual Economies” started especially around the time MMORPG’s started to gain popularity rapidly. However, in the recent years there has not been a great amount of research done about the topic, and, considering the evolution of Data Mining techniques and the variety of data collection methods getting even more precise in recent years, it is crucial to consider looking more in depth to the economy in the virtual environments.

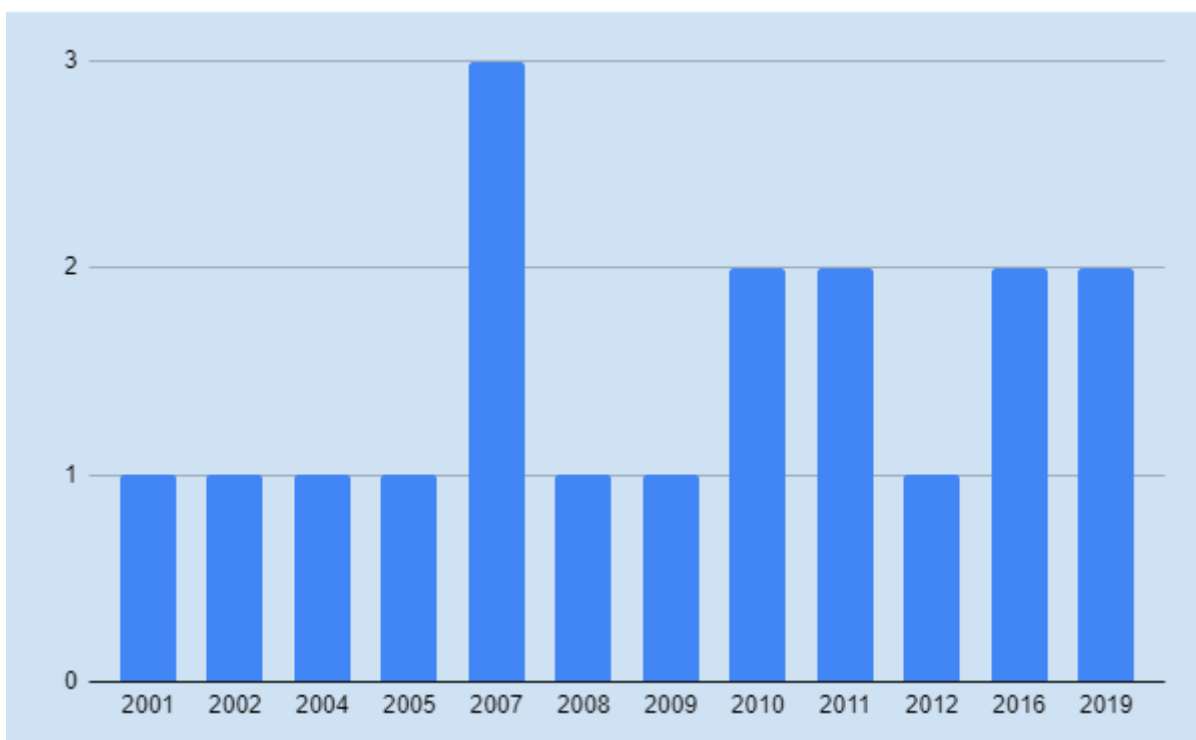


Figure 2. Articles written by year

Since the concept of “Virtual Economy” and MMORPG genre is rapidly evolving, even though the mentioned articles carry a lot of highly relevant data, it is important to see how virtual economies have changed over time. The changes may include significant increase of the number of participants, the complexity the developers use to build their virtual economy and the option to use newer and more reliable data collection methods.

The articles have been classified with three different aspects:

- Articles by categorisation
- Articles by type of data
- Articles by data collection method

It is important to look further into these three aspects in order to differentiate the results these articles have found. Most of the articles talked heavily about the economical aspect of the virtual worlds, however only one article did go through with the economic research using transactional tracking. Articles have mostly used first party data. To conduct an objective and scalable economic research about a virtual world, it is necessary to understand the how the virtual economy works. The articles focused on relatively smaller virtual worlds, unlike massive ones with vast, trackable data. The articles explained the cultural, economical and historical findings in the virtual worlds and virtual economies which is relevant to the findings in this thesis. The data used in the articles as shown in Figure 5, has a distinct lack of transactional data, even though surveys, articles and observational data have their merits, they lack the depth required for thorough analysis of the economical aspect. Transactional data is not susceptible to collection or subject bias and provides an objective insight into the workings of the virtual economy. As an added benefit, transactional data from a virtual economy does not differ in any significant way from transactional data from a real-life economy and provides a 1 on 1 comparison with a minimal need to no need to modify or transform the data.

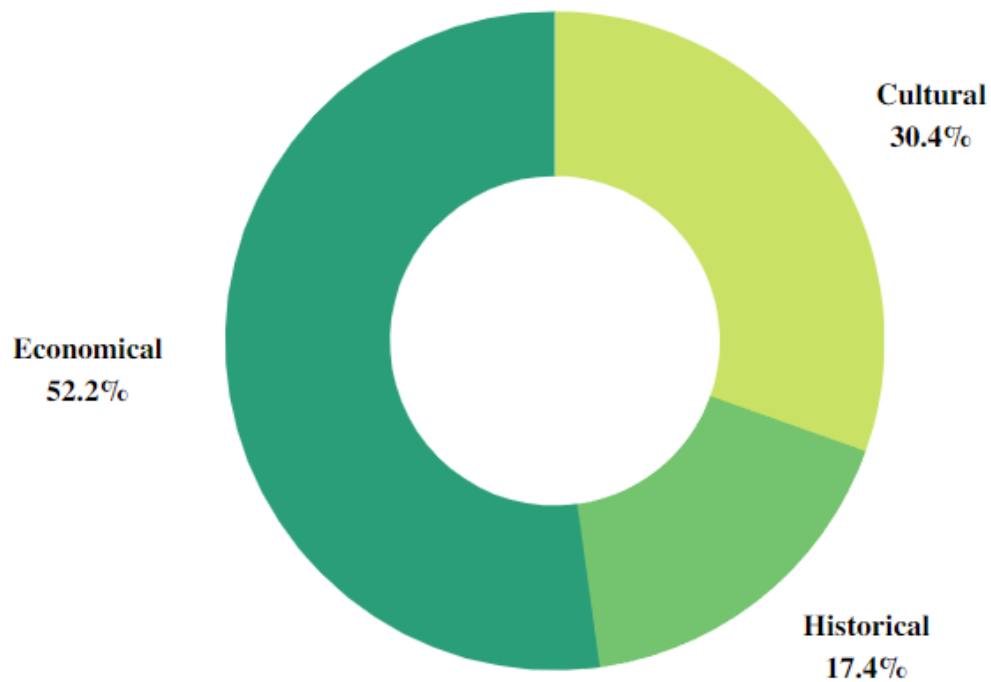


Figure 3. Articles by categorisation

Figure 3 represents the categorisation about related articles in three different aspects; cultural, historical and economical. The majority of the articles found used an economical approach. It is important to understand that all factors affect virtual economies, therefore it is beneficial to categorise these elements in regards to having a greater understanding of the subject matter, in order to have sufficient background information to answer the research questions. All three categories are relevant to the quality of the research that has been conducted. Understanding these categories is important in regards to answering the research questions in depth since player behaviour in MMORPG's are heavily related on those elements.

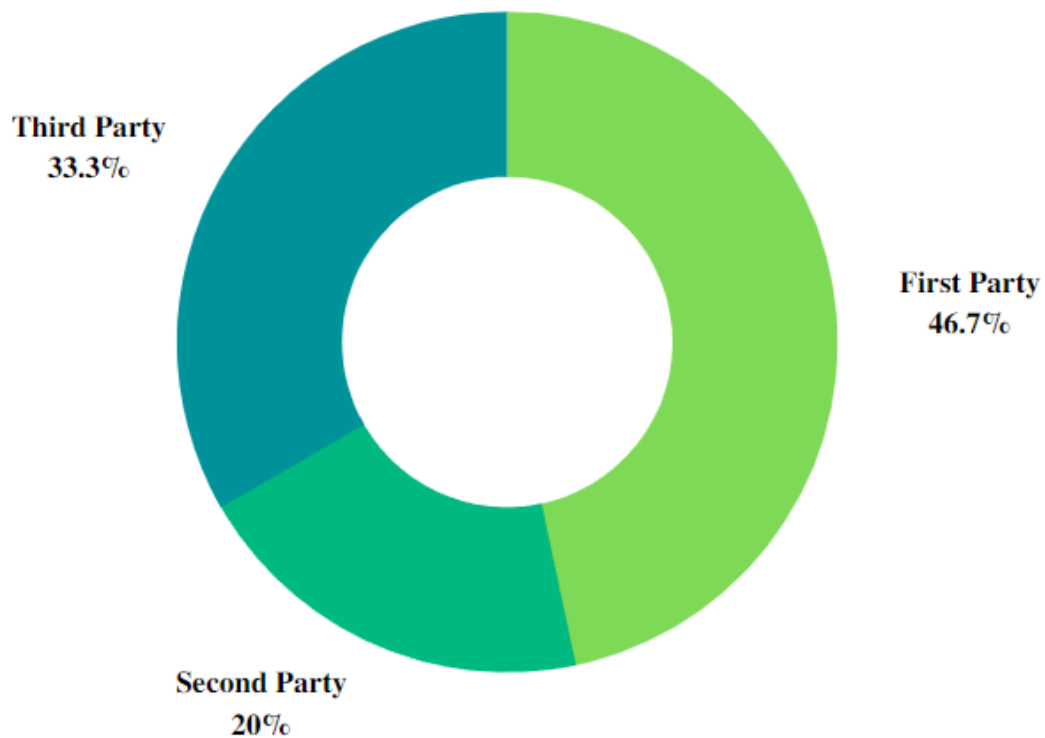


Figure 4. Articles by type of data

Figure 4 represents the Type of Data that the studies used in order to get a better understanding of the subject. There are three types of data that are shown; first, second and third-party data. A lot of the articles found used first party data collection which is unsurprising, since the subject matter is only relatively recently gaining interest among economists and academics. Hence, a lot of researchers were forced to go out and collect the data themselves since there were no (or very few) high quality second party or third-party data sources available.

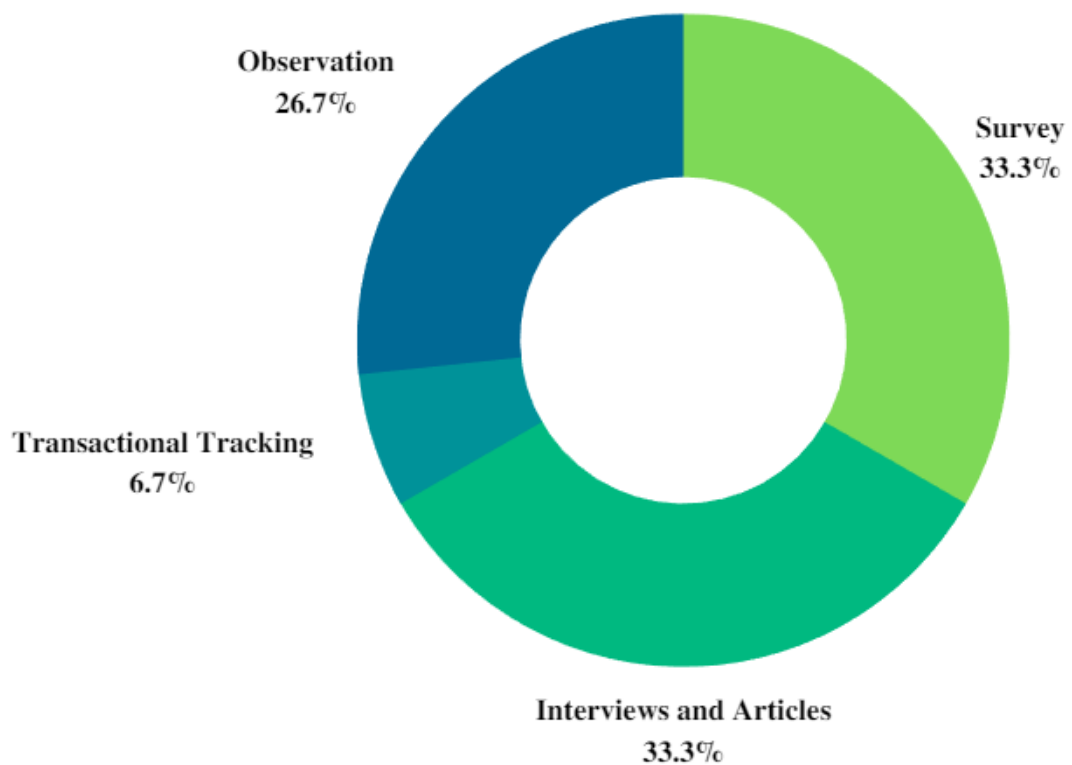


Figure 5. Articles by data collection method

Depending on what Data Collection Method has been used, the answers to the problems will vary. Whilst surveys are going to give more subjective data, transactional tracking will give objective data. In Figure 5, the research articles which conducted these methods to collect data are shown.

Research Gap:

Even though virtual worlds promised a vast economic potential, there is little research had been done about consumer behaviour. (Guo & Barnes, 2012). There seems to be a lack of transactional data tracking among the articles found. A lot of the mentioned articles tend to go with surveys, interviews or observation in order to collect their data. In this paper, the research is going to be conducted using second party transactional data collection in order to reach the most objective results. Transactional tracking would give the most objective and analysable data compared to the data that might be gathered from interviews, surveys or observation, since it would be in vast numbers without any subjectivity involved.

In most of the studies, the testing grounds were not optimal, meaning, the market behaviour did not only shape by the players. This is a big difference than testing a virtual market where no other elements are affecting the market. If other elements affect the market behaviour, examining economic patterns would be harder to do, and the research might even give inaccurate results.

3 Virtual Worlds

A virtual world can be best defined as a computer simulation that is representing the real world whilst allowing players to interact with each other and co-exist in this setting. (Virtual Worlds, 2022). The key difference between a virtual world and real world is that a virtual world cannot be defined with a physical form, however, it will show all the attributes of the real world. (Chambers, 2011, pp. 377-384).

In a virtual world, it is possible for users to present themselves however they desire, therefore, have a more heightened experience from the activities they participated in together. (Hooker, et al., 2019). Users can also create avatars or characters that are not true to the user regarding real-life features or behaviours. Creating different versions of avatars affects the users' consumption habits to become a mix of both real-world and the virtual world preferences. (Hooker, et al., 2019). Aside from the players' ability to represent themselves in a virtual world, they are existing in the same place, real time, with the same set of rules. (Bartle, 2009).

Another opportunity that presents itself while experimenting in a virtual world is that the participants can be drawn globally, which makes the research more accurate considering how different values and cultures affect different elements. (Wiersma, 2011). Virtual worlds do not necessarily bound themselves with limitation, every circumstance could be created and examined upon.

3.1 World of Warcraft

World of Warcraft is one of the most successful MMORPG's of all time.

The success of MMORPG's depends on a variety of things such as world building, player experience, sense of social aspect and the feeling of achievement. In that sense, MMORPG's are similar to real-life. One of the most, if not the most important aspect of MMORPG's is the virtual world they are built in.

Normally, the games have objectives or end-goals. These end goals can consist of unlocking all the levels, having all the achievements, defeating certain objectives or completing the gameplay fully. However, for a RPG's that is not the case. The point of playing a role-playing game does not have to be about beating the game. On the contrary, the objective when playing in a virtual world is different, the objective is to participate in the game, social interaction and experience (Virtual Worlds, 2022).

World of Warcraft works perfectly as a virtual world experience. Players get to decide which side are they going to be playing on, what kind of role that they are going to play, which race their characters belong. It consists of two factions: Alliance and Horde. Players can decide whether they want to be a damage dealer, tank or a healer. Damage dealing classes also consists of physical damage dealers and casters, such as a mage or a warlock. Players can choose to create their characters as night elves, gnomes, dwarves, humans, draeneis, orcs, undeads, taurens, blood elves or trolls. There is plenty of room for customization regarding the physical appearance of the characters as well.

The game geographically consists of "Old World" and the "Outland" (in The Burning Crusade expansion), Old World being the two main continents and Outland being the outer world continent introduced in the beginning of the TBC expansion. Players can run into each other while spending time in cities, gathering materials or just walking or flying around. It is possible to observe that players who play in the same server get to know each other in time and create a sense of community.

Talking about sense of community, in World of Warcraft, players can join "guilds" and defeat objectives together. Although, joining a guild does not have to be about defeating an

objective, some players can just join guilds as “socials”. Being a social in a guild means that the player is more casual compared to other players who play together to defeat bosses (raiding), this does not necessarily mean that they would not contribute to the guild. Players contribute to the playstyle of their friends or their guilds in many ways, this can be gathering materials, managing guild assets (such as guild bank) or simply being there when needed.

In banks, players can store their items and valuables, the guilds also have banks that are not necessarily managed by one player, but anyone who is authorized by the guild. Raiding guilds would have commodities that single players cannot farm (obtain) alone in the game such as some rare gems or recipes that are used to advance the characters. These commodities can be sold or given to the players by the guild authorities, and usually they are highly valuable.

In that sense, the virtual world in the MMORPG World of Warcraft is the perfect place to analyse economical behaviours, considering the tremendous amounts of active players currently playing the game, therefore, trading in the game. Moreover, WoW TBC might be the perfect testing ground, since it does not offer any token that can be bought for real money that affects the server’s economy (it is a closed economy to the outside world, players need to farm gold themselves in order to contribute and trade within the game), therefore it mimics the real-world economy in a more precise way.

3.2 Economy in World of Warcraft

Gold making, just like many other games, is very important in World of Warcraft. Players can make substantial amounts of gold in a variety of ways. There are professions built in the game that players may pick, these professions may be the gathering professions, crafting professions or secondary professions.

Gathering Professions:

- Herbalism
- Mining
- Skinning

Crafting Professions:

- Tailoring
- Blacksmithing
- Leatherworking
- Alchemy
- Enchanting
- Engineering
- Jewelcrafting

Secondary Professions:

- Cooking
- First Aid
- Fishing

The gathering professions are the ones that let players collect raw materials. The most common thing for a levelling player without sufficient funds (when players are lower level, it is common to not have too much money for buying the materials off from the auction house) to do is basically pick one gathering and one crafting professions that support each other. It is important to note that players can only choose two professions amongst all the gathering and crafting professions. Pretty much every profession benefits each other on a level, however, some of them are more efficient and more beneficial amongst each other.

These supporting professions are Herbalism-Alchemy, Mining-Blacksmithing and Skinning-Leatherworking. As said above, almost every profession benefit each other, therefore, mining could, for example, benefit an engineering profession as well but it would be less profiting than picking blacksmithing over engineering. The idea is to gather the raw materials rather than buying them for the crafting profession. Of course, if players want to buy the raw materials and craft items, then sell the items to make profit (which is a higher profit margin since levelling crafting professions are more expensive and time consuming) instead of gathering the raw material, they can do that.

The secondary professions are not within the two professions limit, and all can be picked along with the two main (gathering and crafting) professions by players. Secondary professions benefit each other as well, if a player learns fishing alongside with cooking, there would not be a need for that player to invest in cooking materials, since cooking can be levelled by cooking fish.

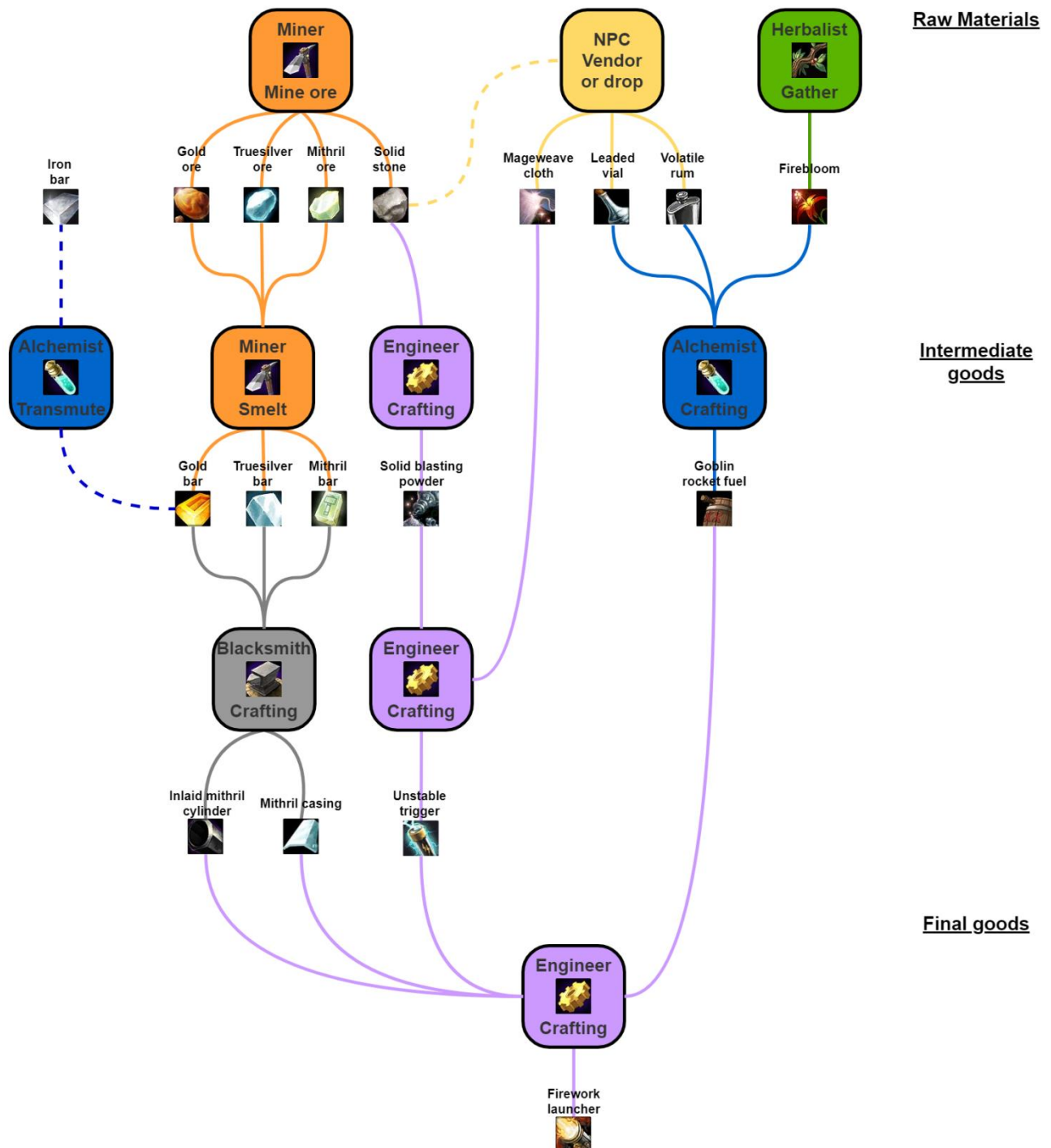


Figure 6. Process of making a firework launcher

The items or goods represented by the data from the World of Warcraft auction house can be split up into three groups, final goods, which are goods ready for consumption/use and raw and intermediate goods, used as materials for producing final goods. In the World of Warcraft economy examples of raw goods would be herbs, ores, cloth, leather and so forth, examples of intermediate goods would be metal bars, jewellery settings, bolts of cloth, and so on. Some intermediate goods can go through several stages of processing before becoming a final good.

Let's take an example of the production cycle of a final good in World of Warcraft, the firework launcher. The chart starts with the required raw materials to create the intermediate goods, each transition of a good is marked with the required profession. Dotted lines along a transition of goods indicate an alternative route for attaining a good. For example, a gold bar is created through the melting of gold ore, but an alternatively it can be created by an alchemist transmuting a bar of iron.

When matching the goods with their average price we can see that the value of an intermediate good is not just the sum of its raw materials but includes a margin for the time and expertise of the crafter. For example, goblin rocket fuel shows an average minimum buyout of 4.22 gold while the sum of its components only an amount to 2.07 gold (Volatile Rum 1.8G, Mageweave Cloth 0.19G, Leaded Vial 0.08g). This demonstrates the economical concept of "value added" describing the enhancement given to products or services.

Auction House:

The Auction House in World of Warcraft is the place where players trade goods. It is a virtual marketplace where any player can put their goods up for sale, the player can put a starting bid (minimum price) and optionally can also set a buyout price at which the goods can be immediately purchased for that set price without the bidding process.

World of Warcraft uses copper, silver and gold as currency. In game, one hundred coppers worth one silver, and one hundred silver worth one gold. Players can choose the duration at which the item will be available for bidding. The durations available are 8 hours, 24 hours and 48 hours.

The player also needs to pay a fee for every item placed up for auction. The fee is a percentage-based price determined by the vendor price (price that the item will fetch if sold to an in-game NPC vendor). The fee also increases based on the duration chosen, the lower duration will have the smallest fee whereas the 48-hour option will have the largest fee.

There are two kinds of auction houses in the game, one is the faction-based auction house, which is by far the most used, it allows Alliance players to trade with Alliance players, and Horde players with Horde players. The faction-based auction house has a set fee that they collect of every good that is sold, which is 5%.

The other auction house is the neutral auction house, which is not used as much as the faction-based auction house, allows players to trade goods in-between factions (Alliance with Horde) and has a set fee for every good sold, which is 10% of the gold that the good is sold. Since the goods in the game are not specific to the factions, the neutral auction house with higher cuts is not preferred most of the time.

4 Economical Aspects

As an example of exactly how similar the virtual and real work economy started to behave there is the hiring of Yanis Varoufakis, an economist, by a prominent developer. In 2011 Valve Software was wrestling with issues when scaling up the virtual economies in their games and they contacted Yanis Varoufakis, at the time an economics professor in Athens. Valve explained their troubles and asked if they could hire him, as they felt that his work aligned with theirs. At first sceptical, Valve managed to convince him to fly over to Seattle for a meeting, he agreed to become their resident economist and afterwards his thoughts on the matter were posted on his blog (Varoufakis, 2012):

"... that what they were describing, the digital community they had facilitated into existence, was an economist's dream-come-true. Think of it: An economy where every action leaves a digital trail, every transaction is recorded; indeed, an economy where we do not need statistics since we have all the data" (Varoufakis, 2012)

"My intention at Valve, beyond performing a great deal of data mining, experimentation, and calibration of services provided to customers on the basis of such empirical findings, is to go one step beyond; to forge narratives and empirical knowledge that (a) transcend the border separating the 'real' from the digital economies" (Varoufakis, 2012).

Game development companies are showing an interest in acquiring knowledge about how the real-world economy behaves so they can apply that knowledge to their games. In the field of economics however, future behaviour seems to be particularly difficult to predict even though the field of economics itself has existed for centuries. (Smith, 1776). This is not due to a lack of interest in the field however, after all the economy has a large impact on daily life, financial crisis of 2008 over 6 million American households lost their homes to foreclosure. (NYU School of Law, 2021). In 2009 the Greek economy suffered the longest recession of any advanced mixed economy to date (Oxenford, et al., 2018), causing a surge in bankruptcy, unemployment and homelessness.

Greater understanding of economic systems could help to avoid the aforementioned financial crises, but would it not be limited to just avoiding negative outcomes but instead foster positive ones. The accumulation of wealth, whether from the perspective of an individual, a corporation or a country is a powerful motivator to gain knowledge about the economic system.

There has been an influx of participation by individuals in economic endeavours such as trading in stock and currency. (Osipovich, 2020). Subsequently an increase can be seen in apps and websites that facilitate that participation or offer some sort of economical expertise, in 2021 the subreddit /r/wallstreetbets where participants discuss stock and option trading was the fastest growing group on the platform, at one point gaining 2 million members in a week. (Ghosh, 2021). The emergence of cryptocurrencies and NFT's and their ensuing popularity could be another indicator for an increased interest in leveraging one's economic knowledge for wealth accumulation.

Among gamers the economy is not a novel concept, one of the dictionary definitions for the word 'economy' is "careful management of available resources." It could be said that this applies to a lot of board games or even very old games such as chess or checkers.

With the advent of video games however the management of resources had a surge in complexity that brought them much closer to a real-world economy, massive-multiplayer online games attract millions of players that buy, sell and trade goods and services inside of a virtual world, they would compete against each other and learn how to eke out an advantage in what seemed to be an increasingly similar analogue to the real world. This increasing complexity also had its downside, it made it harder for developers with little economical knowledge to fix the shortcomings of their game economy.

The idea behind this thesis is that a virtual economy from an MMORPG has sufficient complexity and number of participants to share a high degree of similarity to the real-world economy. If this is the case then the virtual economy should exhibit the same phenomena that are observed in the real-world economy and when examining data from a virtual economy, these phenomena should be identifiable.

4.1 The Similarities

The virtual world creates many resemblances to the real world. One of the most important resemblances to consider is the social aspect of this virtual world. The social relationships carry a high value such as they do in the real world, players with complementary skills or goods are highly likely to trade in a way that is profiting both parties. (Castronova, 2001).

Table 2. Similarities between a virtual economy and a real-life economy

Virtual Economy	Real-life Economy
Agreed upon currency	Agreed upon currency
Social aspect	Social aspect
Aim to make profit	Aim to make profit

The concept of money and the applicability of the trade goods in the virtual world, stating that this trade needs to be accepted by an agreement amongst everyone, creating the currency, and lastly, the economy. (Chambers, 2011). This is important since the key to this research is to understand how applicable the virtual economy would be to the real economy behaviour; the concept of money and trade are well established in real life, and they are also well established in a virtual world.

To give an example to the similarities Table 2 talked about, virtual world has an agreed upon currency just like as the real world. In the real world's everyday life, pretty much no one goes about trading goods for each other or buying goods with gold (the metal); there are agreed currencies. Virtual world is the same, nobody trades flowers in order to buy a good, they use, in this case, gold (the currency WoW has, not the metal in the game).

4.2 The Differences

One of the key differences between a virtual economy and the real economy is that a virtual economy does not necessarily have to be bound by any government or country-based rules. This comes with a lack of regulation, which is not often the case in real world economies.

Another thing to consider is that the power game owner holds in anything related to the game is absolute, therefore, the game owner could potentially manipulate any activity that has been happening in the virtual world without serious notice, including the economy. (Castronova, 2002). In that sense, the game owner can be theoretically acting as the government, but practically, it is a way more drastic of a measure that the real world does not see often.

These points set aside, World of Warcraft - The Burning Crusade does not make any real-life currency-based sales on the auction house, therefore, these manipulations made directly on the economy are severely minimal, if any, by the game owner Activision Blizzard.

5 Economic Trends and Behaviours

This section of the thesis is going to focus on economical background. The law of supply and demand, price elasticity and scarcity are going to be examined in order to give the reader further understanding of the subject matter.

5.1 The Law of Supply and Demand

There are many economical laws & trends that apply to specific situations and let economists understand the market behaviour as best as possible. In order to understand more complicated phenomena, the law of supply and demand needs to be examined. The law of supply and demand is linked to majority of economic principles, despite being one of the basic ones. (Fernando, 2021).

The law of supply and demand can be explained as, in a free market, a commodity's price would depend on customer demand. (Gale, 1955, pp. 155-169). This can be further explained as if an item (good) is desired (demanded) more than that item's supply available, that item's price will rise whilst the demand for that item will fall; and if that item's supply is surpassing the demand, the item price will fall, therefore, the demand will go high. (Gale, 1955, pp. 155-169).

With this process, it is assumed that the economic equilibrium would be reached, which means that the market would regulate itself in such a way that the supply and demand would be at exact balance. (Gale, 1955, pp. 155-169).

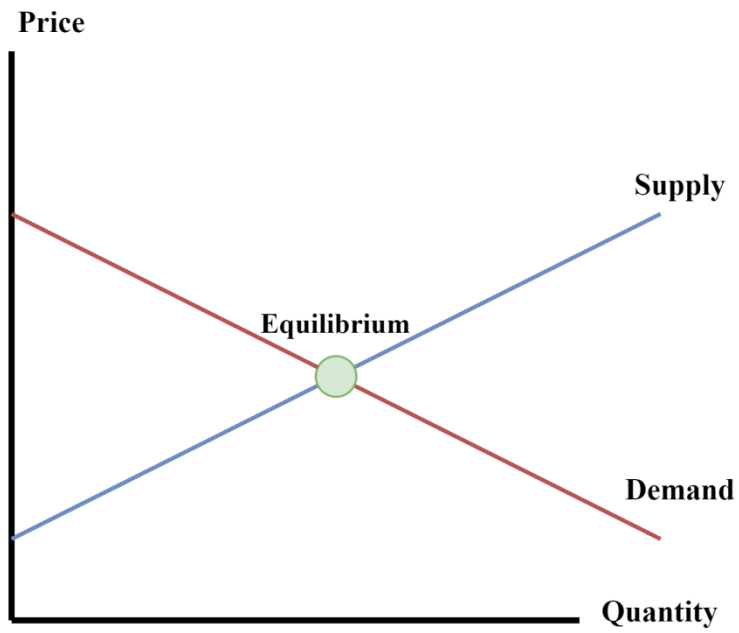


Figure 7. Law of Supply and Demand

As seen in the figure, the equilibrium has been reached when the demand was equal to the supply.

5.2 Price Elasticity

In the former section, the law of supply and demand has been discussed. It is important to explain what “Price Elasticity” is in order to understand how some goods behave differently regarding their price than others.

It is discovered that some goods behave differently regarding their prices than others under similar circumstances in a market environment. To say this in other words, some good’s prices are elastic while other good’s prices are inelastic. It can be explained simply as if the good’s price goes higher or lower, this would not have much effect on consumer behaviour (demand). (Investopedia, 2022).

If demand for a certain good does not change even though the price of that good changes, the good can be called “inelastic”. (Hall, 2022). Items that have a certain necessity level to them, such as low substitute availability, are good examples for inelastic goods. These items could be prescription drugs (Hall, 2022) or gasoline. (Investopedia, 2022).

Elastic goods can be classified as non-luxury, non-essential items. To give an example, elastic goods can include luxury items or particular food items, since there would be more substitutes for those goods if or when the price fluctuates. (Hall, 2022). Beef is also a good example for an elastic good, since people can substitute it with chicken or pork if the price is higher than desired. (Gallo, 2015).

Price elasticity could be calculated as “Price Elasticity of Demand = Percentage Change in Quantity Demanded / Percentage Change in Price”. (Investopedia, 2022).

It can also be said that, even though goods can be defined as elastic or inelastic, it all boils down to what consumer is willing to pay for those particular goods. In that sense, consumer behaviour shapes this concept.

Using price elasticity to determine demand sensitivity is a common practice, moreover, this method can also be used as a forecasting measure for economic events. (Hall, 2022).

5.3 Scarcity

Scarcity can be best defined as the gap between finite resources and unlimited wants. (Investopedia, 2022). Scarcity alters consumer behaviour in a way that the consumer has to make decisions about efficient resource allocation in order to satisfy basic needs while also being able to satisfy some extra wants. (Investopedia, 2022).

It is important to note that a resource (or good) can become scarce depending on more than one factor. Two of the factors that affect this situation are the rise of consumer demand or a new use that has been discovered for that particular resource. (Investopedia, 2022).

Graphic cards can act as an example in this sense, in the last decade, a new way to make use of graphic cards has been discovered; mining cryptocurrencies. Therefore, more and more people wanted to invest in graphic cards, creating a graphic card shortage which resulted in scarcity and rising of graphic card prices.

Semiconductors also got affected by these trends, semiconductors are an important component for electronic devices that are used commonly, such as smartphones and tablets. (Alsop, 2022). The sales of semiconductors in 2021 have reached 555.89 billion United States dollars and the one-year growth rate had been expected to reach a very high number of 26.2 percent. (Alsop, 2022).

Another example for scarcity is the shortages that have been caused by the COVID-19 pandemic. When COVID-19 pandemic required more resources than the United States medical system had available, many patients had to be denied resources that they needed, such as ventilators or intensive care beds. (Marron, et al., 2020, pp. 2201-2205). This issue caused a lot of harm, recommendations have been made in order to alter resource allocation. (Marron, et al., 2020, pp. 2201-2205).

5.4 Virtual World Representation

To analyse these behaviours, the item “Haste Potion” is picked. Haste potion is an item that players use in order to perform better in raids and take the objectives down easier. Normally, if the objective is relatively easy, there would not be a certain need to use this performance booster. However, with a new introduction of the last phase, The Sunwell Plateau, haste potion’s market behaviour changed.

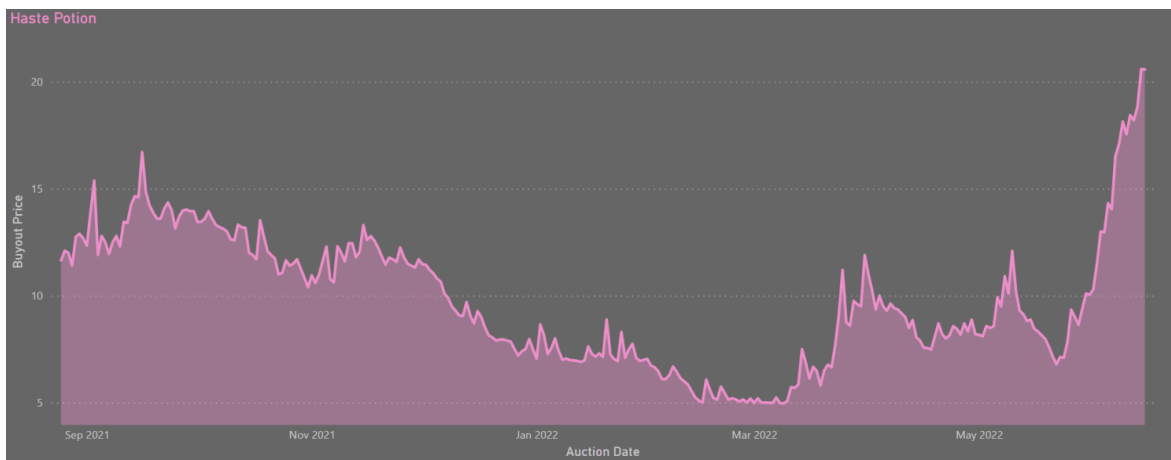


Figure 8a. Haste potion auction data Alliance

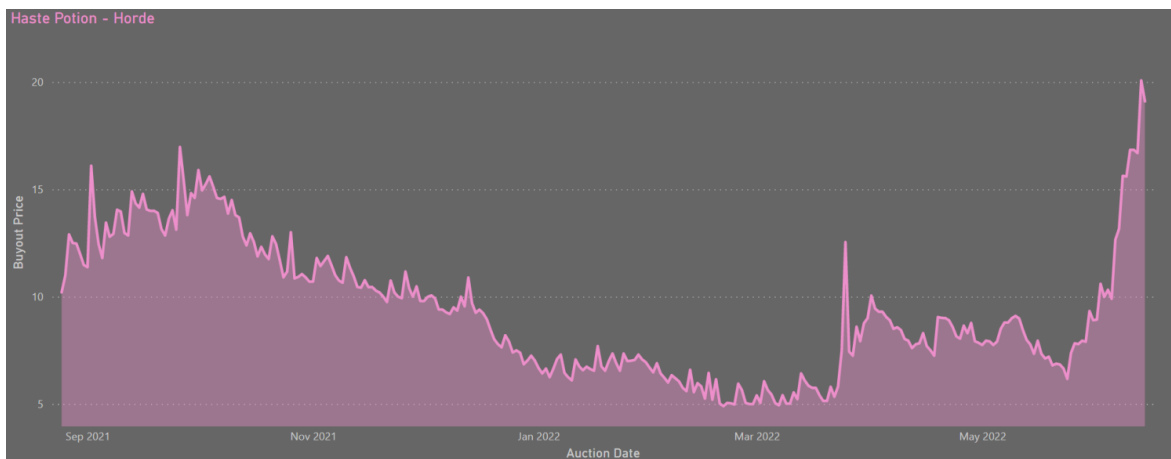


Figure 8b. Haste potion auction data Horde

These figures represent haste potion market behaviour in both Alliance and Horde auction houses. Towards the end of the year 2021, haste potion prices were falling down, until the

spring of 2022. In May of 2022, with the new raid being introduced, haste potion prices spiked, and this trend continued in June, reaching the highest recorded price of over twenty gold.

It is clearly seen that the prices between these dates (November – April) were more consistent, because players did not necessarily need to buy this item in order to complete the objective. The last phase of TBC is considered the hardest, therefore, players cannot substitute on consumables (the performance booster items), they had to invest in the best option available.

In that sense, haste potions can be comparable to a good that has become a necessity. Such as gasoline or a prescribed drug. In real life, if people work and there is no other option than to drive to work, they have to buy gasoline. It is not an investment they make for leisure, but rather it is a must.

Haste potions can also be comparable to ventilators in the beginning of the COVID-19 pandemic. Ventilators were not in short supply before, and they could have been found relatively easily. However, when pandemic spiked the numbers of people who needed ventilators, there were not enough of them, creating shortages and scarcity, even leading them to be sold illegally.

Haste potion is a good that behaved in the terms of an elastic good, but then a new area for them to be used got introduced in a virtual world, and they became inelastic. This can be considered as haste potions behaving in the terms of supply and demand, regulating themselves without huge spikes, until they became a profound item that needed to be used in order to achieve success in the game.

6 Tools & Methods

In this paper, the data used was made available through “Nexushub”. Nexushub is an open source data-tracking and analytics service that provides data from multiple MMORPG’s. The data used in this paper came from the official Blizzard The Burning Crusade EU server “Firemaw”. The range of the data starts at 25th of August 2021 until 5th of June 2022. The data is sampled seven times each day for each item available in the auction house. Giving 5906 records available for each good (item). (Nexushub, 2022). The data includes the timestamp of the scan, the current quantity available for the scanned good and the minimum buyout of the scanned good.

The data made available by Nexushub in JSON format was converted to CSV format and then imported into Microsoft Power BI. The imported data was transformed for the minimum buyout data, the number was represented as copper value was converted into the gold value. The copper values converted to the gold values in order to make the visualisation more understandable and easier to analyse. The timestamp was converted into date format.

Like mentioned before, the data from the official WoW TBC server Firemaw was used. Firemaw in one of the biggest WoW TBC servers around the world. The sample data being collected in a highly populated server gives this research a better understanding of the economical behaviours. The current population of any server can be seen in the site “ironforge.pro”. Ironforgepro is a tool that keeps track of active player numbers based on the data uploaded to Warcraft Logs. Players use Ironforgepro to get information about population and demographics in their respected server.



Figure 9. Firemaw population (Ironforgepro, 2022)

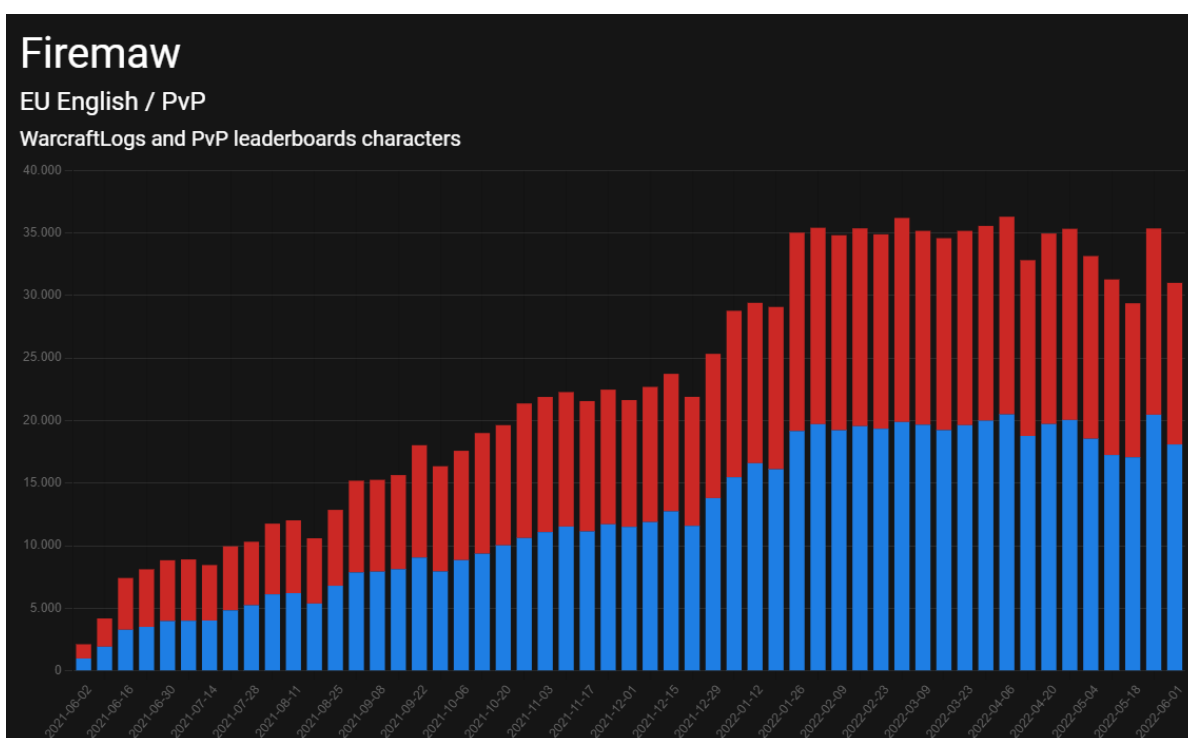


Figure 10. Firemaw population graph (Ironforgepro, 2022)

Microsoft Power BI:

Microsoft Power BI is a data mining tool that has been used primarily for this research. Power BI allows the user to convert large sums of data into coherent and well-visualized insights. (Microsoft, 2022).

Microsoft Power BI is a well customised tool that has fit this research's large requirement of data analysis perfectly. Power BI allows the user to visualize and analyse desired parts of data.

In this research, the vast data that has been gathered from Nexushub needed to be converted into desired shape. This meant that the timestamps had been selected carefully in order to see the patterns of behaviour (such as changes in the game). The currency values had been converted in order to visuals to be more understandable.

While Microsoft Power BI is a great data-mining tool, it is crucial to consider some elements about the data that has acting differently since it is from a virtual world. Auction house data is vast, however, considering WoW TBC's dynamic, it has outliers. This means while data can be analysed normally, the most optimum accuracy can only be obtained considering median values. To give further understanding about this, if an item in the game is not so common for a time, the prices will go up drastically. Auction house also has bots which rely on players clicking the item with a wrong (much higher) price, while that price not being accurate to that specific item. In order to eliminate this, while visualising the graphics, Power BI was used incorporating the median values of items. This gives the viewer a more accurate understanding of the overall market dynamics.

7 Economical Comparisons

In the real-world economy certain behaviours of the market or economical events have been documented and defined, for example a crash in the economic sense is defined as a "sudden and significant decline in the value of a market ". (Investopedia, 2021). Outliers in data such as a crash are not uncommon and highly visible, if a virtual economy behaves as the real-world economy does, it would stand to reason that these type of outliers or economical events also occur in the WoW economy. Which is exactly what is to be seen in the graphs below, a virtual economy, acting like a real-life economy.

The data of a virtual economy can be examined in order to find these outliers or "economical events" and an attempt can be made to classify them according to established real world economy behaviour. In order to further prove that economy reacts similarly in two different datasets in the same environment, the figures shown below represent the Alliance and Horde graphs, taken at the same time. It is important to consider the forementioned economic behaviours while analysing the graphs below. It would be clear to see that the virtual economy is mimicking the real-life economic behaviour.

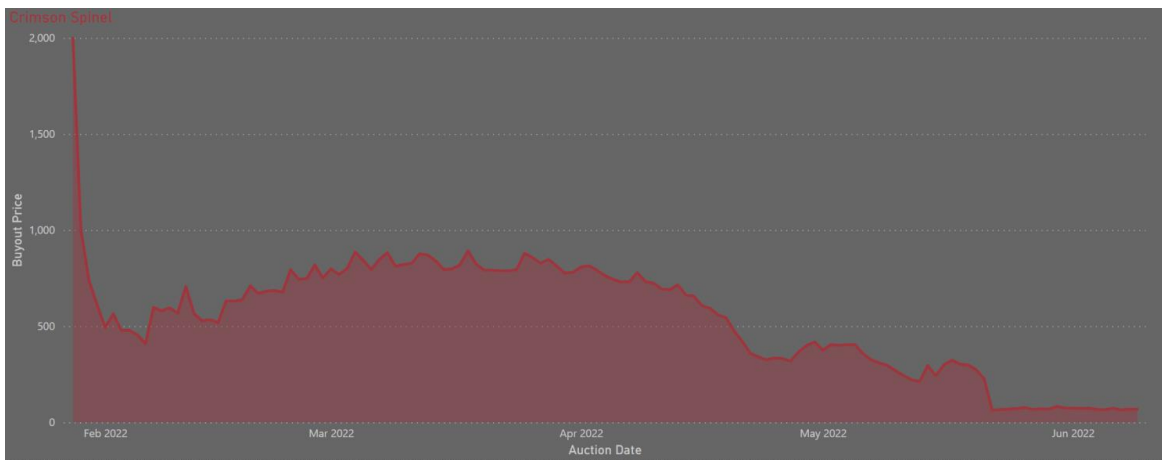


Figure 11a. Crimson spinel auction data Alliance

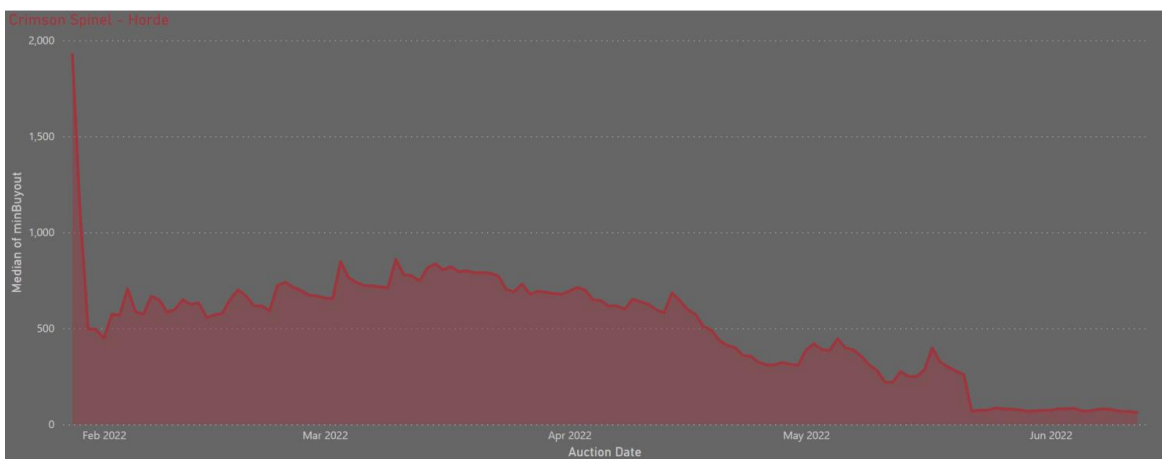


Figure 11b. Crimson spinel auction data Horde

Crimson spinels are raw materials that can be used by professions to create tradeable gems that in turn can be used to significantly boost the effectiveness of a player's character.

These could initially only be attained through completion of the most difficult game content, the first days the item became available only a few players would be able to gather them, and demand would greatly outweigh supply.

The graph shows the early discrepancy between supply and demand as the few sellers set an exorbitantly high price. This is comparable to several real-world examples, when the first 4k monitor was announced by IBM in 2001, the retail price was \$22,000, only a year later the price dropped to \$8400 and at present day 4k monitors can be found at \$200. (IBM, 2001).

The same price behaviour can be for most new technology, where the first iteration sells for a premium price to early adopters and steadily lowers over time. When comparing the data to the Horde faction data the observed behaviour of the graph is the same.

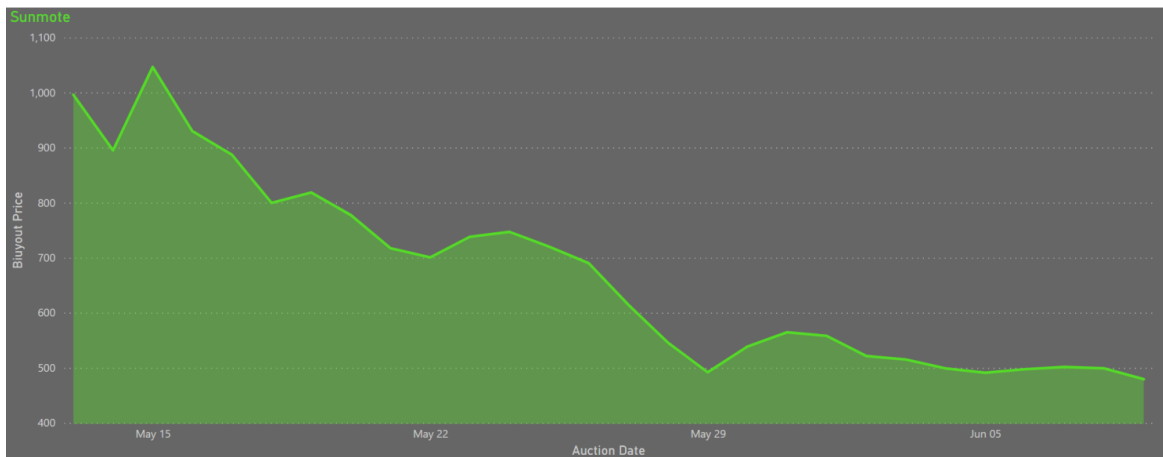


Figure 12a. Sunmote auction data Alliance

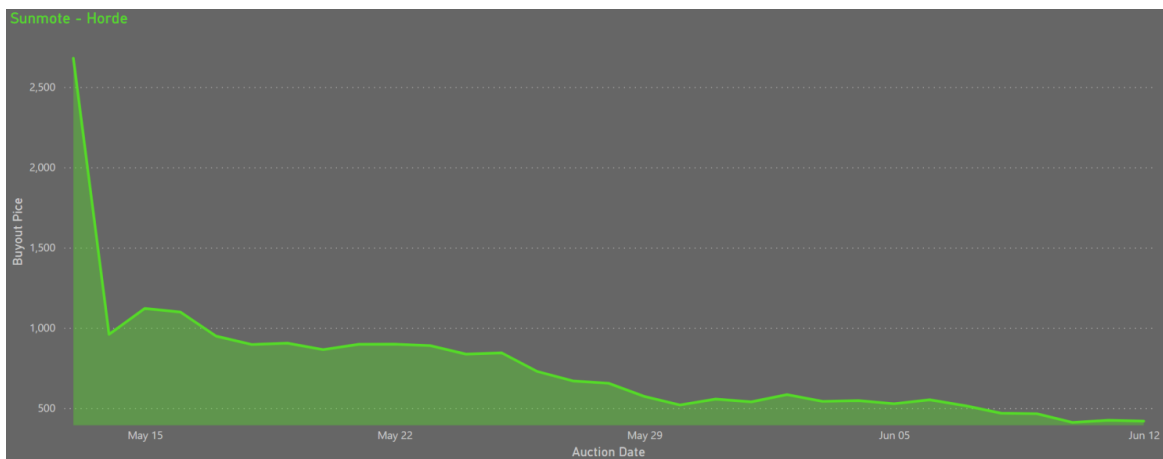


Figure 12b. Sunmote auction data Horde

Sunmotes display the exact same behaviour as seen for the crimson spinels although to a lesser extent.

When comparing the Sunmote data to the Horde faction data, the data matches the previously mentioned crimson spinel behaviour much more closely.

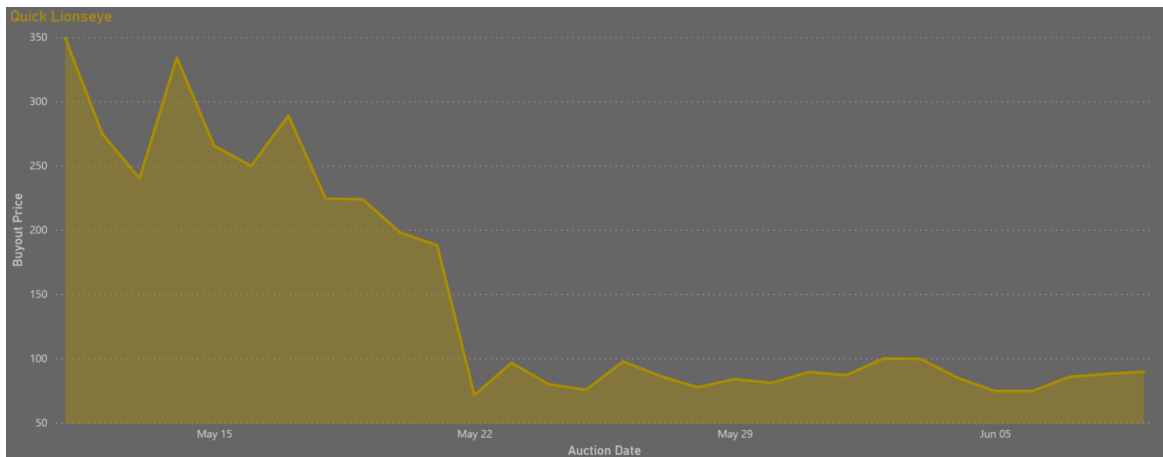


Figure 13a. Quick lionseye auction data Alliance

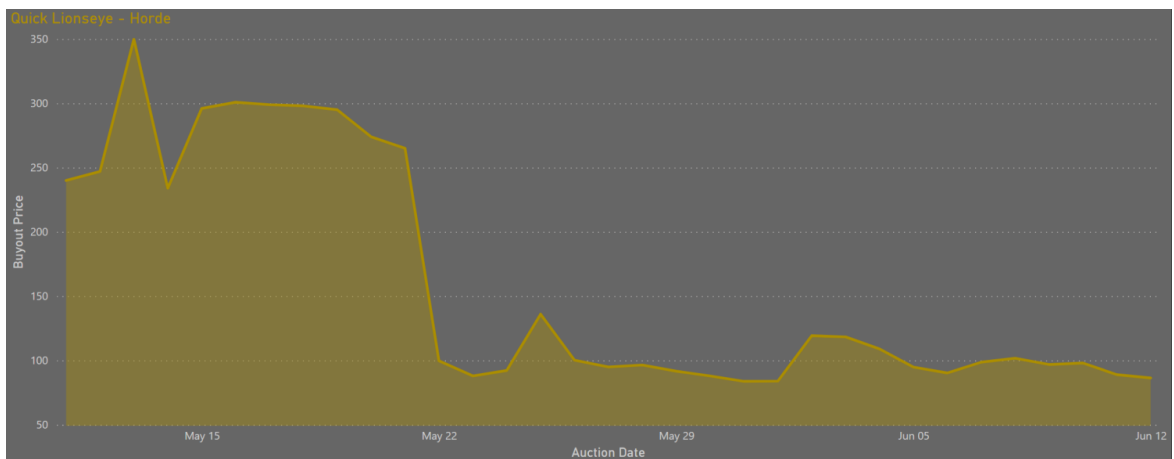


Figure 13b. Quick lionseye auction data Horde

Lions eye gems were gated behind a reputation mechanic where only players who had sufficient reputation with a faction could attain the pattern to learn how to create the gem.

When only few people were able to produce the gem the demand exceeded production as a result the price remained high until more producers were able to enter the market.

Again, this behaviour pattern is observed for the Crimson spinel, but this time the initial period of “price gouging” extends further than seen in the previous examples, this is likely due to the difficulty of overcoming the barrier of entry into the market (the reputation gating system).

When comparing the Quick lionseye data to the Horde faction data, the observed behaviour of the graph is the same.

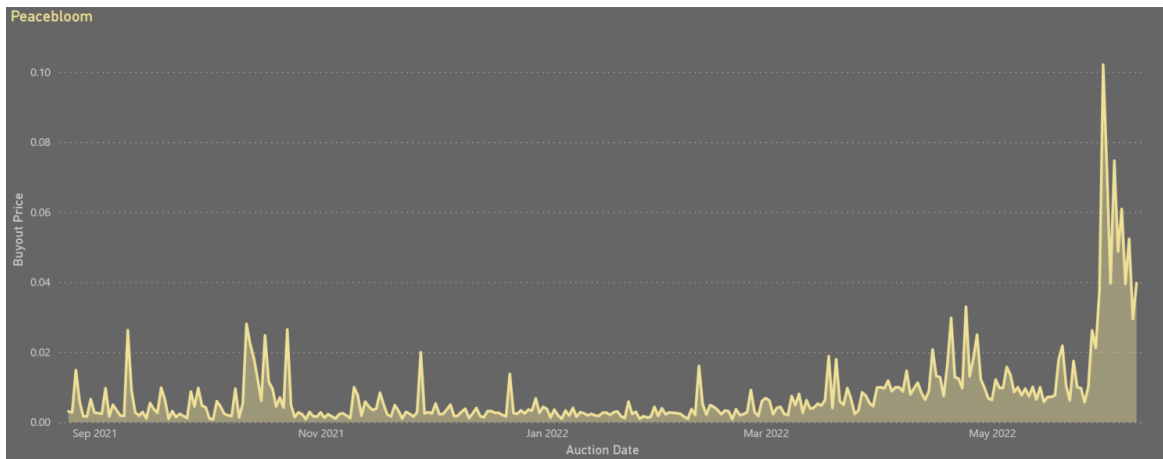


Figure 14a. Peacebloom auction data Alliance

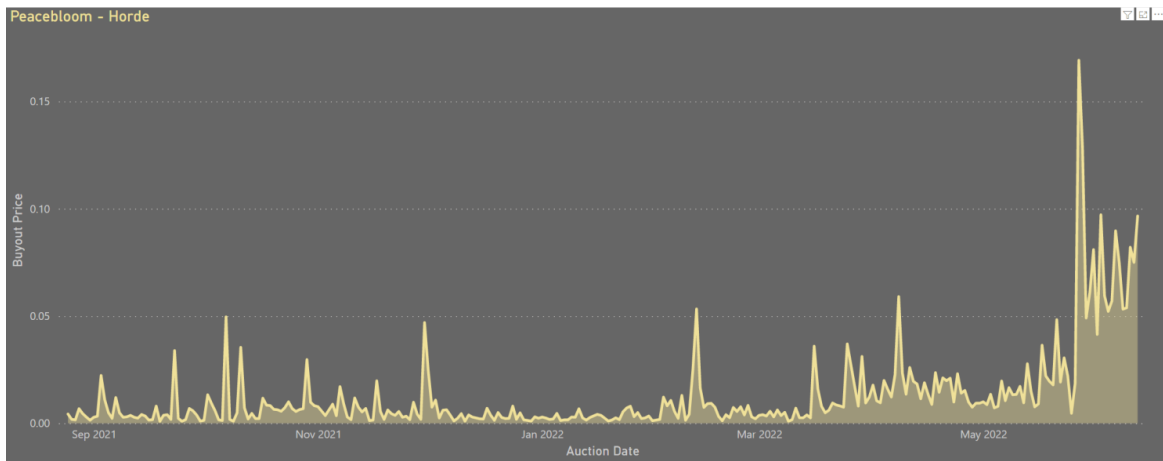


Figure 14b. Peacebloom auction data Horde

Peacebloom is a raw material from a previous edition of the game (WoW Classic) and has little to no use in WoW The Burning Crusade aside from being used as a low-level material for the herbalism profession to learn their craft.

This is reflected by the consistently low price throughout the game's lifecycle, however there is a sudden increase when nearing the end of the lifecycle, due to the announcement of the next expansion in which a new profession is announced that will require peacebloom as a raw material.

Players are effectively speculating on the price of a currently low value raw material that has little use, in hopes of making a profit when new uses for the material become available, and thus driving up the price.

When compared to the data of the Horde faction auction house, the data displays the same behaviour.

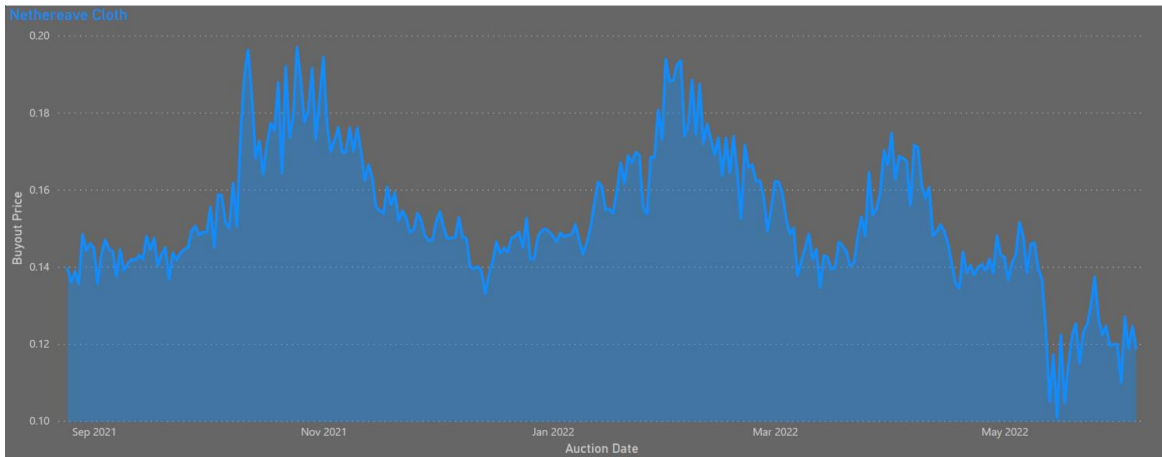


Figure 15a. Netherweave cloth auction data Alliance

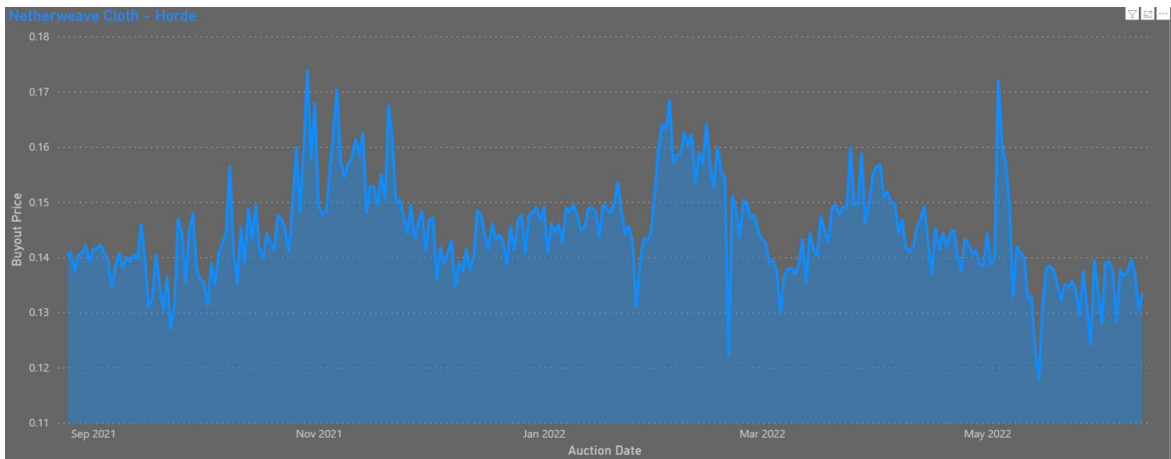


Figure 15b. Netherweave cloth auction data Horde

Netherweave cloth is mostly used as a raw material required by professions to craft new goods, whenever a new content patch is released plans or patterns can be attained that grant the ability to craft new goods, thus driving up the consumption and subsequently the cost of the raw materials required.

This is visible in the graph as a spike in price whenever a new content patch makes new goods available for crafting.

When compared to the data of the Horde faction auction house, the data displays the same behaviour.

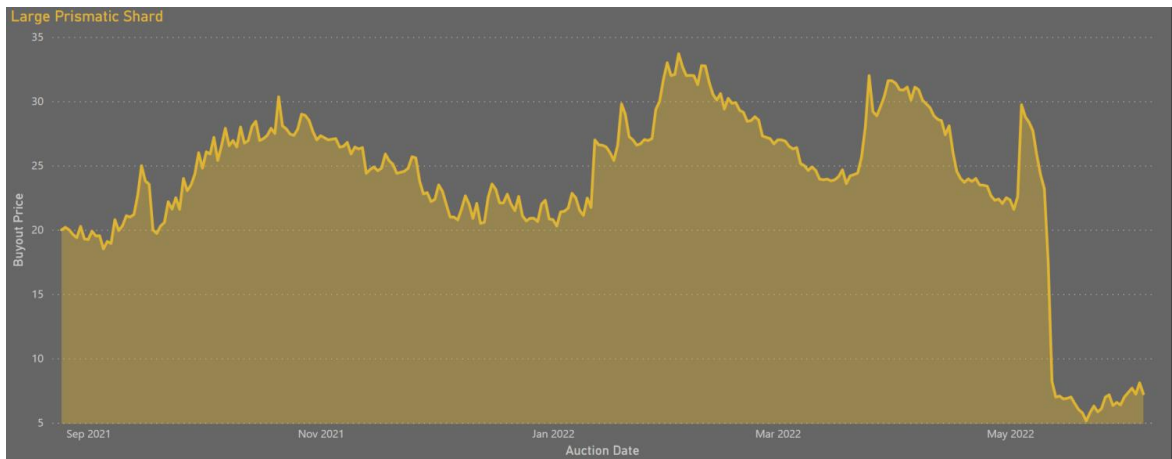


Figure 16a. Large prismatic shard auction data Alliance

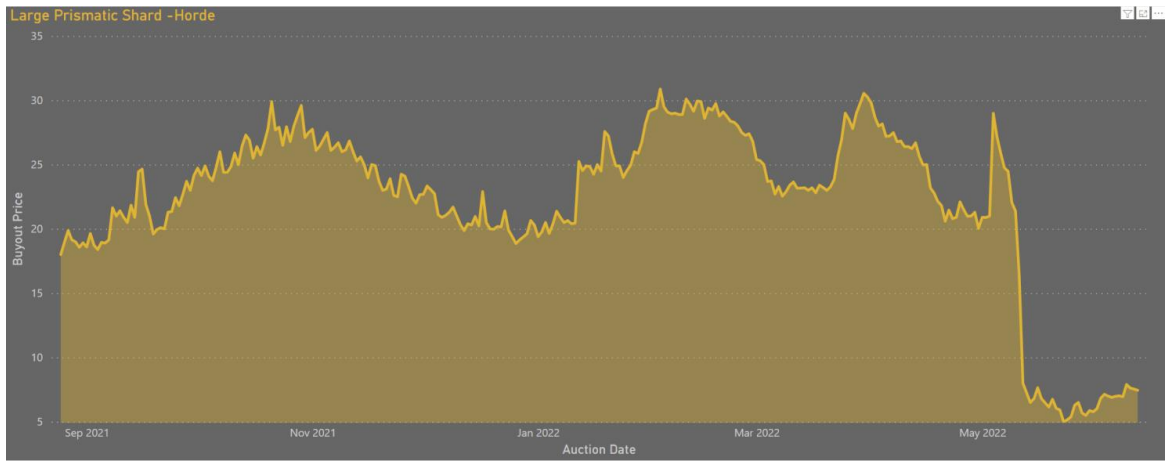


Figure 16b. Large prismatic shard auction data Horde

Large prismatic shards:

Sudden price drop on May 10th, coinciding with the release of the new Sunwell Plateau update. (Blizzard Entertainment, 2022).

The update introduced a new means of producing Large prismatic shards, namely by granting the ability to the enchanting profession convert nexus crystals into prismatic shards.

This event seems to follow the basic principle of supply and demand, a new source of a good was created thus increasing the supply while the demand remained unchanged, resulting in a drop of the price.

Due to the sudden and steep drop of the price the event also seems to follow the definition of a crash "sudden and significant decline in the value of a market"

Additionally, the Large prismatic shard data displays the same price spikes that can be observed in the Netherweave cloth, seemingly also being affected by the release of new content patches, this can be explained by the need for Large prismatic shards for player gear enhancement, players are able to place a permanent enhancement onto their equipment, but said enhancements are costly and thus only performed after a major upgrade in equipment, content patches provide new sources of equipment and thus drive demand for equipment enhancements and subsequently the required components for the enhancements such as Large prismatic shards.

When compared to the data of the Horde faction auction house, the data displays the same behaviour, which proves that under the same circumstances created by the environment, the virtual economy showed highly similar behaviour on each side, proving the testing ground indeed acts as an economy that has the same stable outcome.

8 Conclusions

The results of this thesis indicate that economical phenomena can be detected in virtual economies, several behaviours were identified in the World of Warcraft data that correspond with known real-world economical behaviour. An additional level of verification was achieved by comparing the data from one dataset to another dataset detached from the former, proving a higher degree of confidence in the findings.

Even though the data used only consists of twelve months of historical data, it was sufficient to detect several events during that timeline for the chosen goods. Since it was possible to achieve multiple positive results with the limited data of a single server of a single MMORPG, future research could branch out to using larger datasets of multiple servers and different MMORPG's or even other game genres. This thesis was limited in scope due to the authors lack of experience in the economical field, the restricted amount of data, the use of third-party and the data itself being limited to the fields available in auction listings. But even with these limitations in place the achieved results are promising. Increasing the scope by using data from larger timeframes and multiple servers or genres of games could benefit future research by giving the ability to compare these economical behaviours across geographical regions and potentially other demographics such as age or gender. Additionally, if first party data could be acquired for future research, an investigation of the transactional records themselves which would be greatly beneficial, providing a new level of detail to examine, such as purchase price, volume, time and frequency per individual.

Even though the findings of this thesis are by no means a conclusive answer to the question whether a virtual economy can be used as a direct analogue to the real-world economy for the purpose of creating a model for real world behaviour, they do show a very strong correlation and a positive outlook for further research.

There is no sign that the increase of complexity in virtual economies will stagnate, the availability of greater computing power and the growth of the gaming industry indicate a further growth in that can provide new testing grounds. The search for knowledge into

real-world economic behaviour also continues to grow beyond academic pursuits making the significance of the subject matter one that will persist in the future.

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