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World of Warcraft: *The Viability of Massively Multiplayer Online Role-Playing Games as Platforms for Modeling and Evaluating Perfect Competition*

By Eli Kosminsky, Massachusetts Institute of Technology

Abstract

The objective of the study was to determine whether the virtual economy of World of Warcraft in fact behaves like a real world economy, whether it is a competitive free market approaching the ideal of perfect competition, and if so, whether it constitutes a suitable platform for further economic research. What makes this research feasible is that World of Warcraft exists on hundreds of servers, each of which is a replica of the same world, but with its own unique player population varying in size and experience level. The research makes the following three predictions about how the economy of World of Warcraft would behave if in fact it were perfectly competitive. The predictions are:

1) Servers with larger populations will yield greater price stability;

2) Servers with a higher concentration of players of a given experience level will yield higher prices for the goods most in demand by that set of players, and;

3) Arbitrage exists only to a very minor extent across all server economies.

Data was collected detailing the prices at which selected virtual goods were sold in World of Warcraft auction houses, over a period of thirty days. Using statistical methods, the predictions were tested against the data drawn from economic interactions within the game. The research concludes that the virtual economy of the World of Warcraft in most respects behaves like a highly competitive real world market, and in fact approaches the ideal of perfect competition.

Keywords: economy; perfect competition; MMORPG; World of Warcraft.

World of Warcraft: *The Viability of Massively Multiplayer Online Role-Playing Games as Platforms for Modeling and Evaluating Perfect Competition*

By Eli Kosminsky, Massachusetts Institute of Technology

As the world begins to pull out of a deep recession, which for a time threatened to collapse into a second Great Depression, the future of the global economy remains uncertain. Unstable prices in the real estate, oil, and stock market, frozen credit, and the perilous state of major financial institutions already have led to the spending of hundreds of billions of taxpayer dollars by the federal government in an attempt to stave off financial collapse (Creamer, 2008). Essentially, this situation of economic turmoil has resulted in a high degree of government intervention in the economy, with further involvement highly likely. For better or worse, this interaction is moving the American economy even farther away from the ideal of a free market, in which the price of goods is determined solely by consumers through the processes of supply and demand (O'Sullivan, 2007). In any modern economy, such factors as taxation, regulation, government spending and other forms of market intervention suppress free markets. As these factors increase in the U.S. and likely the other developed economies as a result of the current economic situation, it will become increasingly difficult to find ways to research pure–or close to pure–free market interactions. This paper will demonstrate that virtual economies, in particular the virtual economy of the Massively Multiplayer Online Role Playing Game (MMORPG) World of Warcraft, are promising platforms for economic research of free markets.

In a free market economy, where the prices of goods are determined by buyers and sellers, a spectrum of possible competitive interactions arises, ranging from one-firm monopolies at one end of the spectrum, to perfect competition at the other end. A perfectly competitive market assumes the following: a large volume of buyers and sellers, perfect communication, homogenous goods, and no barriers to market entry (O'Sullivan, 2007). These conditions result in the lowest sustainable price for a given good.

Perhaps the most important factor in such an economy is the existence of a *large volume of buyers and sellers*. The assumption is that buyers will behave in a reasonable manner, buying from a seller whose goods are priced the lowest, given that all goods are of comparable quality. Therefore, in order to make a sale, a seller must be offering a good for a price less than or equal to every other price on the market at the time the sale is made. The more sellers that exist in a market, the more sellers there are that need to be undercut, which drives down prices. A high volume of buyers must accompany this population of sellers in order to provide adequate demand. Additionally, a large volume of sellers is necessary for perfectly competitive low prices because small populations of sellers are able to coordinate with one another and collectively increase prices. However, if the population is large enough, this coordination becomes impossible. The next factor attributing to perfect competition is *perfect communication*. This means that all buyers and sellers in a market know all of the prices at which a good is available. This results in efficient undercutting by competitors and ensures that consumers always buy the lowest priced good. Additionally, perfectly competitive markets must have *homogenous, or identical, goods*. For this condition to be met, all companies must produce the exact same good so that no one good is more desirable than another, as this situation would allow the more desirable good to command higher prices. Finally, a perfectly competitive market must have *no barriers to market entry*. This means that sellers are free to move from one industry to another at

no cost. Common barriers to market entry include the cost of new machinery and the cost of acquiring new knowledge to produce a new good. These barriers to entry prevent new competitors from entering a particularly profitable market, as the change might be too costly in terms of time and capital. This decreases the number of sellers in a profitable industry, which allows the existing firms in the industry to charge inflated prices. However, if no barriers to market entry exist, then when one industry becomes particularly profitable due to increased demand for whatever reason, no company will be able to increase its profits, as more sellers will quickly enter the market. This influx of sellers into a popular market makes abnormally high profit impossible and keeps prices as low as can be.

Perfectly competitive markets are the simplest ones as they are completely unregulated by government (O'Sullivan, 2007). Given the lack of confounding variables such as taxes or quotas, perfectly competitive economies are appealing to study; they are even more important to understand given that fundamental economic concepts, such as supply and demand, are assumed, in their most pure form, to operate under perfect competition. Absolutely perfect competition is not fully embodied in any current economy, although some markets come close. Nearly perfectly competitive markets include online auction sites such as eBay and agricultural markets (O'Sullivan, 2007). While each of these real-world cases matches the assumptions of a perfectly competitive economy in most ways, they break down in other, key areas. For example, eBay offers many homogenous goods and perfectly communicates its prices among users. However, if a certain good becomes profitable, sellers may have difficulty acquiring it and selling it, resulting in a barrier to market entry that drives prices up. A similar problem exists in agricultural markets. While agricultural producers, for example tomato growers, may provide products that are nearly identical, and although there are a large number of farms supplying them, it is difficult for farmers of other produce to enter the tomato market, as switching over to tomato production would involve the time and investment of growing an entirely different crop. (O'Sullivan, 2007).

Since real-world markets all stray from perfect competition in some way, it becomes necessary to search other worlds for such examples. While this prospect may sound impossible, these "other worlds" can be found very simply: they exist online in the form of *virtual worlds* (see Figure 1). A virtual world is an environment that is created online and is accessible to people in a variety of locations. These worlds depict real-world players with a virtual, visual character known as an "avatar," which exists within the graphically presented virtual world. Additionally, these worlds are persistent, meaning that even after a player exits, the world continues to exist and is accessible by other players. Furthermore, such worlds are evolving, so players have an effect on the content of the environment. Virtual worlds also are social places, meaning that there is a high degree of interaction among players. Many of these interactions are economic interactions, and most, if not all virtual worlds have some form of economy among the players (Castronova, 2002).

Figure 1 EverQuest: An early virtual world
Source: Sony Online Entertainment

One virtual world that has become a popular stage for research is Second Life, which was released in 2003. Second Life is less a game than it is a social environment in which players,

represented by completely customizable in-game characters, gather to interact and obtain virtual goods, such as clothing and other objects. Second Life hosts economic exchanges through which a virtual currency known as Linden dollars can be exchanged for real U.S. dollars. Although the exchange rate between the virtual dollars of Second Life and real, US dollars, varies somewhat with supply and demand, the cost of a Linden dollar is fixed within a range against the US dollar to prevent hyperinflation (Svensson, 2007).

Another type of virtual world that exists is known as a Massively Multiplayer Online Role-Playing Game, or MMORPG. These games are less socially oriented and more achievement oriented. Here, large numbers of players work with and against one another in an effort to create the most powerful avatar possible. The most popular MMORPG to date is World of Warcraft, or WoW, with over 10 million subscribers worldwide (Blizzard Entertainment, 2008, see Figure 2). Here, a player's power is measured on three major scales. The first of these is the virtual "wealth" of the player, which is measured by the in-game currency known as "gold." Gold can be obtained through trade with other players, or by killing virtual enemies, or "monsters," which are programmed to behave in certain ways and are not controlled by other players. When a monster is killed, it yields not only gold, but also a type of currency known as "experience," which is the second way in which a players' power is measured. A player's experience points are cumulative and never decrease. As a player reaches various fixed numbers of experience points, he or she acquires additional "experience levels," or simply levels, which are visible to all players. At the time of this study, these ranged from one to a maximum of 70. In general, as one gains levels of experience, wealth (as measured in gold) increases as well. The third and final way in which the strength of a player is measured is by the "power" of his or her equipment. Avatars in World of Warcraft are equipped with a full set of armor and a variety of weapons, all of which must be constantly upgraded to increase the overall strength of the player. Enemies or monsters that are killed by a player all yield a fixed probability of "dropping" one of these pieces of equipment, or of dropping a particular "ingredient" that could be used to create one of these items. These ingredients, or materials, such as cloth or iron, can be turned into armor or weapons by players with the right skills. Every monster within WoW can only drop a pre-set group of items upon its death, and each one of these items has a pre-set chance of dropping. Through the use of external tracking websites such as Thottbot.com, players are able to learn both of these statistics for every creature within the game. It is therefore possible for a player to travel to a specific area within the virtual world to try to obtain a specific good needed to create a specific piece of equipment, which will in turn increase his or her power. For example, in order to obtain wood to create a more powerful shield, a player could travel to a forest in an effort to kill "tree-spirits" (see Figure 3).

Figure 2 Dozens of WoW players gathered together online.
Source: Blizzard Entertainment

Figure 3 A tree-like "Treant" monster from the woods of WoW
Source: Blizzard Entertainment

Although World of Warcraft players are constantly competing with one another for wealth and power, it is not technologically possible to host each of the over ten million players of World of Warcraft in one place at a given time. In order to prevent overcrowding, players on World of Warcraft must be split up in some way so that they are not all in one location at a time. WoW players, therefore, are divided among approximately 200 servers, each of which functions like its own separate world that cannot contact other servers. A given player must enter the same server every time he or she logs on to the game, thus giving each server a unique and relatively stable population. The game designates a server as having a "low," "medium," or "high" population. When they first log on under a particular account (some players may have more than one account) players are asked to make an initial decision about which population size server to play on. Higher population servers can be desirable when one wants to find other avatars to play with, but since the servers are more crowded, the competition for goods "dropped" by monsters is fiercer. Servers also vary in the dates since which they have been in use, and the level distribution of players on them. However, these data are not transparent to the player and must be obtained on outside websites. As will be seen, all of these factors may come into play when analyzing price stability and price determination within the economy of WoW.

Within each server, instances of economic interactions are constantly occurring. The majority of these interactions take place through an in-game auction house where players post goods for sale which they have obtained by killing monsters or from other players. Goods are sold for "gold" (see Figure 4). When a good is won by a bid or immediate buyout, a virtual payment is made in gold to the player who is selling the desired good. Interestingly enough, the market of WoW has advanced to the point where gold has taken on a value that transcends that of a simple virtual object. Many companies make it their business to amass as much of this virtual capital as possible and sell it to players for real-world money (Castronova, 2002), despite the fact that this practice breaks an agreement that all players must make upon entering the game (Blizzard Entertainment, 2007). In any case, virtual World of Warcraft gold has developed into a pseudo-currency with a general exchange rate to the dollar (Castronova, 2002). Thus, the currency of a virtual game has taken on realistic characteristics without any direct exchange rate being set up by Blizzard, the producer of the game.

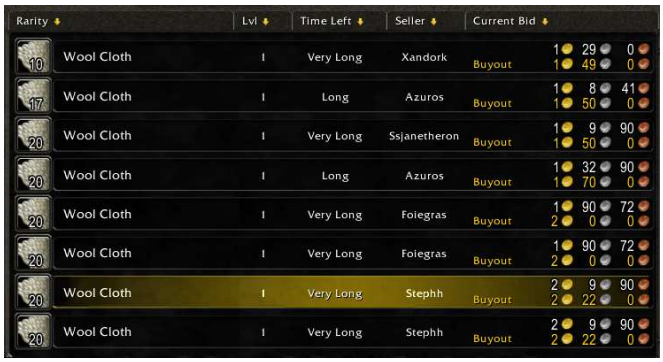

Figure 4 Activity in the WoW auction house
Source: Blizzard Entertainment

An initial look at WoW's virtual auction house would indicate that it demonstrates to some degree all of the aspects of a perfectly competitive, or nearly perfectly competitive, market. Again, these four assumptions are: the existence of a large volume of buyers and sellers, identical products, perfect communication, and no barriers to market entry. To begin with, all of the goods in a particular market in World of Warcraft are entirely homogenous in a way that no real-world goods can be: that is, they all are the result of the exact same coding and function identically. For example, one silk shirt is exactly the same as another silk shirt in World of Warcraft because it is composed of the same code, whereas real-world silk shirts may vary slightly from one another due to mechanical or human imperfections in manufacturing. Additionally, there is seemingly perfect communication among players, as the auction houses,

where most trades take place, list every available price for a good in question and are easily accessible by all players (Yee, 2006). Due to the large number of subscribers of World of Warcraft, there is certainly a large population of both buyers and sellers, particularly because each player must act both as a firm and as a consumer, in order to acquire gold to buy things, and to spend gold to obtain goods that are necessary to "survive" in the game. Finally, there are minimal barriers to market entry for the majority of common goods in World of Warcraft. Many goods that are commonly traded and sold are obtained simply by slaying a virtual creature through the use of a player's avatar. These monsters and their withheld goods are normally available in a number of different locations and are relatively abundant. This makes the process of entering new markets simple and inexpensive as all a character must do to change markets is kill a different type of monster. The only real cost involved here is the minor amount of time lost when an avatar travels from one location to another.

Although World of Warcraft may demonstrate many aspects of perfect competition, it is unknown how close the WoW economy comes to the ideal. One of the best quantitative indicators that an economy is perfectly competitive is that the prices of its goods remain stable. This is because individual sellers in the market do not have enough power to raise or lower prices, and the number of sellers is so large that colluding to raise prices is impossible; prices do not change very often as a result. It has been demonstrated that many of the commodities within World of Warcraft generally do maintain highly stable prices, suggesting a high degree of competition (Korth, 2006). However, given the unique populations and levels of relative wealth on each server, the degrees of price stability and competition could vary from one server to another. That is, servers with higher populations should demonstrate greater price stability than lower population servers. In real-world markets, larger numbers of firms create a higher degree of competition (Janssen, 2001). This is because the actions of a small group of people are less predictable and more susceptible to chance than those of large numbers of people. This assumption should hold true within World of Warcraft as well. When there are very few characters supplying a good, the available amount of a good at a given time should fluctuate given the random (from the standpoint of the players) drop rates of a given good by the monsters. However, as the number of suppliers increase, this randomness would becomes less relevant as the "luck" of one player would be balance out by others, and the good would remain in relatively stable supply. Therefore, servers with higher populations on World of Warcraft should demonstrate prices that are more stable, demonstrating a higher degree of competition. (see objective 1 below).

A second quantitative indicator of perfect competition in WoW would be that where higher concentrations of players of a particular level exist, the prices of the goods used by that level of player would be higher than on other servers where lower populations of those players exist. That is, two servers may have the same or a similar total population, but if one has a larger relative number of high level players then the goods used by higher level players should command higher prices. This is because production levels for a good are capped by the number of monsters dropping that item. Since supply remains relatively constant and demand increases on high level-dense servers, prices should rise (see objective 2 below).

A final factor that would help determine whether World of Warcraft is an example of a perfectly competitive market would be the lack of arbitrage. Arbitrage occurs when an investor is able to take advantage of price differences between two markets and turn a profit without risking the loss of any money. Arbitrage exists when a factor such as lack of perfect communication, or government regulation, interferes with economic transactions. A simple example of arbitrage in

the real-world would be found in currency exchange rates that are not equivalent. If one were able to buy a currency in one country for a lower price than it was being sold in another, then arbitrage would exist. If WoW is perfectly competitive, the possibility of arbitrage should not exist. This could be demonstrated through freely convertible goods, such as "Planar Essences," which are used to enhance pieces of equipment. Any World of Warcraft character is able to convert three Lesser Planar Essences into one Greater Planar Essence, and reverse the process. If WoW is a perfectly competitive market, the price of one Lesser Planar Essence would be exactly one-third that of a Greater Planar Essence (see objective 3 below).

Research Objectives

The objective of this study is to determine whether WoW is a highly competitive free market approaching perfect competition, and therefore a suitable platform for further economic research. If WoW is a perfectly or near-perfectly competitive market, the following testable predictions should be true:

1) Servers with larger populations will yield economies with more stable prices.

2) Servers with a higher concentration of players in a given level range will yield higher prices for the goods demanded by the group of players in question.

3) Arbitrage exists only to a very minor extent across all server economies within World of Warcraft.

Methods

Due to the high degree of interest in various World of Warcraft servers from the over ten million players, there are multiple websites that track auction house data for a number of goods. One such website is wowecon.com. Using the LUA files generated by a program that runs through World of Warcraft, it is possible to track the prices of all goods available for purchase through the auction house on one WoW server at a time. The collected information is organized on the website and includes statistics such as low, median, and mean prices per good, along with their standard deviation and volume over a period of days ranging from one to thirty. In this study, the prices will be tracked on a commonly traded consumable in order to ensure that there is a consistently large demand for the good that will yield a large number of auction instances and data points. The consumable focused on in this study is netherweave cloth, an item used to craft pieces of armor and bandages. Key price statistics posted over a thirty day time period were extracted from wowecon.com for netherweave cloth across multiple servers of low, medium, and high population.

In order to collect population data, the website WarcraftRealms.com is utilized. This website makes use of another program that runs through WoW known as Warcraft CensusPlus UI Mod. Essentially, this add-on runs surveys of the populations of various servers and records the level of each player that is logged on at the time. Since the add-on is only able to record snapshots of the population, it is only useful for determining relative percentages of player levels. In this study, data was collected for players with levels ranging from 58 to 70, since netherweave is obtainable only in areas not normally reachable by players below level 58 due to constraints within the game itself. This collected population data is then compared to the median price of netherweave cloth on the respective servers to determine how prices are influenced by the relative concentration of a given range of players.

General price data was collected from a website, wow.allakhazam.com, in order to test for arbitrage. Since arbitrage should have no relationship to individual server characteristics, the average prices of goods throughout the entire game are used as opposed to the prices on a single server. This provides more numerous, and therefore more accurate, data points. The items used to test for arbitrage are known as Lesser Planar Essence and Greater Planar Essence. Planar Essences were chosen to test for arbitrage because of their interchangeability, as is discussed above.

Results & Discussion

Objective 1: Test whether servers with higher populations yield economies with more stable prices.

Low Server 1: Khaz'goroth
Table 1.1

30-Day Statistic	Value (Gold)
Median	12.00
Average	12.29
Std. Dev.	1.50
Volume	3449

Low Server 2: Hakkar
Table 1.2

30-Day Statistic	Value (Gold)
Median	16.25
Average	16.21
Std. Dev.	1.73
Volume	2709

Medium Server 1: Trollbane
Table 1.3

30-Day Statistic	Value (Gold)
Median	12.00
Average	11.97
Std. Dev.	2.09
Volume	7440

Medium Server 2: Executus
Table 1.4

30-Day Statistic	Value (Gold)
Median	14.33
Average	14.30
Std. Dev.	2.61
Volume	3009

High Server 1: Anvilmar
Table 1.5

30-Day Statistic	Value (Gold)
Median	11.77
Average	11.49
Std. Dev.	.92
Volume	2362

High Server 2: Illidan
Table 1.6

30-Day Statistic	Value (Gold)
Median	17.50
Average	17.48
Std. Dev.	.87
Volume	1364

Data retrieved from wowecon.com

Tables 1.1 through 1.6 show the gathered data for the highly traded consumable netherweave cloth. Each set of data was collected on two examples of low, medium, and high population servers with information collected on at least 1000 auctions within the past 30 days. The results below represent auction data from September 13, 2008 to October 13, 2008.

The following graph was constructed to analyze tendencies seen within the standard deviation data presented above (see Figure 5). Standard deviation is used as a measure of price stability.

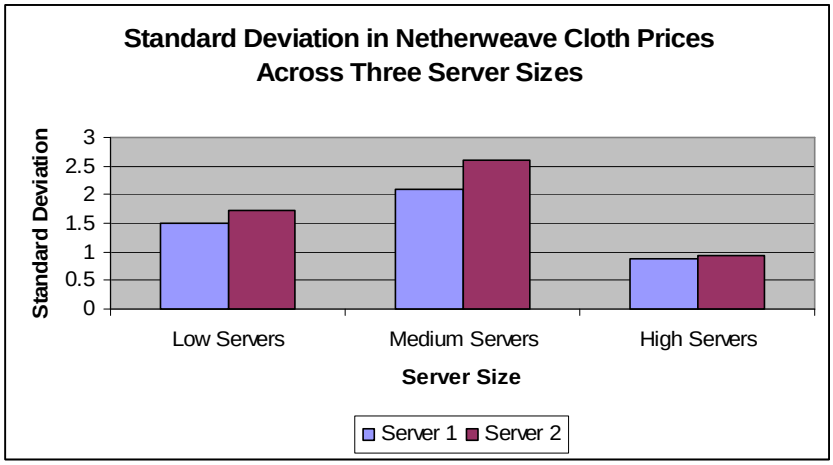

Figure 5
Data retrieved from wowecon.com

In every case, the two servers of each given type demonstrate a relatively similar standard deviation, with the servers in each pair varying by an average of 12.9% percent, whereas the average F-value is 3.76 and yields a p-value less than .001, meaning that the differences in price among server types are significant. Additionally, low population servers (average standard deviation 1.62) do hold less stable prices than high population servers (average standard deviation .895). Unexpectedly, however, medium population servers hold less stable prices for netherweave cloth (average standard deviation 2.35) than either low or high population servers. This inconsistency will be addressed later in this section.

Objective 2: Test whether servers with a higher concentration of players in a given level range will yield higher prices for the goods demanded by the group of players in question.

First, the percentage of players on each server in the level range of 58 to 70 was determined (see Table 2). The percentage of players at level 70 exactly is listed as well, and the relevance of this data will be seen later.

Server Size	Low Population		Medium Population		High Population	
Server Name	Khaz'goroth	Hakkar	Trollbane	Executus	Anvilmar	Illidan
Players Level 58 to 70	57.9%	76.6%	63.6%	71.2%	57.5%	79.7%
Players Level 70	45.6%	58.9%	51.0%	57.4%	44.6%	66.7%

Table 2
Data retrieved from WarcraftRealms.com

These percentages are then compared to netherweave cloth prices on each of the respective servers (see Figure 6).

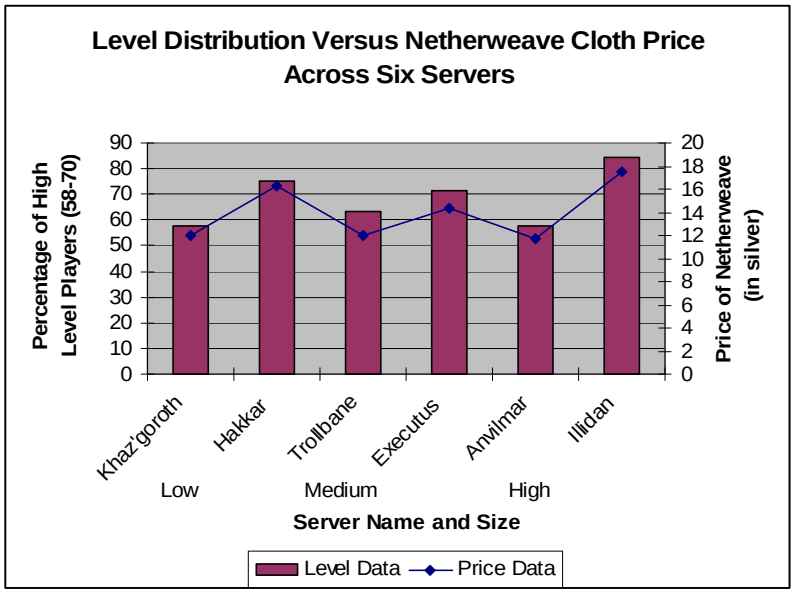

Figure 6

Here, it can be seen that in each pair of servers, the one with a higher percentage of players level 58 to 70–those who have a high demand for netherweave cloth–also has a higher price for netherweave cloth. This is what would be predicted.

Another interesting relationship between the percentage of players within the level range in question and the price of netherweave can be seen when the two are plotted against one another (see Figure 7).

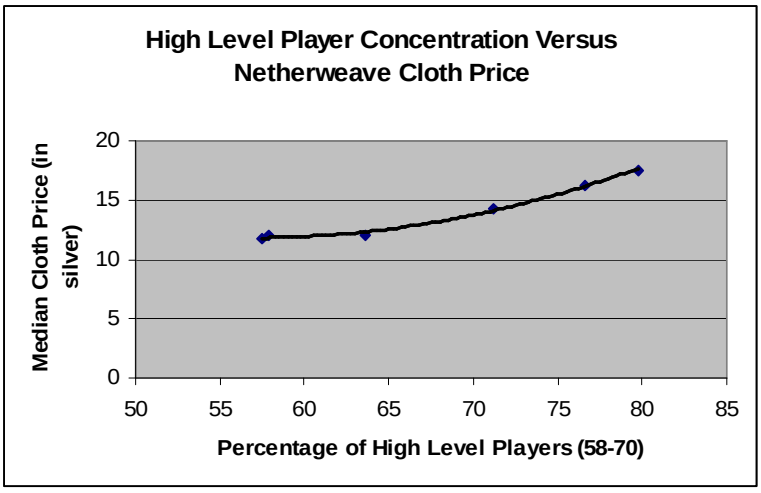

Figure 7

A best-fit line has been applied to the line above of $y = .0110x^2 – 1.25x + 47.27$ which yields an R^2 value of .993. This suggests that, regardless of population size, an increased concentration of players in the level range of 58 to 70 results in a predictable increase in the price of netherweave.

One question raised by the data is this: If larger numbers of players in a given level range drive up the prices of related goods, it would seem to follow that larger population servers would demonstrate higher prices on the whole, since the maximum supply of goods is identical across all servers. However, this tendency is not exhibited within the data, as can be seen in Figure 6, where the bars do not progressively increase with server size. One possible explanation for this is that players self-select onto high, medium, or low population servers. Players selecting high population servers are choosing to play in more competitive environments. These players enjoy competing to obtain goods such as netherweave cloth by slaying monsters that drop netherweave. Thus, on high population servers, the level of output of netherweave may well be higher than on low population servers, even though in principle the maximum level available is the same. On low population servers, players may opt for an activity other than obtaining netherweave cloth, such as socializing or exploring. This essentially lowers the production levels, and hence the supply, on lower population servers. Through this, the overall ratio of supply to population remains relatively constant, leaving level concentration as the only factor that determines the price of netherweave cloth, and indeed this is borne out in the data.

Self-selection can also explain why, in the test of price stability, medium population servers demonstrated the highest degree of price instability. Players who self-select into high population servers have a high tolerance for competition, and those who self-select into low population servers have a low tolerance for competition. Players who choose a medium population server, however, may be drawn from both groups, or are unable to predict the level of competition that they will be able to handle. Therefore, their tolerance for competition may be more variable. Some players will look for monsters to kill to obtain netherweave, and then bring it to market. Others may choose other activities instead, creating unstable, less predictable supply, and hence unstable prices. In the long run, these instabilities even out to the point where actual prices for netherweave cloth are still determined solely by level distribution within the server; prices just happen to be found in a wide range in medium population servers around these predictable, mean values, as witnessed by the higher standard deviations in these cases.

Objective 3: Test whether arbitrage exists only to a very minor extent across all server economies within World of Warcraft.

Auction data was collected on Greater and Lesser Planar Essences in order to test for the existence of arbitrage. Since three Lesser Essences create one Greater Essence, the mean prices were multiplied or divided by three, respectively, to obtain the predicted price of the other good in question. Error equals the predicted price minus actual price, and variation is equal to the absolute value of mean price minus the predicted mean, all divided by the mean price (see Table 3).

Planar Essence Type	Mode Price	Predicted Mode	Mode Error	Mode % Variation	Mean Price	Predicted Mean	Mean Error	Mean % Variation
Lesser	5.00	5.00	0	0%	6.02	5.71	-.31	-5.15%
Greater	15.00	15.00	0	0%	17.12	18.06	+.94	+5.49%

Table 3
Data retrieved from wow.allakhazam.com

When analyzing the mode prices of both goods in question, no arbitrage exists at all, as the price of a Lesser Planar Essence (hereafter LPE) is exactly one-third of that of a Greater Planar Essence (hereafter GPE), as it should be. When looking into mean prices, however, there appears to be a roughly 5% profit to be made by breaking GPE's into their LPE's. This can be explained by the fact that characters at level 70, which are most common in the relevant experience range, are more likely to obtain GPE's as they come from more powerful monsters (see Table 2). Such players do not bother to break down their Essences, which floods the market with GPE's, driving the prices down. It would be expected that servers with lower concentrations of level 70 characters would experience less arbitrage in this market; however, such data was not available for this study. Regardless of this arbitrage revealed by mean prices, the fact remains that the most common exchanges for LPE's and GPE's occur in a perfect 1:3 ratio, with no arbitrage, as seen by the mode results (see Table 3).

Conclusion

It has been demonstrated that, with certain caveats, World of Warcraft is an example of a highly competitive market approaching perfect competition, and a suitable platform for further economic research. Each of the three conditions studied, which one would expect to find in a highly competitive market, are present in the economy of World of Warcraft: price stability, prices of goods increasing where higher concentrations of players require that good, and a lack of arbitrage. The self-selection of players into different server population sizes is the most likely explanation for certain observed differences from what would be expected in a perfectly competitive environment, a supposition that can be tested through further research. Future researchers also can avoid self-selection issues by analyzing players within a given server population size, rather than across the entire WoW economy as a whole.

Other improvements to the methods used throughout this paper could also yield more refined results. Due to the limited amount of auction house information published on the websites used to collect data, only a small number of servers could be studied in depth. Data could be obtained from a greater number of servers by taking it directly from the game. Auction house and population data could be collected in this way using the Auctioneer and CensusPlus add-ons, although additional programming would be required to parse the data. More thorough population data could be particularly useful, as the broad, qualitative server population classifications could be replaced with the actual number of characters on the server in question, allowing for more involved analysis. In either case, frequent scans of the relevant data source at regular time intervals over several weeks should be sufficient to provide more significant results.

Further inquiry into the use of World of Warcraft as a means to study perfect competition seems warranted, given the results of this research. Although the methods could be expanded upon, the fact that the economies of World of Warcraft behave so predictably under the assumptions we would make about real-world economies with similar parameters is an encouraging one.

Understanding near-perfectly competitive markets can have manifold advantages in terms of understanding real-world economies. New forms of technology are constantly changing the face of our world, and our markets. To help us comprehend such advanced economies, it is important to understand their foundation, which essentially is a free, perfectly competitive market. As such knowledge becomes more relevant, however, real-world economies provide us with fewer and fewer examples of such markets. Now, such real-world examples seem less vital as we can learn from a virtual one: the World of Warcraft.

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Bibliography

Arthur, O., & Steven, S. M. (2007). *Economics: Principles in Action*. Boston, MA: Pearson Prentice Hall.

Auction Pricing Info. (n.d.). In *Allakhazam*. Retrieved from http://wow.allakhazam.com/

Castronova, E. (2001, December). Virtual Worlds: A First-Hand Account of Market and Society on the Cyberian Frontier. *Social Science Research Network*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=294828

Castronova, E. (2002, July). On Virtual Economies. *Social Science Research Network*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=338500

Creamer, R. (2008, September 30). What the Failure of the Bailout Package Means to the Presidential Race. *The Huffington Post*. Retrieved from http://www.huffingtonpost.com/robert-creamer/what-the-failure-of-the-b_b_130534.html?page=2

Janssen, M., & Moraga-Gonzalez, J. (2001, November). Two Firms is enough for Competition, but Three or More is better. *Tinbergen Institute Discussion Papers*. Retrieved from http://www.tinbergen.nl/discussionpapers/01115.pdf

Korth, A. (2006). *Predicting Commodity Prices Using Artificial Neural Networks* (Master's thesis, University of Minnesota).

Svensson, P. (2007, September). Virtual Bernanke guides 'Second Life'. Retrieved from http://msl1.mit.edu/furdlog/docs/2007-09-04_apwire_second_life_bernanke.pdf

Norris, F. (2008, October 20). First Birthday for the Recession? *The New York Times*. Retrieved from http://norris.blogs.nytimes.com/2008/10/20/first-birthday-for-the-recession/

Warcraft Census. (n.d.). Retrieved from http:///www.warcraftrealms.com/census.php

World of Warcraft Auction House Price Database. (n.d.). Retrieved from http://www.wowecon.com/

World of Warcraft End User Liscence Agreement. (2007, February 2). Retrieved from http://www.worldofwarcraft.com/legal/eula.html

WORLD OF WARCRAFT® REACHES NEW MILESTONE: 10 MILLION SUBSCRIBERS. (2008, January 22). In *Blizzard Entertainment*. Retrieved from http://www.blizzard.com/us/press/080122.html

Yee, N., Ducheneaut, N., & Moore, R. J. (2006). Building an MMO With Mass Appeal. *Games and Culture, 1*.