CASE HISTORIES AND ANALYSES OF SYNTHETIC ECONOMIES:
IMPLICATIONS FOR EXPERIMENTS, GAME DESIGN, MONETIZATION, AND
REVENUE MAXIMIZATION

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Special thanks to Torn.com for allowing me access to a vast array of economic data with which to analyze and the wherewithal to implement significant changes to Torn’s synthetic economy. The scope of this thesis would have been limited without access to such extensive data.
Chapter 1: Introduction to Synthetic Economics

Synthetic Economics is the study of human-to-human economic activity contained within the virtual worlds of multiplayer video games, and is an extremely young branch of economic study. The exploration of this subject has spanned barely 13 years; my objective is to expand the existing scope of Synthetic Economics by utilizing my eight years of experience playing multiplayer games, three years of developing browser-based multiplayer games, and one year of economic consulting with a prominent browser-based multiplayer game.

The exploration of Synthetic Economics can be traced back to Zachary Simpson’s research which explored the economic structure of the popular online multiplayer video game Ultima Online. In addition to explaining the gameplay mechanics of Ultima Online, he briefly explored a variety of economic applications within the game (Simpson 1999). I will expand and adapt two of his contributions: one which describes how virtual goods and currencies flow through multiplayer games, and another regarding the negation of virtual good scarcity.

The most prolific author of this field is Dr. Castronova, with no fewer than 13 works on the subject. He was the first economist to contribute to the field, and as a pioneer he has laid out the framework for Synthetic Economics. In addition to explicating the nature of Synthetic Economics and the virtual worlds in which they exist, Castronova developed
Arden, a Shakespearian multiplayer game, as a tool to study economic behavior and conduct economic experiments. While the Arden project was unsuccessful, I propose an alternative approach to developing games as research tools. My approach entails using browser-based game engines which, unlike the 3D game engine Arden was built on, are cheap to develop and operate, require less technically adept developers, and are accessible to a wider range of potential experiment participants (Castronova, et al. 2009).

In addition to strengthening existing literature, my thesis will introduce a number of economic phenomena and crises which are common in synthetic economies but have not yet been extensively explored. In my first case history, I explicate the hyperinflation crisis of Ruined City (ruined-city.net), a browser-based game which I helped develop and operate. I also explore the issue of inflation on Torn (torn.com), a game which I have consulted with since January 2012, as well as the issues of price controls and abnormal market conditions. I also present my theory for revenue maximization of multiplayer games, which is supplemented by two attempts to maximize revenue on Torn. The first attempt failed, but the second has succeeded, providing empirical support for my generalized revenue maximization approach.
Chapter 2: Framework and Existing Literature

This chapter will establish the framework of virtual worlds and synthetic economies in light of existing literature. I will establish the significance of synthetic economies and review the fundamental concepts necessary to follow the case histories of Chapter 3 and understand the business applications of Chapter 4.

2.1: Fundamental Framework

In Castronova’s seminal work, he concluded that video games had evolved to a level of significance beyond rudimentary entertainment (Castronova 2001). Made possible by the emergence of high-speed internet, video games which allowed thousands of players to simultaneously play together in the same virtual space began to proliferate. In time, some of these games began to attract millions, and have appropriately been defined as Massively Multiplayer Online Games (MMOGs). Everquest, one of the earliest MMOGs and the focus of Castronova’s first study, had attracted one of the largest player populations of the early 2000s with more than 450,000 subscribers (Geel 2012).

Castronova (2001) conducted a survey of 3350 players who were members of a third-party Everquest forum. 20% of respondents agreed that they “live” in Everquest’s virtual world but travel outside of it regularly (i.e., to the real world); 58% agreed with the statement “I wish I could spend more time in [Everquest’s virtual world] than I do now”;
22% agreed with the statement “If I could, I would spend all of my time in [Everquest’s virtual world] (Castronova 2001).” While the survey’s sample is biased (players who actively participate in an Everquest forum are likely to play more often and more seriously), the results suggest that virtual worlds are a significant source of entertainment and utility for many individuals.

**Player Demographics**

From the same survey (3619 observations), player demographic data was collected. The average Everquest player was a 24 year-old American male who worked 39 hours per week at a wage of $20/hour. That average player had invested 792 hours into his primary avatar (a customized, virtual character which he controls), and played about 28 hours in a typical 7-day period. Castronova sorted his survey data to discern the difference of player habits between Residents, players who claimed they “live” in Everquest’s virtual world, and Non-Residents, players who did not claim they “live” in Everquest’s virtual world (Castronova 2001). Table 2.1, below, exhibits select results from Castronova’s surveys.
Table 2.1: Select Results of Castronova’s Survey on Everquest Players  
(Castronova 2001)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>All Respondents</th>
<th>Residents</th>
<th>Non-Residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24.3</td>
<td>22.4</td>
<td>24.8</td>
</tr>
<tr>
<td>Female (%)</td>
<td>7.8</td>
<td>10.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Region: US (%)</td>
<td>81.3</td>
<td>82.4</td>
<td>81.1</td>
</tr>
<tr>
<td>Region: Canada (%)</td>
<td>6.6</td>
<td>7.5</td>
<td>6.4</td>
</tr>
<tr>
<td>Region: Western/Southern Europe (%)</td>
<td>8.9</td>
<td>7.1</td>
<td>9.4</td>
</tr>
<tr>
<td>Married or Cohabiting (%)</td>
<td>22.8</td>
<td>15.9</td>
<td>24.5</td>
</tr>
<tr>
<td>Single (%)</td>
<td>60.0</td>
<td>68.0</td>
<td>58.1</td>
</tr>
<tr>
<td>Have children to care for daily (%)</td>
<td>15.0</td>
<td>11.4</td>
<td>15.9</td>
</tr>
<tr>
<td>Education: less than High School (%)</td>
<td>12.4</td>
<td>18.4</td>
<td>10.6</td>
</tr>
<tr>
<td>Education: High School degree only (%)</td>
<td>35.6</td>
<td>41.7</td>
<td>34.1</td>
</tr>
<tr>
<td>Education: College degree or more (%)</td>
<td>31.0</td>
<td>18.6</td>
<td>34.1</td>
</tr>
<tr>
<td>Employment status: Working full time (%)</td>
<td>53.4</td>
<td>41.5</td>
<td>56.4</td>
</tr>
<tr>
<td>Employment status: Student, working (%)</td>
<td>19.4</td>
<td>22.3</td>
<td>18.6</td>
</tr>
<tr>
<td>Employment status: Student, not working (%)</td>
<td>15.8</td>
<td>21.1</td>
<td>14.3</td>
</tr>
<tr>
<td>Weekly work hours</td>
<td>39.0</td>
<td>36.5</td>
<td>39.5</td>
</tr>
<tr>
<td>Monthly earnings</td>
<td>3154.12</td>
<td>2621.35</td>
<td>3268.96</td>
</tr>
<tr>
<td>Hourly wage</td>
<td>20.7</td>
<td>17.6</td>
<td>21.4</td>
</tr>
</tbody>
</table>

**Motivation**

Beyond Castronova’s quantitative player demographics such as income and education, Simpson categorized four types of players by their motivation to play multiplayer games: Socializers, Killers, Achievers, and Explorers. Socializers enjoy interacting with other players by using in-game features to create the setting; Killers like to compete with other players, and use virtual items to enhance their avatar’s abilities; Achievers seek fame, and use virtual items to acquire it; Explorers just want to experience everything the virtual world has to offer (Simpson 1999). Players can certainly pursue more than one of these motivations simultaneously, though one aspect will likely predominate.

Not explicitly identified in Simpson’s work, the motivation for these player types represents how different players perceive value from games—the entertainment and
satisfaction experienced by playing an avatar in a virtual world harboring a synthetic economy.\textsuperscript{1} Castronova (2011) conducted a survey of players on the social MMOG Second Life (SL), where he gained insight into the life satisfaction of SL players compared to the rest of the world (as per the 2005 World Values Survey). On the whole, SL players were more satisfied with their life than the mean of their respective countries. Further, across the board SL players were more satisfied with their life in the SL world than in their “first life.”

**Virtual Worlds**

The virtual spaces in which players control avatars are known as Virtual Worlds (or Synthetic Worlds, interchangeably). Avatars exist only in their virtual worlds and, through their players, must negotiate through the virtual world as if it were a person in the real world. Decomposed, virtual worlds (VWs) embody three primary attributes: Interactivity, Physicality, and Persistence (Castronova 2001).

The Interactivity element signifies that VWs exist on a dedicated computer (or network of computers) known as a server, and are simultaneously accessed by multiple players. Each player will typically use a mouse and keyboard to input commands to a VW’s server which will directly affect that player’s avatar. The player is not the avatar, but the avatar’s actions are explicitly dictated by the player’s commands (Castronova 2001).

\textsuperscript{1} Simpson’s ideas on player motivation strongly correlate with Ron Edwards’ GNS theory from the world of tabletop role playing games such as Dungeons & Dragons and Warhammer 40k. Edwards’ theory categorizes players as predominantly Gamist, Narrativist, or Simulationist.
Physicality embodies the players’ use of avatars to interact with a VW in a physically limited manner. In the case of VWs such as World of Warcraft (WoW), players are constrained by an artificially constructed three-dimensional environment with rules similar to the real world. To move from point A to point B, an avatar may need to “walk” across a simulated street and “hike” up a simulated mountain (or perhaps “walk” around the mountain). The player may need to find a bridge for their avatar to safely cross a river, then follow a marked path to navigate through a thick forest. The player is usually not able to teleport their avatar from one location to another. The players, acting through their avatars, must contend with the physical limitations imposed by a VW (Castronova 2001).

Persistence entails a VW’s perpetual existence, regardless of whether any particular group of players is actively interacting with it. Any subset of a VW’s players can access and interact with the VW at a particular time while the remainder does not. Critically, the VW will “remember” a player’s ownership of avatars and assets, which allows players to take a break from the game and return where they left off at their leisure (Castronova 2001). In my own experience, I once stopped playing Runescape, a fantasy 3D MMOG, after losing a particularly devastating battle; when logging back in three years later, my avatar was standing in the same location with the same equipment and capabilities.

2 Though “ownership” is truly in a figurative sense. Players typically agree to an MMOG’s use terms that define everything the player does and possesses in-game is actually property of the VW’s company. This is a gray area however; such agreements may not hold up in a court of law.
**Avatars**

In most MMOGs, players will create and be represented in the VW by simulated beings known as Avatars, which are typically (but not necessarily) humanoid.\(^3\) The only constraints on avatar customization are the finite capabilities of the VW’s infrastructure and any additional limitations imposed by the developers. Avatars are often allowed a breadth of customization to suit the player’s desires regardless of the player’s physical attributes and limitations. Avatars can be male or female, tall or short, fat or thin, human or elf, and so on (Castronova 2001).

Beyond appearance, avatars must typically specialize in specific skills. Just as one may specialize as a financial analyst or nurse in real life, a player may design their avatar as a warrior who swings two-handed swords, a wizard who throws fireballs, a stealthy archer who shoots precise shots, or a priest who heals the wounds of other avatars at will. A player will use their keyboard and mouse to command their avatar to use an axe to cut down a tree, shoot an arrow into a bear, or stab another player’s avatar with a sword. Similarly, the player can command the avatar to walk, speak, and trade when appropriate (Castronova 2001).

Depending on the VW, players may face a variety of restrictions on avatar ownership. While it is technically possible for a single player to own multiple player accounts, and for individual player accounts to own and access multiple avatars, restrictions on player

\(^3\) In World of Warcraft, players can choose from a variety of races such as Human, Elf, Goblin, Troll, Dwarf, and many others. (For a full list, visit us.battle.net/wow/en/game/).
account ownership, avatar ownership, and avatar access are often imposed by VWs. On WoW, players are allowed to own up to 50 avatars on a single player account, but the player is only able to access one avatar at a time; to access more than one avatar simultaneously, the player must purchase access to multiple player accounts. On Torn, players are only allowed one player account, which can only support one avatar; there are severe punishments up to and including a permanent ban for being caught with multiple accounts, as it is deemed an unfair advantage over other players.

**Virtual World Shards**

Virtual Worlds, existing only on a computer, can be easily replicated. Each replication is known as a “shard,” and each shard may have a unique set of rules which constrict the abilities of avatars (Bradley and Froomkin 2004). The motivation for unique shards to exist could be a variety of reasons, most notably because shards with different rule sets can provide vastly different player experiences. Avatars typically cannot be transferred from one shard to another, even if the shards are based on the same VW engine.

While MMOGs can attract millions (WoW maintains more than 9 million subscribers), the players will be dispersed among numerous shards (Geel 2012). WoW’s players must choose to play an avatar on one of 244 available shards, each providing a slightly different experience than others (US WoW Realms 2013). On the 3D MMOG Ragnarok Online, players are able to choose from hundreds of shards, each providing different rates of avatar improvement, different limits on avatar abilities, and different elements of gameplay (Rate My Server 2013).
To exemplify the multiplicity and popularity of shards, Figure 2.1 plots the quantity of avatars which have been registered to each WoW shard. Note that individual shard populations do not represent the number of players which are actively playing the shard, but the total number of avatars that are registered to the shard.

![Figure 2.1: WoW Shard Populations: Ranked by Total Avatar Population](image)

Total Avatar Population: 18,303,365 (US WoW Realms 2013)

Similarly, Figure 2.2 is a series of active avatar snapshots from “Tranquility” and “Serenity,” two of the most populated shards of the MMOG EVE-Online. This figure tracks active player counts rather than the total player base (as in Figure 2.1), hence the daily cyclicality.

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4 Tranquility is the most populated and Serenity the third most populated; the second most populated shard, “API”, does not publish historical population data.
2.2: Fundamental Economic Concepts

**Artificial Scarcity, Specialization, and Avatar Capital**

It is critical to understand that, within a VW, everything that exists can be controlled by the developers, and any abilities which avatars have are those which developers explicitly designed and allowed. Castronova defined the nature of Avatar Spaces, a subset of VWs where players are allowed to alter any aspect within the capabilities of the game; virtual items are infinitely available, devoid of any factors of production, which precludes players from needing to trade or interact with one another (although Avatar Spaces tend to be social in nature). These Avatar Spaces failed to attract player populations on the
scale of MMOGs, which Castronova attributes to a lack of scarcity as a fundamental gameplay element (Castronova 2001). Today there are some predominantly social VWs where avatars act as tools for player-to-player interaction, similarly to Avatar Spaces, but avatar assets in those games are indeed scarce.\(^5\)

In a MMOG VW, a player’s avatar is constrained most notably by its limited ability to acquire scarce assets, which must be harvested from the VW directly or purchased from a player who has already done so. Avatars often become more efficient over time as they continually harvest the same type of asset, such as mining ore or crafting jewelry. To be more competitive, players are forced to improve their avatar’s skills, and are therefore induced to specialize their avatar’s skill set to become adequately efficient and masterful in a targeted role since it is often impractical to master a wide range of skills (Castronova 2001).

The progressive improvement of an avatar accumulates as avatar capital: the inseparable abilities and skills of the avatar (Castronova 2002). The skills and abilities explicitly belong to the avatar, though the avatar is owned by a player.\(^6\) Avatar capital, which does not include the avatar’s assets such as virtual items and virtual currency, is often preserved upon death. Death may come with the penalty of lost progress navigating through the VW and partial or complete loss of assets the avatar was carrying, but death

---

\(^5\) Second Life and Habbo Hotel are examples; similar to Avatar Spaces, but embody elements of scarcity.

\(^6\) That is to say, the avatar’s avatar capital belongs to the avatar. It cannot be transferred from avatar to avatar. While a player may own an avatar, and by extension its avatar capital, ownership of the avatar itself can be transferred (whether allowed by the VW or not) and is thus not considering human capital.
itself is partially trivialized because the avatar does not permanently die and its avatar capital is preserved.\textsuperscript{7}

To illustrate, consider a simplified application of artificial scarcity, skill specialization, and development of avatar capital in Runescape: a typified interaction between three avatars, one specializing in smelting ore into weapons-grade metal, another in forging swords and armor, and a third who specializes in sword combat. The smelter’s skill may be initially limited to smelting tin and copper together to produce bronze. From the smelter, the blacksmith may buy the bronze, the only metal with which he is initially skilled enough to utilize, in order to forge a bronze longsword as well as a suit of bronze armor. The warrior will buy the sword and armor to supplement offensive and defensive capability in combat. As each avatar becomes more skilled through experience, they will be able to accomplish more difficult tasks: the smelter will be able to smelt more difficult metals like iron, steel, and mithril (a fantasy material); the blacksmith will be able to use the more difficult materials to produce superior arms and armor; the warrior will be able to slay more fearsome creatures, supplemented by superior equipment from the blacksmith and his progressively improving combat prowess (Castronova, et al. 2009).\textsuperscript{8}

\textsuperscript{7} In Torn City, a VW explored in Chapter Four, avatars never die but are “hospitalized”; Avatar capital and assets are entirely preserved upon being defeated in battle, though the victorious avatar may choose to “mug” the defeated avatar and steal some money. In World of Warcraft, an avatar’s armor may become damaged upon “death”, which can require a costly repair. On Runescape, players lose all but three items upon dying (all but one item if they have recently killed another avatar).

\textsuperscript{8} The true economic system is much more complicated than this. For example, the blacksmith depends on a miner who must increase his skill to mine more difficult ores. The miner himself depends on a blacksmith to supply progressively superior pickaxes. A miner may depend on a warrior escort to safely access dangerous mining grounds. As in the real world, many aspects of an economy are intertwined.
Real Value of Virtual Items and Virtual Currency

Perhaps the most fundamental concept of Synthetic Economics is that virtual goods have real value. The fact that virtual goods are digital rather than physical, existing in a game rather than the “real world,” does not preclude players from assigning real value to those goods (Castronova 2002). Value is, after all, a property assigned to anything humans desire. Applying this concept to video games, many players would be willing to spend at least $0.01 on a desired virtual item, such as an extremely powerful sword which would give them an edge over other players.

By extension, the value of virtual currency (VC) is derived from the players’ mutual willingness to accept VC in exchange for virtual goods. Just as Americans view the United States Dollar (USD) as valuable because other Americans will accept it in exchange for real goods, VC is valuable because players can use it to purchase virtual goods from other players (Castronova, et al. 2009). The real value of VC can be determined by comparing how much USD one would be willing to pay for a virtual item against how much VC one would be willing to pay for a virtual item. Deriving this value results in an exchange rate, which is discussed later in the Exchange Rates subsection.

Player Utility Functions and MMOG Difficulty

The utility players receive from playing games as derived through their avatar does not follow the usual logic of “more is better.” While an avatar can be thought of as having high utility if its constraints are significantly relaxed, the player is likely to become bored
over time due to a lack of challenge. Scarcity of virtual items and avatar abilities are critical for player utility; as Castronova (2001) conveys: scarcity is what makes VWs fun.

To provide the maximum utility players can derive from playing their avatars, the level of challenge must be balanced. If a game is far too difficult or too easy, the players may quickly lose interest and cease playing. The entertainment- and satisfaction-maximizing level of challenge is somewhere between the extremes of too easy and too difficult. Therefore, items and avatar abilities should not be too abundant or too scarce. This is analogous to an adult piecing together a puzzle: the most enjoyable puzzle is not comprised of two pieces or a million pieces but perhaps 500 or 1000 pieces (Castronova 2002). Not too easy nor too hard.

**Black Markets**

The real value of VC is affirmed by the existence of black markets. These markets, while not explicitly illegal, are typically forbidden by VWs since the activity could undermine the VW’s revenue stream. Black markets specialize in exchanging virtual goods and VC for real currencies, predominantly via the US Dollar, Euro, and British Pound. While VWs often do not directly allow players to buy (and certainly not sell) VC with real currency, players can easily conduct these types of trades in a clandestine manner; VWs often allow avatars to exchange most assets without restriction, so any arrangements outside of the VW are secret. For example, one could pay a friend real cash under the agreement that the friend will send his avatar a virtual good—to the managers of the VW,
the transfer just looks like the player received a gift from another player (Castronova 2001).

To gain better insight into black market activity, I interviewed a player of Torn who has spent more than $5,000 on the black market. He predominantly trades in black markets because he feels he doesn’t have time to acquire sufficient VC through the VW itself. He has personally traded with about five players, and estimates that perhaps 100 players (0.4% of Torn’s population) trade in the black market, so Torn’s black market is not particularly extensive. He recalls that some accounts have been sold for $1,000-$2,000, and that one billion Torn City Dollars may sell for $45-$75 (though he claims he would only pay $25-$30). Outside of Torn, he had played World of Warcraft and eventually sold his avatar for $4,500. The full interview can be found in Appendix A.

**Exchange Rates**

Castronova extrapolates the idea that because VC (also denoted as $V$) has real value, there are implicit exchange rates between virtual and real currencies (Castronova 2001). Exchange rates between VC and USD, for example, can be determined by dividing the USD price of a virtual good by the VC price of the same virtual good. The general equation for approximating the value of a generic VC is exhibited by Equation 2.1 below:

\[
\text{USD price of } \frac{V_C}{\text{VC price of a virtual good}} = \frac{\text{USD price of a virtual good}}{\text{VC price of a virtual good}}
\]

*Equation 2.1: Generalized Virtual Currency Exchange Rate Derivation*
For example, if a sword can be purchased from the VW for $5 and is competitively traded in-game for ¥600 then the exchange rate is 0.0083 USD per VC, as calculated by Equation 2.2. It should be noted that the exchange rate calculated through this method is approximate; items sold through a black market are likely to be sold at a discount due to the risk of being caught.

\[
0.0083 = \frac{5}{¥600}
\]

*Equation 2.2: Example Exchange Rate Calculation*

**Agglomeration Economies and Relocation Costs**

Castronova explicated why players tend to be attracted to large MMOGs: Besides the likelihood that some MMOGs provide a superior player experience compared to others, there is an additional social aspect. Player-to-player interaction is often a key component of the MMOG experience, and one will tend to prefer playing with friends or with a large network of other players with which to pursue mutual goals (and perhaps to encounter hostile players with which to compete) (Castronova, et al. 2009).

The difficulty of acquiring avatar capital and the inviability of transferring avatar capital between VWs and VW shards is a factor that causes players to agglomerate as well. If a player’s avatar has accumulated significant avatar capital on a particular VW, representing a significant investment of time, they may be unwilling to start a new, entry-level avatar on another VW or VW shard (Castronova 2002).
2.2: The Faucet-Drain Model

The basic concept of the Faucet-Drain model was first laid out by Simpson (1999), who modeled the economic system of Ultima Online (UO). It was not a closed system where items and currency are circulated among players. Rather, UO had a system where virtual goods and VC were constantly generated, circulated in a limited manner, and eventually destroyed.

I have built upon Simpson’s UO-targeted model with the Generalized Faucet-Drain Model of Synthetic Economies, shown by Figure 2.3, which embodies five major sections: Faucet, Circulation, Drain, Transformation, and the Macroeconomy. The Faucet, Circulation, and Drain are adapted from Simpson, while the Transformation and Macroeconomy elements are added to more accurately model the Faucet-Drain mechanism.
This model maps the flow of VC, virtual items, real currency, and premium features throughout a VW’s synthetic economy. All major MMOGs embody this model; it is the most simplistic model to base a VW’s economic framework upon.⁹

The Faucet

The Faucet represents all means by which both VC and virtual items are created. Since a synthetic economy is an element of VWs, the means of production are theoretically unlimited; VWs could provide an unlimited quantity of every item to every player.¹⁰ To

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⁹ All of the significantly populated MMOGs embody this model, including: World of Warcraft, Everquest, RuneScape, and Ragnarok Online.

¹⁰ While an infinite number of unique items could exist, due to constraints of data storage, any type of item (i.e. Iron Dagger, Steel Shield, Leather Armor, Sheep, and Wooden Cart) can be indefinitely available with the marginal cost of the player clicking a button if the VW were to allow it.
induce scarcity, a central element of game difficulty and by extension player satisfaction, VWs arbitrarily limit or inhibit the means of production. Note that the players are in control of the Faucet, the developers merely bestow that control; players, rather than developers, are the ones who activate the Faucet mechanism.

Consider a synthetic economy where players demand firewood. The VW’s designers have decided to supply some number of trees for the players to harvest firewood from. The supply of trees will be limited to perhaps five, however. The five trees arbitrarily exist—no inputs were required for the trees to be present; they simply exist as the developers defined. There could easily be zero, one, 5000, or 70 trillion trees, but the developers of this example VW have defined only five trees to exist. By extension, the firewood which can be harvested from the five trees is arbitrarily allowed to exist if the players decide to harvest it. Each tree will replenish at an arbitrarily defined rate of one hour after harvesting, allowing players to harvest it again (i.e. the supply of trees never permanently depletes). The act of avatars harvesting firewood from trees is a simple example of Faucet flow: while the item “firewood” would not have otherwise existed, it is created and added to the avatar’s assets upon being harvested.

To extend the arbitrary supply concept to a generalized virtual currency, assume the VW allows players to sell harvested firewood to a VW-operated store. Just as the quantity of trees was arbitrarily limited to five, the store’s quantity of money could be infinite but is

---

11 Similarly, the quantity of the item Firewood avatars receive through harvesting is arbitrary. The quantity per harvest could be 0, 1, 5, 20, 5000, 30 billion, etc.
arbitrarily limited to ¥200. If the shop arbitrarily pays ¥50 for one piece of firewood, then players can sell up to four pieces of firewood to the shop and receive, in aggregate, ¥200. The act of players selling firewood to the VW is a Faucet for VC which actually increases the monetary base—VC is not transferred from one entity to another, but instantaneously generated the moment the player sells firewood to the VW.

The Drain

The Drain encompasses all means by which VC and virtual items are removed from the synthetic economy. Just as items and VC are arbitrarily created via the Faucet mechanic, the Drain arbitrarily destroys via Consumption—the destruction of items to fulfill a player’s wants, and Waste—the destruction of items without fulfillment of the player’s wants. Consider how a piece of firewood created by the Faucet could be drained from the economy. If a player uses a piece of firewood to build a fire, the firewood item is destroyed via the Consumption mechanism. If the player lets the piece of firewood rot beyond usability, then the firewood item is destroyed via the Waste mechanism.

Transformation

A player action which destroys one item but generates another is known as Transformation. The destroyed item is an intermediate good for the generated item. On Runescape, players can carve an Uncut Ruby item with a chisel, destroying the Uncut Ruby and freshly generating a Ruby item. The Ruby can then be used to craft a variety of other items such as a Ruby Necklace. Both cases are examples of Transformation; one or
more items are destroyed but another is created. Transformation could be considered a simultaneous Faucet and Drain, but it is clearer to distinguish this mechanism separately.

**Circulation**

Circulation encompasses all means by which items and VC are exchanged between players in a limited, closed system. Items and VC are not created or destroyed, only transferred from one avatar to another.

For example, if Avatar A (“A”) buys firewood from Avatar B (“B”), VC is transferred from A to B and lumber is transferred from B to A. No items or VC have been generated by the Faucet or destroyed by the Drain, the players have just willingly exchanged their avatars’ assets.

**The Macroeconomy**

The final element is the Macroeconomy, which encompasses the flow of real currency. The most visible element of the Macroeconomy is a VW selling premium features for real currencies like USD. Runescape, for example, will sell players a month of premium access for $5 USD. Premium players receive access to the entire VW map and can use any item their avatars acquire, whereas non-premium members are restricted to a relatively small section of the VW map and their avatars are restricted to using relatively less effective weapons and armor.
The second aspect of the Macroeconomy is black markets, encompassing player-to-player trades involving real-world currencies such as USD. In effect, one player will give another player real money through a third party payment processor and the other will transfer items and VC to his or her avatar in-game.

**Instability of the Faucet-Drain model**

The Faucet-Drain model can become precariously unbalanced if the Faucet and Drain are not well-managed over a prolonged period. Faucet inflow can oftentimes exceed Drain outflow. This imbalance systematically increases the quantity of items over time, reversing efforts to induce scarcity as a gameplay element (which I call Trivialization), and systematically increases the quantity of money, leading to monetary base expansion and, hence, price inflation.

**Item Trivialization**

If an unbalanced Faucet-Drain model significantly increases the supply of a particular item, then that item may undergo Trivialization. Trivialization is the reversal of artificial scarcity, eroding that central gameplay element of balanced difficulty. For example, consider a hypothetical item which many players need on a constant basis; harvesting this item at the source is somewhat challenging, and therefore it is somewhat expensive (but affordable) to purchase from other players. If this item becomes too common, perhaps because avatars became exceedingly efficient at harvesting it, its economic significance will be negated as its availability will be assumed. The item’s Trivialization may then
preclude players from needing to interact with one another or venture into the VW to acquire the item, which eliminates that aspect of gameplay.

2.3: Synthetic Markets

Markets in a VW often mimic the behavior of markets in the real world; synthetic markets are, after all, comprised of individuals who make up the real-world markets. As Castronova states, the human interaction in VWs are real despite being in a virtual setting. However, due to the fact that scarcity in a VW is induced rather than inherent, markets can sometimes have radically abnormal supply and demand curves. This section will introduce the market models, normal and abnormal, then exhibit models of price inflation under both market conditions.

**First Model of Markets**

This model, exhibited by Figure 2.4, is the standard relation between Supply (S) and Demand (D); as Price increases, Quantity Demanded (Q^D) decreases and Quantity Supplied (Q^S) increases. The point where Supply and Demand intersect is called Equilibrium (E): the Price where Q^D and Q^S are equivalent.
Second Model of Markets

The Second Model of Markets is exposed to intervention by the VW through Supply (exhibited by Figure 2.5), Demand (exhibited by Figure 2.6), or both. Supply intervention entails the VW infinitely supplying the market at a constant price while Demand intervention entails the VW infinitely demanding from the market at a constant price.\footnote{A random price within a constant range qualifies as well. For example, a VW may offer an infinite quantity of a virtual item at a price between \(200\) and \(500\), whereby the price is randomly selected on some interval.}
By modifying the First Model of Markets to account for both types of intervention, we produce the Second Model of Markets as exhibited by Figure 2.7. The market behaves normally when the price is below $S_{VW}$ and above $D_{VW}$. Out of that range the VW predominates, either forcing prices to be lower (if supply intervention is in effect) or
higher (if demand intervention is in effect) than it would be in a strictly player-to-player market.

Figure 2.7: Second Model of Markets

First Model of Price Inflation

The First Model of Price Inflation, exhibited by Figure 2.8, is based upon the First Model of Markets, and details the effect of monetary base expansion on the equilibrium price and quantity of a Supply and Demand relationship. The initial Supply and Demand curves are denoted by $S_0$ and $D_0$, respectively. Their intersection constructs the initial equilibrium point $E_0$, which corresponds to $P_0^*$ and $Q_{0,2}^*$. 
When the monetary base is expanded, more VC falls into the hands of players, increasing their aggregate budget constraint. This results in a Demand shift to $D_1$, shifting equilibrium to $E_1$ and increasing the equilibrium price and quantity to $P_1^*$ and $Q_1^*$, respectively. However, while players are suppliers in secondary markets, they comprise the demand element in the market for factors of production. Thus the nominal cost of producing their product has increased, which shifts the Supply curve in the First Model of Price Inflation to $S_1$. The ultimate result is equilibrium at $E_2$, corresponding to the inflated equilibrium price level $P_2^*$ and the original equilibrium quantity $Q_{0.2}^*$.

**Second Model of Price Inflation**

The effect of inflation in markets adhering to the Second Model of Markets follows the Second Model of Price Inflation, exhibited by Figure 2.9 (for simplicity, only supply intervention is modeled). The underlying inflation mechanic is identical to that of the
First Model of Price Inflation: as the monetary base expands, demand shifts to the right and supply shifts to the left. The complicating factor is the infinite $S_{vw}$, which shifts to the left but remains infinite at the same price.

![Figure 2.9: Second Model of Price Inflation](image)

In effect $S_{vw}$ disrupts the normal inflation mechanism, which would result in the same $Q^*$ though at an elevated price level. Conversely, in the Second Model of Price Inflation, $P^*$ remains constant while $Q^*$ continually increases as the monetary base expands (once the natural equilibrium price exceeds the price set by $S_{vw}$).
Chapter 3: Browser-Interface MMOGs and Case Histories

While existing literature on Synthetic Economics focused on the most populated MMOGs such as WoW and Everquest, a subset of MMOGs which I call Browser-Interface MMOGs (BIMMOGs) have gone unnoticed. BIMMOGs are accessed through any internet browser such as Internet Explorer, Mozilla Firefox, and Google Chrome, and typically utilize an HTML/PHP user interface (sometimes with supplemental Java/Flash interfaces). Breaking the paradigm that MMOG Virtual Worlds are inherently 3D, the BIMMOG VW is instead a network of linked web pages through which the player navigates. Avatars are a collection of attributes and data rather than graphical mock-ups of what the player wants to role-play. While individual BIMMOGs have not attracted millions of players like WoW, a BIMMOG’s player base can still become substantial; Torn, the focus of this chapter’s case histories, is a BIMMOG that maintains an active player base of 25,000 players.

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13 A notable exception to the HTML/PHP generalization is RuneScape, a BIMOGG which completely runs on java and is therefore capable to be played through a browser, though it requires a desktop or laptop computer and cannot be played on mobile phones. RuneScape is also available as a downloadable computer program as an alternative to browser-based access.

14 The physical features of an avatar in a Browser-Based MMO are left to the imagination; an avatar with a high “strength” statistic may be envisioned as having large muscles, just like an avatar with a job as a surgeon may be envisioned as wearing a lab coat.

15 25,000 is a significant figure which rivals the average active shard population of EVE Online, and likely rivals the active avatar populations of many WoW shards.
3.1: Browser-Interface Classification

As BIMMOGs are a subset of MMOGs, they do embody the three fundamental VW attributes: Interactivity, Physicality, and Persistence. There are significant differences of VW format between 3D MMOGs and BIMMOGs, however. A 3D MMOG’s VW requires a moderately powerful computer supplemented by a keyboard and mouse for efficient command input. BIMMOG VWs are not nearly as intense and only require an internet browser, which are integrated in mobile devices such as laptops and smartphones. The BIMMOG format allows a VW to be more accessible than their graphic-intense, client-based 3D MMOG counterparts—a significant benefit in regard to market size.

A breakdown of video game classifications as relevant to this thesis is exemplified by Figure 3.1:

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17 If using a computer, a keyboard and mouse may be preferable to use, but are not required to access a BIMMOG VW. Conversely it is impossible to effectively play a 3D MMOG without a keyboard or mouse; laptop trackpads are ill-suited for 3D MMOGs as well since trackpads are clumsy to use compared to mice.
Figure 3.1: Partial Classification of Video Game Subsets

The nested subsets exemplify how BIMMOGs relate and differ from other forms of video games. MMOGs are a subset of Multiplayer Video Games, while Browser-Interface Games are a subset of Video Games which overlaps both Multiplayer Video Games and MMOGs.

**Browser-Based Physicality**

The Browser-Based attribute of BIMMOGs is a modification of the Physicality attribute, which entailed that avatars are restricted by the rules of a 3D VW most noticeably by the limitation of movement in a realistic manner similar to human limitations in real life. BIMMOGs are not 3D however; avatars are instead restricted by the rules imposed by the
network of webpages which players explore. It is not a simulated physical world which restricts them, but the constraints of webpages the player visits.

To represent this distinction, consider how an avatar in a 3D realm and an avatar in a BIMMOG would travel to a fishing dock in their respective VWs. The player of a 3D realm must navigate the avatar through the physical limitations of the artificial environment by finding an efficient path to the specific X-Y-Z coordinate which has been defined to be the fishing dock. An avatar of a BIMMOG VW would require the player to instead click a link that says “City” to instantly send the avatar to the City webpage, then “Beach” to instantly send the avatar to the Beach webpage, then “Fishing Dock” to instantly send the avatar to the Dock webpage.\(^\text{18}\)

As another example, consider how avatars may travel to a faraway location via plane. In a 3D VW, the player needs to find a path for his avatar to walk to the airport, then purchase a ticket and board the appropriate plane; the player will then watch the avatar being flown to the new area. In a BIMMOG such as Torn, there is no graphical representation of travel—the player simply clicks a web link to instantly send his avatar to the “Airport” webpage, then clicks a link to simultaneously pay for the ticket and board the plane for the desired destination. The avatar is then prevented from conducting normal activities until a countdown timer reaches zero, signifying that the plane has “landed.” For example, in Torn, it takes 20 minutes for an avatar to travel to Mexico. 57

\(^\text{18}\) If the VW’s main webpage is ‘game.com’, then the corresponding web pages would be ‘game.com/city.php’, ‘game.com/beach.php’, and ‘game.com/dock.php’. Depending on the structure of the VW, a player may be able to directly send their avatar to the Dock webpage by rather than going through City and Beach first.
minutes to travel to the Cayman Islands, and 169 minutes to travel to Switzerland; during the duration of flight, avatars are unable to participate in most activities.

3.2: The Faucet-Drain Model of Torn and Ruined City

Figure 3.2 is an expanded version of the Generalized Faucet-Drain Model of Synthetic Economies, customized for the economic system embodied by Torn and, by extension, Ruined City (a small-scale BIMMOG modeled similarly to Torn).\textsuperscript{19} The model includes the most significant elements of Torn’s economy and should be referenced for Sections 3.3 and 3.4

\textsuperscript{19} Ruined City, as a lesser-developed game largely based upon Torn City’s design, did not have every element in this model. Elements which Torn City has but Ruined City did not have include: Stock Market Sales, and Stock Market Purchases.
Figure 3.2: Torn’s Faucet-Drain Mechanism
3.3: Gameplay and Economic Framework: Torn and Ruined City

Torn and Ruined City have very similar underlying gameplay mechanics and can be explained simultaneously. Both games are BIMMOGs, with all players interacting in a single VW shard. The games primarily use an HTML/PHP user interface, though Torn has some flash-based applications.²⁰ An in-game day is a full 24 hours real-time; you cannot fast forward, rewind, or pause. While certain activities may require a player’s attention at a specific time, and players must play actively to be competitive, gameplay can usually wait until the player decides to log on. For simplicity, this section’s context will only be in regard to Torn because it was much more developed than Ruined City.²¹

Players are allowed only one player account, whereby one account corresponds to only one avatar.²² Since there is no graphical representation of the avatar, the player effectively is the avatar, though the player’s anonymity is preserved. Owning multiple accounts, known as “multis,” is explicitly forbidden; multis could be used to acquire assets for a player’s primary avatar, which is deemed an unfair advantage. Players who

²⁰ Torn’s flash-based applications include Poker, Chess, Slots, Roulette, Craps, and numerous seasonal mini-games.
²¹ Note that Torn used to be known as “Torn City”, often abbreviated as “TC”. Many elements of Torn’s gameplay still include “City”, such as with the Torn City Stock Exchange or the Torn City Times (the VW’s “newspaper”).
²² This contrasts with World of Warcraft, where accounts can harbor more than one character and players are allowed to own more than one account (if they pay for multiple memberships).
own multis, when caught, will see their extra account(s) deleted and their primary account severely punished.\textsuperscript{23}

**Battle Stats, the Gym, and Happy**

An avatar’s Battle Stats (also simply known as “stats”) determine how well it performs during a fight with another avatar. Battle Stats are preserved over time with no degradation, and are not expended during combat. There are four Battle Stats: \textsuperscript{24}

- **Strength**: Increases damage dealt when striking another avatar.
- **Speed**: Increases the chance of successfully striking another avatar.
- **Defense**: Decreases damage taken when struck by another avatar.
- **Dexterity**: Decreases the chance of being struck by another avatar.

New avatars are born into the VW with 10 points in each stat. That avatar’s player can expend a limited store of Energy at the Gym to permanently increase their avatar’s Battle Stats. Superior Battle Stats are vital to many players as Torn is, at its core, a competitive game where avatars will often fight each other. Relatively high Battle Stats are often necessary to win fights, so players train their avatar’s Battle Stats in expectation of future conflict with other players.

\textsuperscript{23} Indication of multiple accounts can be easily determined if multiple accounts access the VW via the same IP Address. More advanced methods of detection, such as passive analysis of player activity and player-to-player interactions, can detect players savvy enough to avoid detection by IP address.  

\textsuperscript{24} Ruined City introduced a fifth battle stat, “Weapon Skill”, which supplemented combat prowess in general.
By visiting the Gym, a player may expend 5 of their avatar’s Energy points to train a Battle Stat once. In addition to a miniscule random element affecting stat gains, the following three factors determine how many points of a trained stat an avatar gains:

1) Avatars gain a linear bonus to stat gains dependent on how high their Happy, determined by the quality of the avatar’s virtual house, is.
2) The more of a stat an avatar has, the more they will gain by training that stat. My avatar on Torn saw the following sequential stat gains for Dexterity:
3) Avatars can use VC to purchase membership to better gyms, whereby increasingly better gyms confer an incrementally larger bonus to stat gains.

**Attacking, Hospitalization, and Morphine**

The primary use of Battle Stats is, of course, to do battle. Avatars can attack any other avatar at-will at a cost of 50 Energy; the outcome of the battle will be determined by both avatars’ Battle Stats, weapons, armor, and luck. If the attacking player succeeds, he can command his avatar to select from the following options:

1) Leave the defeated avatar: Hospitalizes the target avatar for a short length of time.
   
   “You leave Jeff lying on the ground and quickly run away.”

2) Mug the defeated avatar: Hospitalizes the target avatar for a short length of time. Transfers a small percentage of the target avatar’s on-hand VC to the attacking avatar.
3) Hospitalize the defeated avatar: Further harms the target avatar, hospitalizing them for a long amount of time.

Whenever an avatar is in the hospital, its actions are severely limited; it cannot train Battle Stats, roam the city, or partake in many other gameplay elements. Avatars do, however, have the ability to consume Morphine (if the avatar owns some) in order to reduce its stay in the hospital by 100 minutes. An avatar which is hospitalized for 360 minutes, for example, may consume four Morphine items to immediately leave the hospital.

**Energy**

Energy is a central aspect of Torn’s gameplay mechanic. Avatars can only store a maximum of 100 Energy at a time, which recharges at a rate of 5 points every 15 minutes (20 points per hour). A fully expended Energy bar will therefore refill to 100 in five hours, and any Energy beyond 100 which would have been conferred upon the avatar is wasted. Energy can be used for a variety of purposes including:

- Training Battle Stats at the Gym (5 Energy per train).
- Attacking other avatars (50 Energy per attack).
- Enrolling in Education (Varied Energy cost).
• Breaking other avatars out of Jail (5 Energy per attempt).
• Hunting animals overseas for VC (5 Energy per hunt).

The scarcity of Energy is one means by which major avatar actions are limited, an application of the Physicality attribute. The player must determine how to best utilize their avatar’s limited Energy. The more Energy an avatar uses to train its Battle Stats, the more powerful it will become. The more an avatar breaks other avatars out of Jail, the more criminally adept it will become, increasing the avatar’s potential income from committing crimes. The more an avatar hunts, the more efficient it will become as a hunter, which increases the avatar’s profit potential. Instead, perhaps it may be best to attack other avatars now rather than later. The decisions of energy allocation are left to the player. However, to use the maximum amount of Energy would require accessing Torn at least once every five hours, which would likely interrupt sleep, work, and social occasions; the player must also determine a suitable balance between real life and life in Torn.

**Crimes and Jail**

Crimes are Faucets by which players can receive virtual items and VC. Crimes are the primary means by which players expend their Nerve (explored in the next section).²⁵ From as minor as selling pirated music to as severe as kidnapping the Mayor or hacking the FBI, the magnitude of a crime’s reward is commensurate with the difficulty of

²⁵ At least 150,000 crimes are conducted on Torn every day.
performing the crime. The more crimes an avatar successfully commits, the more criminally adept it becomes, increasing the avatar’s crime success rate (though failing crimes will reduce an avatar’s criminal prowess). A selection of crimes which players can commit, their Nerve requirements, relative difficulty, and estimated payoff is exhibited by Table 3.1 below:

Table 3.1: Crime Difficulties and Rewards on Torn

<table>
<thead>
<tr>
<th>Crime</th>
<th>Nerve Cost</th>
<th>Relative Difficulty</th>
<th>Estimated Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sell Pirated Music</td>
<td>3</td>
<td>Very Easy</td>
<td>$7-$20</td>
</tr>
<tr>
<td>Larceny</td>
<td>6</td>
<td>Easy</td>
<td>$150-$300</td>
</tr>
<tr>
<td>Drug Trafficking</td>
<td>8</td>
<td>Moderate</td>
<td>$500-$900</td>
</tr>
<tr>
<td>Grand Theft Auto</td>
<td>12</td>
<td>Challenging</td>
<td>$5,500-$100,000</td>
</tr>
<tr>
<td>Bombing</td>
<td>17</td>
<td>Difficult</td>
<td>$100,000-$167,000</td>
</tr>
<tr>
<td>Hacking</td>
<td>18</td>
<td>Very Difficult</td>
<td>$200,000-$450,000</td>
</tr>
</tbody>
</table>

When an avatar fails a crime, it may be imprisoned in Jail where its abilities are heavily restricted; it cannot roam throughout the city or interact with other avatars.\(^{26}\) When imprisoned, an avatar must wait for its sentence to be served (typically 1-6 hours), for another avatar to bust them out of Jail, or for another avatar to pay bail for its release.

**Nerve**

Nerve, similar to Energy, is another central gameplay element by which major player actions are limited. Nerve regenerates at a rate of 1 point every five minutes. The maximum Nerve an avatar can store is variable, beginning at a limit of 5 for new avatars and increasing in increments of five as the avatar becomes more proficient as a

\(^{26}\) Imprisoned avatars are restricted to a mediocre Jail Gym. Battle Stat gains when using the Jail Gym are much lower than using a normal gym.
Nerve is critical for many players, despite only being used for the following two purposes:

- Committing a crime: Avatars expend Nerve to commit a crime (variable Nerve cost).
- Breaking out of Jail: Avatars expend Nerve to attempt to break out of Jail when imprisoned (costs half of an avatar’s maximum Nerve).

### Merits and Awards

Merits are a form of limited avatar capital which players can allocate to supplement their avatar’s abilities. For example, Merits can be spent to add a passive bonus to Battle Stats, increase the probability of scoring a critical hit, or to increase the avatar’s maximum Nerve. Each bonus category can be upgraded a maximum of 10 times, whereby the Nth upgrade costs N Merits (i.e. the 4th upgrade costs 4 merits, the 5th upgrade costs 5). Merits cannot be transferred between avatars. Table 3.2 below lists the upgrades to which players can allocate Merits:

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27 Up to 40 Nerve in Torn. Due to a hyper progression mechanic on Ruined City, maximum Nerve for an avatar was effectively limitless.
One Merit is always credited with an Award, which are generally credited upon achieving a gameplay milestone. There are hundreds of awards for players to achieve, a small selection is exhibited by Table 3.3.

**Table 3.2: Possible Merit Allocations on Torn**

<table>
<thead>
<tr>
<th>Upgrade</th>
<th>Bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brawn</td>
<td>Confers a passive bonus to Strength</td>
</tr>
<tr>
<td>Sharpness</td>
<td>Confers a passive bonus to Speed</td>
</tr>
<tr>
<td>Evasion</td>
<td>Confers a passive bonus to Dexterity</td>
</tr>
<tr>
<td>Protection</td>
<td>Confers a passive bonus to Defense</td>
</tr>
<tr>
<td>Nerve Bar</td>
<td>Increases maximum nerve by 1</td>
</tr>
<tr>
<td>Critical Hit Rate</td>
<td>Increases critical hit rate by 1% (linear)</td>
</tr>
<tr>
<td>Life Points</td>
<td>Confers a 5% passive bonus to hit points</td>
</tr>
<tr>
<td>Crime Points</td>
<td>Increases crime success rate by 3% (linear)</td>
</tr>
<tr>
<td>Education Length</td>
<td>Decreases education time requirement by 2%</td>
</tr>
<tr>
<td>Awareness</td>
<td>Increases ability to find items</td>
</tr>
<tr>
<td>Bank Interest</td>
<td>Increases bank interest by a small amount</td>
</tr>
<tr>
<td>Masterful Looting</td>
<td>Increases money gained by mugging</td>
</tr>
<tr>
<td>Stealth</td>
<td>Increases chance of anonymously attacking another avatar</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>Increases hospital time of hospitalized avatars by 10 minutes</td>
</tr>
<tr>
<td>[Weapon Category] Mastery</td>
<td>Increases damage and accuracy of a particular weapon category [11 to choose from]</td>
</tr>
</tbody>
</table>

**Table 3.3: Sample of Awards on Torn**

<table>
<thead>
<tr>
<th>Award</th>
<th>Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kill Streak</td>
<td>Win 10 Attacks without being defeated</td>
</tr>
<tr>
<td>Spray and Pray</td>
<td>Fire 2,500 bullets during fights</td>
</tr>
<tr>
<td>Blood Money</td>
<td>Mug another player for ₹1,000,000</td>
</tr>
<tr>
<td>The High Life</td>
<td>Own a Private Island with yacht</td>
</tr>
<tr>
<td>Instant Billionaire</td>
<td>Win the Casino Lottery</td>
</tr>
<tr>
<td>Jackpot</td>
<td>Win the Slot Machine jackpot</td>
</tr>
<tr>
<td>Spinner</td>
<td>Spin the Roulette wheel 1000 times</td>
</tr>
<tr>
<td>Discovery</td>
<td>Build a Dirty Bomb</td>
</tr>
<tr>
<td>Slow Bomb</td>
<td>Use a Dirty Bomb</td>
</tr>
<tr>
<td>Driving Elite</td>
<td>Reach racing class &quot;A&quot;</td>
</tr>
<tr>
<td>Silicon Valley</td>
<td>Code 100 viruses</td>
</tr>
<tr>
<td>Urban Camo</td>
<td>Win 50 attacks</td>
</tr>
<tr>
<td>Digital Camo</td>
<td>Win 1,000 attacks</td>
</tr>
<tr>
<td>Fire Starter</td>
<td>Commit Arson 5,000 times</td>
</tr>
<tr>
<td>Joy Rider</td>
<td>Commit Grand Theft Auto 5,000 times</td>
</tr>
<tr>
<td>Society's Worst</td>
<td>Commit crimes 10,000 times</td>
</tr>
</tbody>
</table>
**Donator Status and Points**

Torn is completely free to play. Players can, however, “donate” $5 USD to receive a consumable Donator Pack item. Using a Donator Pack confers upon the avatar 31 days of Donator Status and 50 Points. Donator Status is a premium attribute which increases an avatar’s maximum Energy bar from 100 to 150, and increases an avatar’s rate of Energy regeneration from 5 Energy per 15 minutes to 5 Energy per 10 minutes. Due to their ability to consume more Energy, avatars with Donator Status have an inherent edge over non-donators, and thus Donator Packs are traditionally necessary for competitive play. Donator Packs can be traded among players on the VC-denominated markets, so players can either purchase Donator Packs for $5 USD from Torn directly or buy from another player with Torn City Dollars through the secondary, in-game market.

The Point, bundled with Donator Packs, is a central item for competitive players. Points can be used for a variety of purposes, as exhibited by Table 3.4 below:

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### Table 3.4: Merit Allocation Options on Torn

<table>
<thead>
<tr>
<th>Consumption Option</th>
<th>Point Cost</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recharge Energy to 100%</td>
<td>25</td>
<td>Once per Day</td>
</tr>
<tr>
<td>Recharge Nerve to 100%</td>
<td>25</td>
<td>Once per Day</td>
</tr>
<tr>
<td>Replenish Casino Tokens to 100%</td>
<td>25</td>
<td>Once per Day</td>
</tr>
<tr>
<td>Purchase one Merit</td>
<td>250</td>
<td>Limited Lifetime Use</td>
</tr>
<tr>
<td>Reset Merit Allocation</td>
<td>Variable; increases with use</td>
<td>Indefinite</td>
</tr>
</tbody>
</table>

---

28 Note that Points were known as “Credits” on Ruined City.
Jobs, Companies, and Working Stats

A multitude of occupations are available to employ avatars. Though, once an avatar is accepted for a job, no additional input is required from the player and the avatar’s abilities are never restricted due to “working.” The introductory fields which avatars can work in are offered by the VW itself, and include the Army, Grocery Store, Casino, Hospital, Law Firm, and Education. Each field has multiple ranks to which avatars can be promoted. For example, in the Medical field avatars can progress from Medical Student to Houseman, Senior Houseman, General Practitioner, Consultant, Surgeon, and finally Brain Surgeon. As avatars progress through these ranks (whereby progression is determined by the avatar’s Working Stats), their pay and benefits increase. Additional job specials become available as avatars rank up, such as stealing morphine in the medical field, which are received by expending Job Points. To tie these concepts together, the following table displays the Income, Working Stats Requirements, and Job Specials by Rank in the Medical field:

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29 Indeed, the avatar could work as a shelf stocker at the Grocery Store, visit Mexico for a month, and get paid every day. One could keep their avatar in Switzerland for three years, cease logging in, and return to three years’ worth of income.

30 In addition to the VW-offered jobs, entrepreneurial players are able to run their own companies and employ other avatars. Each company has its own start-up costs, employee working stat requirements, profit potential, and job specials.
Factions and Faction Capital

For competitive players who want to band together, there are Factions. Factions are official groups of players, up to 100 per Faction, with at-will membership. Factions often battled each other for dominance and power; Torn has a rich history of factional power struggles and shifting hegemony. On Torn, there are 3450 factions. Each faction has a statistic known as Respect; new factions start with 250 respect Points. Respect can be increased through three means:

- **Organized Crime**: Groups of faction members can complete organized crimes. If successful, the faction gains some respect points and VC.
- **Company Specials**: The Television Network company has the “Propaganda” job special, which allows employees to exchange 5 Job Points for 1 respect.
- **Faction Warfare**: During war, faction members can take respect from an enemy faction to add to their own by attacking another faction’s members.

---

31 Ruined City’s equivalent of Factions were called Forces.
32 Torn’s Faction history seems to mirror international conflict in real life, with constant wars in the past until power centralized to a few, and now there exists a significantly powerful Faction which enjoys power hegemony similar to the United States.
Factions can lose respect as well, and are destroyed when faction respect reaches zero. Upon destruction, all faction assets such as VC and items are permanently deleted as well.\(^{34}\) Faction respect can be lost through the following means:

- **Faction Warfare:** During war, if a faction member is attacked by an opposing Faction, that avatar’s faction will lose respect.

- **Dirty Bombs:** An extremely rare and expensive item, the Dirty Bomb will remove more than 10,000 respect from the target faction and hospitalize each member. Total respect loss is variable, though it is known that factions with higher respect will lose more.\(^{35}\) Respect is not transferred by a Dirty Bomb, but destroyed.

- **Company Specials:** The Fireworks Stand company has the “Pyromania” job special, which allows employees to exchange 150 Job Points to reduce a target faction’s respect by 10 Points (respect is not transferred, but destroyed).

Respect which a faction has accumulated and retained can be spent on faction specials which supplement the activities of the faction’s members. A select list of faction specials are as follows:

- **Steadfast:** Increases Battle Stat gains in the Gym for faction members.

- **Gallant:** Increases Nerve of faction members.

- **Enormity:** Increases Crime success rate of faction members.

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\(^{34}\) This is a form as the Waste function of the Drain mechanic.

\(^{35}\) Respect have ranged from about 10,000 up to 45,000. Another likely factor of respect loss is the number of members in the faction.
• Chaining: Increases the maximum interval between attacks during a faction chain (covered in the next section).

• Cumber: Increases maximum item capacity during travel for faction members.

• Pertinent: Decreases the Energy cost of breaking other avatars out of Jail.

• Adept: Decreases the longevity of Education courses.

• Hermetic: Reduces the addiction effect of drug usage.

**Faction Wars**

Factions are able to declare war against other factions, often with the goal of increasing respect but sometimes for the purpose of exerting dominance. When an avatar hospitalizes an avatar of an opposing faction, some respect is transferred from the target avatar’s faction to the attacking avatar’s faction. Recall that factions are destroyed once their respect reaches zero; wars can become a struggle for survival, and thousands of factions have been destroyed throughout Torn’s history. A faction’s war effort may involve extensive infrastructural and logistical supplements, however the most central aspect of faction war is the Chain. A chain is a series of attacks from one faction to another without more than a 300 second delay between one attack and another. As the quantity of attacks in a single chain grows, the quantity of respect transferred for each

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36 The fragility of factions has been mitigated in recent years, and has been a controversial issue. While factions are now much harder to destroy, this change has eroded the gameplay mechanic of war.
subsequent attack increases; keeping a chain “alive” is often critical for a war effort, and chains spanning multiple days have been known to occur.

**Drugs and Addiction**

Players can instruct their avatars to take drugs, which supplement avatar abilities. A sample of drugs that avatars can consume and their effects are exhibited by Table 3.6:

| Table 3.6: Drug Selection and Effects on Torn |
|-----------------|------|-----|-----|-----------------|
| Drug            | Energy gain | Nerve gain | Happy gain | Other Effects               |
| Cannabis        | -            | 1-2         | -           | Temporarily increases crime success rate |
| Ecstasy         | -            | -           | Doubles current Happy | - |
| LSD             | 50           | 5           | 25-50       | - |
| Opium           | -            | -           | 90-100      | Revives avatar if hospitalized |
| PCP             | -            | -           | 250         | Increases effectiveness of Strength and Dexterity |
| Vicodin         | -            | -           | 75          | Reduces attack cost from 50 to 25 Energy |
| Xanax           | 250          | -           | 75          | - |

As avatars consume more drugs, they become increasingly addicted. As addiction increases, the effectiveness of Battle Stats decreases. When extremely addicted, the avatar will be barred from training at the Gym. To cure addiction, avatars must travel to Switzerland to undergo rehab, which can become very expensive. Even so, the effectiveness of Battle Stats will always be reduced by some indeterminate percentage, and the cost to use rehab becomes progressively more expensive as an avatar continually uses it.
3.4: Case: Hyperinflation in Ruined City

Ruined City was a BIMMOG with only about 200 active players at peak. It was developed on the popular MCCode engine, a license for which could be purchased for a few hundred dollars. This VW ran on a rented, shared server costing $5 per month, and was developed and operated by two teenagers. By most measures Ruined City was an insignificant venture, however, its plunge into hyperinflation can serve as testament to the detrimental effect of an imbalanced Faucet-Drain mechanic.

**Hyperinflation of Ruined City’s Virtual Currency**

One of Ruined City’s central gameplay mechanics was based on introducing progressively more expensive properties and more difficult, more profitable crimes in order to afford them. Superior residences were critical for competitive players; better houses provided higher Happy and, thus, better stat gains.

Repeatedly adding more profitable crimes for avatars to afford new properties in a Faucet-Drain system inevitably led to rapid expansion of the monetary base; while players needed to commit more profitable crimes in order to afford more expensive houses, players would accumulate excess VC once the one-time housing expenses were

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37 Visit [www.mccodes.com](http://www.mccodes.com) to investigate this service; the Products page offers a free version of MCCodes 1.1.0c as well as two variants of MCCodes v2.
38 For example, the best residence a player could initially purchase was a Palace, which is attainable once the avatar earned enough cash from difficult crimes. Eventually players were able to purchase countries, continents, a “space base”, and other ridiculous (and ridiculously expensive) residences.
incurred. As individual avatars became flush with VC, they were able to spend more on virtual items. In the markets for critical goods, such as Points, competition rapidly raises the price level as per the First Model of Price Inflation. On Ruined City, Points were once competitively priced at about 10,000 Ruined City Dollars (denoted as RCD or R). As inflation took hold, the RCD-denominated price of Points rose to $2,147,483,647 (2^{31}-1), the maximum value able to be stored by the int (integer) fieldtype in Ruined City’s database. This was a significant problem because any RCD above $2,147,483,647 would be lost in a market exchange, effectively acting as a punishing price ceiling. In order to circumvent this limitation, the database fieldtype was switched to bigint, which can store numbers up to 9,223,372,036,854,775,807 (2^{63}-1). Continuing the progressive introduction of more expensive properties and more profitable crimes, the equilibrium price of Points exceeded the implicit price ceiling of $9,223,372,036,854,775,807—an astonishing inflation rate of 429,496,729,700% over the course of less than a year.

3.5: Case: Inflation in Torn

Torn is one of the most populated BIMMOGs with 25,000 active players, approximately 14,000 of which maintain Donator Status for their avatars. Torn has operated for more than eight years, has made its primary owner a millionaire, and continues to thrive (Vlad 2009). Torn’s 2012 revenue exceeded $700,000, indicating that Torn is a game many players are willing to pay for.
Despite Torn’s success and survivability, its past was rife with economic missteps which have burdened its synthetic economy, hindered gameplay, and ultimately reduced Torn’s profitability. Residual effects likely cost Torn at least 10% of potential revenue for the 2012 year, which recent efforts may have mitigated (explored in Chapter Four).

As with Ruined City, Torn experienced significant inflation due to an unbalanced Faucet-Drain mechanism. Thankfully, Torn’s gameplay model did not exactly mimic that of Ruined City, and the magnitude of Torn’s inflation was much lower. Rather, there was always a low, manageable level of inherent inflation which was then compounded by a significant Faucet misstep. Targeted data collection began in January 2012, and so relevant historical data preceding 2012 is not available. Figure 3.4 exhibits the changes in Torn’s monetary base since January 2012.

![Figure 3.3: Monetary Base of Torn City Dollars](image)

7 Day Moving Average. M0 includes held in wallets, banks, factions, companies, active trades, racing bets, vaults, and the offshore bank. Does not include illiquid cash holdings.

Increases in the monetary base, all else held constant, will inevitably lead to price inflation as exemplified by the First Model of Price Inflation in Chapter 2. My first-hand experience playing Torn since 2006 affirms that price levels have risen significantly,
despite some items undergoing Trivialization. The price of Morphine, for example, has increased significantly despite its supply expanding radically. Absent inflation, the increased availability of Morphine would correlate with lower prices; the contradiction of Morphine being more available and nominally more expensive supports the claim that significant inflation occurred between 2006 and 2013.

**Normal Expansion of the Money Supply**

Torn, operating with a Faucet-Drain mechanism, has always had a systematic inflation rate. The VC generated by the Faucet, predominantly via crimes, consistently exceeded the quantity of VC destroyed by the Drain. The effect over time was an ever-increasing monetary base. Torn’s systematic inflation rate was manageable however; if Torn always had an inflation rate similar to 2012’s inflation rate (18%), and began with a monetary base of 500 billion (a generous assumption), it would have taken 21 years for the money supply to reach the 2013 monetary base of ₩23 Trillion. The definitive turning point of Torn’s manageable price inflation was the introduction of the Torn City Stock Exchange.

**Faucet Widening: Significant Expansion of the Money Supply**

The Torn City Stock Exchange (TCSE) gave players the ability to buy shares of various “companies” owned by the VW itself. A player may buy shares of Wind Lines Travel
(WLT) for example, the VW-owned company which charters jets in and out of the city.\textsuperscript{39} In addition to potential profit from selling shares at a higher price than they purchased it for, players benefit from stocks by forms of compensation such as dividends, item grants, and other specials. Holders of at least nine million WLT shares, for example, get access to a private jet which allows the avatar to travel overseas faster than with a normal plane.

An oddity of the TCSE is that the share prices listed by the VW do not represent a competitive valuation as determined by the players participating in the market; share prices are somewhat arbitrarily set by the VW.\textsuperscript{40} Rather than trade through the TCSE, players would more often directly trade with each other. If the player-competitive price of a stock was higher than the TCSE offer price, players would purchase all of the TCSE’s shares and sell the shares to other players at a higher price. If the player-competitive price was lower than the TCSE offer price, then players would trade with each other at a lower price while many of the TCSE’s shares would remain on the market.

\textsuperscript{39} Players are able to fly from Torn City to countries like Mexico, Canada, China, and Japan to buy exotic items, avoid being attacked by other players, to hunt animals in South Africa (to earn money), or to supplement their account by other various means.

\textsuperscript{40} Price movements are not entirely arbitrary. For example, the share price of the airport is influenced by how many flights are chartered, but the TCSE-listed price often does not reflect its true value.
Sub-case: Crude & Co. Stock Bubble

One company on the TCSE, Crude & Co., experienced an extreme increase in the price listed by the VW over a few days. Despite the VW projecting a high price to the players, the benefit players received from C&C was constant. Further, while the TCSE does purchase stock back from players, the process is not instantaneous. Theoretically, avatars would be able to earn a substantial profit if the VW would buy stock back at the inflated price, but the expectation (and reality) was that the price would quickly crash again. At the peak of C&C’s price bubble, players were selling shares to each other at 3% of the TCSE offer price.

Rather than efficiently trading on a central platform, players instead advertise their bid and ask prices in the public forums; the sole fact that the TCSE doesn’t operate like a real stock market isn’t a major problem. The problematic factor is that the TCSE itself would buy shares from and sell shares to avatars without any regard to price and without any budgetary restrictions over time. The certainty that the TCSE would buy shares from avatars was exploited; players would simply buy shares when the offer was low and sell shares back when the offer was high. The TCSE quickly became the largest VC Faucet in the game. In addition, by design, companies on the TCSE cannot go bankrupt, so there is little risk of ruin. This exploit is what ultimately increased the rate of VC Faucet flow, expanded the monetary base and, hence, caused a high rate of inflation.

41 Holding 5,000,000 C&C shares lets players open their own oil rig at a discounted rate and boosts profit when operating an oil rig.
42 In Torn today, a daily budget constraint has now been placed on how much the TCSE can purchase in order to limit the rate of inflation.
43 Though, theoretically, a stock’s price could drop significantly and stabilize on the long term, potentially causing a loss to investors.
**Torn Case History: Price Inflation**

As it happened, Torn’s monetary base continued to expand due to the structure of the TCSE, which rapidly inflated prices. Of particular interest was the Points Market because it is an extremely liquid market which quickly corrects for equilibrium shifts, as occurs with inflation. The Points Market at this time followed the First Model of Markets, which means it was subject to the First Model of Price Inflation. This means that the price of Points increased significantly due to the sharp increases in the monetary base.

**Response to Inflation**

In response to the Point Market’s rapidly rising prices, and undoubtedly in response to player backlash in the public forums, a price ceiling of ¥50,000 was established. As the equilibrium price was above ¥50,000, the price ceiling inevitably led to a shortage of Points; few players were willing to sell at ¥50,000, but many were willing to buy at ¥50,000.

The effect of a general price ceiling under the First Model of Price Inflation is illustrated by Figure 3.5. Note that as inflation occurs, the magnitude of the shortage (determined by the difference between the appropriate $Q^S$ and $Q^D$) continually increases.

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44 A potential compounding factor, which unfortunately cannot be ascertained due to a lack of data, was market manipulation by wealthy players. It is surmised that ultra-rich players (those who were likely manipulating the TCSE) intentionally drove up prices in the Points Market. While this factor would compound natural increases in Point prices, the theory behind the proposed model still holds and is likely the most significant factor of price inflation over the long term.

45 This statement holds true, except for players who used Points exclusively as a store of value.
The magnitude of the Point Market shortage rose as inflation continually took hold due to the TCSE’s unprecedented expansion of the monetary base. The magnitude of this shortage quickly led to discontent among players with a desire to use Points, which led Torn to implement an update which radically altered the Points Market and, indirectly, its revenue stream.

**Introduction and Effect of VW Point Supply Intervention**

In response to player unrest, Torn began to sell bundles of 5000 Points on the Points Market at the ₩50,000 price ceiling. Thus the behavior of the Points Market shifted to the Second Model of Markets and became subject to the Second Model of Price Inflation. Since Points were then infinitely available at a constant price, over time the real value players had to exchange for Points continually decreased as price inflation continued to occur. Effectively, Points underwent limited Trivialization. However, prior to this
implement the primary means by which players could create Points was by donating, so it is possible that the players, in aggregate, benefitted from this update.

**Subcase: Infinite Availability of Stat Enhancers at ₪450,000,000**

Another market subject to VW supply intervention is the market for Stat Enhancers (which does not have a dedicated trading platform like the Points Market). Stat Enhancers can be purchased from Torn’s VW indefinitely for ₪450,000,000. However, the equilibrium prices for Stat Enhancers are between ₪250,000,000 and ₪360,000,000, rendering the VW’s supply irrelevant for the time being.

While the players may or may not have benefitted from partial Point Trivialization, it almost certainly reduced Torn’s revenue stream. Recall that a Donator Pack credits the redeemer with 31 days of Donator Status and 50 Points; these are the two components of value which players receive by donating. Recently, the competitive price of a Donator Pack was approximately ₪17,000,000; effectively, this would mean 31 days of Donator Status is competitively worth ₪14,500,000, since 50 points can only be exchanged for ₪2,500,000. The competitive price for Points absent VW supply intervention was unknown however, since the normal equilibrium price would be above ₪50,000 per point.

**Removal of VW Point Supply Intervention**

Eventually, the unlimited supply of Points from the VW was removed, but lasting damage had been done; the supply of points undoubtedly increased significantly. A primary culprit of the expansion was likely due to players using points as a secure store of value. Players tend to avoid keeping large sums of TCD on-hand since other players could steal that money by attacking and mugging them. There are very few methods to
safely store large sums of TCD while maintaining liquidity. Points are one of Torn’s most liquid assets however, so players, myself included, would buy mass quantities of points from the VW, knowing we could sell them to other players at a negligible loss.

**Overview of Revenue Effects**

Unfortunately for Torn, the price ceiling and subsequent infinitization of the Point supply certainly impacted the demand for Donator Packs. Most directly, Torn allowed players to exchange 100 Points for 31 days of Donator status. At ₪50,000 per point, this means a player could avoid paying $5 USD for a Donator Pack. This also establishes an implicit price ceiling of ₪7,500,000 on Donator Packs in game. The implication of these concurrent factors—a price ceiling on the Points market, an infinite supply of Points at the price ceiling, and the ability to exchange 100 Points for Donator Status—is to discourage players from actually donating $5 to Torn.

**Subcase: Removal of In-Game Donator Status Sources**

Another misstep of Torn was announcing the planned removal of the ability to exchange 100 Points for 31 days of Donator Status. Many players, myself included, responded by exchanging thousands of Points for years of Donator Status, further diminishing Torn’s source of profit. As announced, the ability to exchange Points for Donator Status was removed, but the damage had been done. The infinite supply of Points and price ceiling remained for years, however.
3.6: Case: Attempted Correction

Up to this point, Torn had been operating without significant informed consideration for its synthetic economy. In late 2011, Torn and I began to coordinate; in exchange for analyzing Torn’s economic system and helping establish an understanding of its inner workings, I was given access to market data such as the money supply, virtual good supplies, and most player-to-player exchange data. Money supply data is recorded daily, while exchange data is recorded instantaneously. Data collection began in January 2012. Additionally, individualized revenue data as far back as December 2010 was made available to me by request.

In addition to observing market activity, I was given the wherewithal to propose alterations to Torn’s synthetic economy if I had the proper justification. The first change I sought to implement was to raise the Points Market price ceiling.

**Raising the Points Market Price Ceiling**

The theoretical support for raising the Points Market price ceiling was that doing so would increase the value of a Donator Pack (DP); allowing Points to be traded at a higher price was expected to increase the price of DPs (recall that Points are a component of DPs). Since some players purchase DPs from Torn specifically to sell to others for TCD, they have a greater incentive to do so when the TCD price is higher; on the margin, a player is more likely to donate $5 if they will receive ₪18,000,000 compared to
Additional support for raising the price ceiling was to eliminate the shortage. The price ceiling made it exceedingly difficult for many players to acquire Points, even if they were willing to purchase at a price higher than ₪50,000.

Rather than remove the price ceiling, I decided it would be best to merely raise the ceiling to a point well above the expected equilibrium price. Maintaining a price ceiling close to but above the equilibrium price has the advantage of dissuading market price manipulation by limiting profit potential. Also, I believe keeping a price ceiling helped to quickly re-stabilize the market since the potential magnitude of speculation was limited.

Based on secondary market data, I estimated the equilibrium price of points to be ₪65,000±₪15,000. Thus, a price ceiling of ₪100,000 was deemed appropriate to implement: high enough to enable free trade, but low enough to dissuade manipulation and limit speculation.

As exhibited by Figure 3.6, the immediate effect of the new price ceiling (implemented on June 15th 2012) was a sharp rise in the price of Points, followed by a crash and subsequent stability at approximately ₪70,000. This stability may have been artificial however, an example of sticky prices, as the price drop to ₪60,000 in early September was without any discernible impulse. It would seem Point prices are now “stuck” at

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46 While the expected effect was accurate on the margin, the logic was not sound. A more rigorous analysis of targeting prices is reviewed in section 4.3.

47 The secondary market is the Trading Post forum, where players can advertise items they want to sell or buy. This is an inefficient trade channel, though it is commonly used. Points could be traded at prices higher than ₪50,000 through factions: buyer and seller would need to be in the same faction at the time, and whoever joins the faction would need to leave their own (if they are a member) and will be stuck in that faction for 7 days (since players cannot leave or be kicked from a faction for 7 days).
The price remains stable as of May 2013, indicating that T$60,000 is close to the true equilibrium price.

![Figure 3.5: Price Effect of Raising the Point Market Price Ceiling](image)

Against my expectation, DP prices stabilized at approximately the same price as before the price ceiling being raised. This is exhibited by Figure 3.7 below.

![Figure 3.6: Price Effect of Raising the Point Market Price Ceiling on Donator Packs](image)
Lack of Expected Revenue Increase

While I expected raising the Points Market price ceiling would have marginally increased revenue on the long term, such an effect was not realized.\textsuperscript{48} Despite the competitive Point price stabilizing ₩10,000 higher than before the update, the stable price of Donator Packs remained the same. The lack of revenue increase may be indicative that the equilibrium price of Points was already accounted for in Donator Pack prices. The raising of the price ceiling did nothing to alter the value of Points, so if the true value of Points was already reflected in the Donator Pack market, then it is not surprising that DP prices and, hence, long-term revenue did not increase.\textsuperscript{49}

\textsuperscript{48} While June’s revenue was higher than previous months, the revenue of subsequent months were among the lowest; overall, the average revenue of June through August roughly equaled the average of all months prior.

\textsuperscript{49} While Points could only be traded at ₩50,000 on the Points Market, Point trade through Factions was possible. In addition, players (myself included) would enter agreements with other players to trade points on the Points Market and, additionally, send VC to achieve a more agreeable price; the market for Points, in spite of the price ceiling, may have been closer to equilibrium than the Points Market data suggests.
Chapter 4: Implications for Experiments, Game Design, Monetization, and Revenue Maximization

This chapter focuses on the application of Synthetic Economics to the video game industry by setting a framework for sustainable multiplayer game design. Specifically, I am interested in elements which pertain to or affect the synthetic economy rather than the entirety of game design itself, though many gameplay features affect the synthetic economy in some way. I will also lay out VW monetization approaches and my theoretical approach to revenue maximization, which is supported by a final case which puts the theory into practice.

First however, I will explore the use of BIMMOGs as the most feasible VW format for conducting social science experiments. This section is inspired by Castronova’s unsuccessful release of Arden, a 3D MMOG, which was developed for economic experimentation. Where Castronova’s Arden failed, BIMMOGs are poised to succeed.

4.1: Implications for Experimentation

The emergence of MMOGs has presented a flexible tool for conducting social science experiments, an observation first made by Castronova (Castronova, et al. 2009). He made the first significant attempt to develop an MMOG as a research tool, which he called Arden, which was released in November 2007 according to Terra Nova, Castronova’s
blog. Arden unfortunately failed on many accounts, and was shut down in 2008. “Arden II: London’s Burning,” the supposed successor to Arden, was mentioned on Terra Nova, but the project appears to have been abandoned (Castronova 2008). Reflecting on Arden’s failure, Castronova hinted at BIMMOGs as a superior solution by referencing the “HTML-driven online game” Tribal Wars as a more suitable development platform for small-scale VW productions (Baker 2008).

Castronova reported the demise of Arden to Wired Magazine in 2008, citing some tips for VW developers in light of Arden’s failure. At the core of Arden’s problems was having been built as a modification of the 3D MMOG Neverwinter Nights, a development platform which required expertise and time which Castronova’s team did not have. Castronova cited staffing requirements as an obstacle for small projects; his development team consisted of graduate students who periodically needed to focus on exams rather than the game’s development and maintenance. Castronova also cited the importance of aligning the VW’s design to the target audience, stating “We put Arden in front of Shakespeare experts and they loved it. We put it in front of play testers and they yawned. […] Too much reading, not enough fighting” (Baker 2008). This section will amplify Castronova’s findings on VW design, focusing on BIMMOGs as a superior platform for experiment-purposed VW development.

**Development Costs**

The most distinct benefit to utilizing a BIMMOG engine for experiment-purposed VWs is the relatively lower cost of development. Arden was funded by a $250,000 grant;
significantly cheaper than developing a 3D MMOG from scratch, but still a substantial sum dedicated to develop an experimentation platform (Baker 2008). High development costs are only the norm if one adheres to the paradigm that VWs are inherently 3D, since 3D MMOGs necessitate more advanced VW engines, more technically adept developers, and more development time. My proposed alternative is the BIMMOG model, for which a suitable engine costs less than $200 to purchase, less than $200 per year to host online, and requires much less technical knowledge to develop than 3D MMOGs do.\(^{50}\)

Ruined City was built upon a variant of MCCode version 1, a baseline BIMMOG source code found at mccodes.com, and was primarily developed by a 14 year-old. Later, as a 16 year-old, I had involvement with Ruined City’s development and operation as well. Additionally I founded, developed, and maintained Broken Ground, a BIMMOG based on the MCCode 2.0 engine.\(^{51}\) While Ruined City and Broken Ground were small-scale multiplayer games, hundreds of people actively played them for more than a year. Many players paid for Donator Packs, similarly to Torn’s model; both games earned revenue far exceeding their operating costs.

The success of Ruined City and Broken Ground, albeit on a small scale, exemplifies that even teenagers with minimal programming experience and devoid of any formal economic knowledge can successfully develop games on the BIMMOG model. Development costs are low, which is how teenagers were able to afford the venture.

\(^{50}\) It could actually be free to develop a VW using MCCode’s free BIMMOG engine in conjunction with free web hosting.

\(^{51}\) Broken Ground is not discussed at-length since its economic system was mostly balanced, and limited data is available.
Technical expertise requirements are low, which is how teenagers were able to independently develop the games. Maintenance requirements are manageable, which is how teenagers were able to operate the games. If two teenagers can fund, develop, and operate profitable BIMMOGs for a prolonged period, economists with a budget and access to experienced developers can as well.

**Ease of Access**

Another advantage of BIMMOGs, which may have helped Ruined City and Broken Ground establish their player bases, is the ease with which players can access the VW. 3D MMOGs tend to require gaming computers and the use of a keyboard and mouse, while BIMMOGs require only an internet-connected device with an internet browser; smartphones as well as budget computers are powerful enough to access a BIMMOG. 52

Another aspect of the BIMMOG platform’s heightened accessibility is the lower level of computer aptitude required of experiment participants. It is easier to train participants to interact with a BIMMOG rather than a 3D MMOG; many people have used internet browsers, but far fewer have controlled an avatar in a simulated 3D world, so BIMMOGs allow participants to use a familiar format. A BIMMOG’s accessibility ultimately allows scientists to draw a sample from a wider range of participants.

52 In terms of cost, a computer meeting the recommended hardware requirements for the 3D MMOG World of Warcraft would cost at least $800; a computer capable of running a BIMMOG would cost about $400 new, though most used computers will suffice. For the purpose of experimentation, the computers which universities will already own are sufficient to run BIMMOGs. Large screens and quality keyboards and mice may be *desirable* for a BIMMOG, they are not *required*. 
**Using the BIMMOG Platform**

The coupling of low-cost, low-tech development and superior accessibility has positioned BIMMOGs as an experiment platform superior to 3D MMOGs. Large-sample experiments which span months now become more viable since participants can access the VW remotely. Due to low development costs, more funding may be available to incentivize a larger quantity of participants, or to compensate participants more greatly, which may be critical for experiments which span long time periods. On the whole, BIMMOGs are more suitable than 3D MMOGs for constructing social science experiments.

**4.2: Implications for Multiplayer Game Design**

Evidenced by the economic missteps exhibited by Ruined City and Torn, it is clear that game design informed by the fundamentals of Synthetic Economics is critical for sustainability and profitability. Engaging gameplay designed by a creative development team is vital to attract and maintain players, but a rich and balanced economic system must supplement it. Development of core gameplay and the specific implementation of this section’s concepts are left to the developers; this section focuses on the design of synthetic economies as a critical and fundamental gameplay element for MMOGs.
Inducing Scarcity and Faucet-Drain Mechanics

In a VW anything that can exist may exist if the developers create it, and anything that does exist may exist in infinite quantity if the developers allow it. A complete lack of scarcity does not provide sustainable entertainment for players however; the inducement of scarcity is a fundamental element of synthetic economies which must be explicitly considered (Castronova 2001). The preservation of scarcity through time, necessitating a balanced Faucet-Drain model, must be carefully considered as well.

A closed Faucet-Drain mechanism, where the Faucet is regulated by the Drain, is possible to implement for VC, and may be preferable to an open system since it provides a greater measure of monetary base control and balance. In such a closed system, the VW must reward players with items rather than VC, forcing the players to trade with others. In addition, data analysis should become easier when constant adjustment for inflating price levels is unnecessary. The supply of currency can be expanded and contracted as appropriate by instructing the VW buy items from or sell items to players, much like the Federal Reserve buys and sells securities through open market operations to control the supply of US Dollars (Castronova, et al. 2009b).

If, instead, a VC system based on the open Faucet-Drain model is preferable to implement, care should be taken to ensure only a low rate of monetary base expansion takes place to avoid excessive price inflation over time. Extreme inflation rates, as exhibited by the Ruined City case history, can create adverse market conditions which hamper the player experience.
For virtual items, an open Faucet-Drain model seems to be the only feasible economic mechanism; a closed system where item generation is governed by item destruction would be overly complicated to implement. Using an open Faucet-Drain model may subject items to Trivialization over time however, so effort should be made to ensure the inflow of the faucet does not exceed the outflow of the drain for a prolonged period.

**Avatar Capital Development**

The ability for players to acquire avatar capital is critical as a central gameplay element; if the players’ avatars’ abilities do not improve over time, players will be less able to justify their investment of time into the game. However, the extent to which avatar capital can be developed should be managed, particularly for games where avatars can fight any other avatar. Allowing avatar capital for older avatars to accumulate to the extent which new avatars cannot feasibly match over time could dissuade players from joining a VW they might otherwise enjoy.53

**Swift Abuse Corrections and Economic Monitoring**

Despite rigorous testing of gameplay features, crafty players will likely find ways to reap significant rewards for utilizing gameplay elements in unforeseen fashions. Such abuse may entail players artificially boosting their avatar’s inherent abilities, generation or duplication of items, and generation or duplication of VC; just like developers, the

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53 This mechanic may have influence on Torn; Battle Stat gains are time-linear or time-exponential
players can control any aspect of the VW if they discover a method to exploit the VW infrastructure to act outside of the intended boundaries imposed by developers. While it may be possible to reprimand players who abuse such exploits, their activities may have significant impact on the synthetic markets which cannot be easily reversed.\footnote{For example, if a player were to have access to infinite VC, and purchased many items from other players, reversing the transactions may be difficult to reverse, and honest players involved in the transactions may end up worse off if the transactions are reversed.}

**Sub-case: Item Duplication on Runescape**

In 2003 a player on Runescape discovered a method to duplicate items, and proceeded to duplicate Purple Party Hats, one of the most expensive items in the game (due to extreme rarity) and the most expensive of six differently-colored Party Hats. The result of his duplication was a sharp decrease in the price of Purple Party Hats, and it remains the cheapest of the Party Hats to this day.\footnote{http://runescape.wikia.com/wiki/Partyhat_duplication_glitch}

Due to the likelihood that players will, eventually, discover methods to bypass the boundaries of VW infrastructure, it is critical to determine what constitutes normal economic activity in order to identify abnormal, exploitative economic activity as soon as possible in order to swiftly pursue a resolution. Some automated processes would be suitable for this purpose, such as checking for abnormal growth in the money supply, supply of items, player activity, and other critical elements of gameplay.\footnote{A system on Torn automatically banned any player who held more than $1,000,000,000 on their avatars account; one such player legitimately acquired the currency and was banned, though the sentence was reversed.} Such systems may have come in handy for Torn in the past; there have been instances of exploits by players in each category.\footnote{Players abusing battle stats}
Sub-Case: Exploitative Energy Abuse on Torn

During a faction war between the two strongest factions of their time, one side had some members who discovered a method to use unlimited energy, and used that energy to significantly boost their Battle Stats. In response, the opposing faction was forced to expend a significant stock of assets to legitimately boost their Battle Stats. While the abusing players were banned from the game, the members of the other faction had permanently expended their assets when they otherwise may not have.

Disincentivizing Cheating

In addition to explicit abuse of the VW system, players may be able to gain an unfair advantage over other players without transcending the VW’s limitations. Instead, players may be able to supplement their play by developing computer programs which play more optimally than most humans. On Torn, for example, a player may be able to develop a program capable of autonomously logging into the player’s avatar, visiting the gym, and training the avatar’s Battle Stats. Such a program could be used while the player sleeps, works, or socializes, bestowing an advantage over other players.58

The typical approach to combat cheating is to make it more difficult to cheat. “Captchas”, a method of verification whereby the player must translate the contents of an image into text, are common implements. While captchas do make it difficult for cheaters to develop automated programs, captchas hamper gameplay and immersion by forcing legitimate

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58 An extreme example of programs being used for an unfair advantage is “aimbots” in first-person shooter multiplayer games, where players compete by shooting each other on a battlefield. The aimbot automatically and flawlessly aims the player’s weapon, which bestows a significant and unfair advantage to the user of such an aimbot.
players to solve them as well. Moreover, captchas can be bypassed by skilled programmers capable of reading in-image text.

An example of developing programs to bypass captchas comes from Final Earth, a BIMMOG where players join either the Axis or Allies and vie for global domination. Similarly to Torn, avatars on Final Earth became more powerful by training their stats. Unlike Torn, avatars on Final Earth were not restricted by Energy but by time; players were only able to train one stat at a time, and each stat train came with a semi-random cooldown timer. Only once the cooldown timer reached zero could players select another stat to train. Unfortunately the most effective stat to train only came with a cooldown timer of approximately 120 second, which means, to play optimally, players had to continually train that stat, clicking the train link each time.

In order to automatically train a player’s avatar, programs known as “autotrainers”, were developed by both sides. The advantage of using an autotrainer was significant, and despite the threat of being caught and banned by administrators, both the Axis and Allies developed some autotraining capability in fear of being at a disadvantage.\textsuperscript{59} While Final Earth routinely forced players to solve a graphical captcha, both sides developed autotrainers capable of bypassing the captcha with sufficient accuracy.\textsuperscript{60}

\textsuperscript{59} I was a member of Axis’ command group. Axis had a distinct record of defeating the Allies strategically and tactically, without the need to cheat. Regardless, we did develop autotraining capability in the event that the magnitude of our strategic and tactical advantages were lessened.

\textsuperscript{60} This is an example of how players and groups of players compete in the meta-game. While the Axis and Allies fought within the VW, they also fight outside of the VW by developing means to supplement and streamline the war effort, and sometimes violated the VW’s rules in order to gain an advantage.
As a player, I had proposed a solution to the autotrainer problem which was later implemented. Rather than forcing players to routinely click the “train” link, a queue system was implemented whereby the player could assign up to four additional trainings for the avatar to complete sequentially. This system significantly reduced the advantage of using an autotrainer, decreasing the occurrence of their use.

On the BIMMOG “Tribal Wars,” another method to dissuade players from cheating is used. Tribal Wars is an extremely competitive game; players must seemingly play 24 hours per day in order to compete long term. The competitiveness would normally persuade players to develop programs to automatically play. Tribal Wars has an “account sitting” feature however, which lets players assign other players to control their account for a short period. A player in the US, for example, may coordinate with a player from Europe or Asia to ensure both players’ accounts are constantly active. The players are barred from interacting for a short period at the conclusion of account sitting, but this approach seriously reduces the advantage of a player supplemented by automated programs.

4.3: Implications for Monetization

The goal of this section is to lay out critical monetization features, monetization models, and methods to maximize revenue for a given monetization model. Elements of each model can be combined, but it is most clear to introduce them separately.
**Premium Features**

To monetize VWs, premium features which cannot be easily replicated by in-game sources must exist. Such features could entail access to the VW itself, or be supplemental features such as avatar abilities, items, or VC. Premium avatar abilities could bestow an inherent edge to the avatar, or perhaps be an additional customization feature such as a fancy title or cool dance animation as a social tool. Similarly, supplemental items could give avatars an edge against other avatars, or be purely cosmetic in the form of additional avatar customization features.

**Paid Access and Subscriptions**

Most 3D MMOGs require players to purchase the ability to access VWs (i.e. purchase the MMOG’s software) and, additionally, pay a monthly subscription to access the VW. WoW and EVE Online embody this monetization model; both MMOGs charge $15 per month for VW access.

The paid access and subscription model is the most direct monetization approach, a very common approach for MMOGs, but it may not be the most profitable. Forcing players to pay upfront to access the VW dissuades potential players who cannot justify paying real currency for access upfront or at all; an individual who never plays a game will never be monetized. The next two monetization models are alternative approaches which may increase the total quantity of monetized players over time.
**Freemium Model**

The Freemium model allows players to access VWs at no charge, but only on a limited basis unless the player elects to purchase access to the entire VW (which can be considered a premium feature itself). Non-premium players can still interact with premium players, but the capabilities of their avatar will be limited. By giving free players a taste of the game, and allowing their avatars to accumulate avatar capital, such players have the potential to convert into paying players. Even if free players never convert into premium players, their presence and economic activity may make the VW more attractive to players who do maintain premium access.

**Free to Play Models**

Free to play models allow players to access the VW in its entirety, instead opting to monetize by selling virtual items, avatar abilities, and VC. Items and abilities are typically, but not necessarily, cosmetic in nature. VC purchases allow the player to spend more on their avatar’s abilities; while VC can be acquired via in-game sources, direct purchase requires much less of the players’ effort to equip their avatar as desired.

The Multiplayer Online Battle Arenas (MOBAs), Team Fortress 2 (TF2) and Super Monday Night Combat (SMNC), embody the Free to Play model. Both games are monetized by allowing players to purchase cosmetic customization for their avatars such as outfits, customized weapon appearances, and hats (for which TF2 is notorious). SMNC also allows players to purchase VC, which can be used to buy superior equipment; it is
possible for a player to fully equip their avatar without paying with real currency, but doing so requires substantial effort over time.61

4.4: Implications for Revenue Maximization

Once a VW has sustainably monetized its active player population, it may be possible to increase revenue by modifying its synthetic economy. This section details such an approach; the concepts should be applicable to many monetization models, though some tweaking may be necessary.

Commoditization of Premium Features

I define Commoditization as a state of consumability and tradability. Donator Status on Torn, for example, is Commoditized as the Donator Pack. Rather than only allowing players to purchase Donator Status directly, players buy the consumable Donator Pack which, upon consumption, confers Donator Status. Once Commoditized, premium features such as Donator Status can be exchanged among players with VC, increasing a VW’s monetizable players. Even if a player purchases a premium feature with VC, another player had to initially purchase that premium feature with real currency from the

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61 A maximum-level avatar would require at least a 200,000 Combat Credit (CC) investment for equipment. The average match lasts 30 minutes and rewards the avatar with about 100 CC. Fully equipping an avatar without paying real money would therefore require about 2000 matches, or about 40 days’ worth of aggregate play.
VW. All else held equal, revenue with a Commoditized premium feature will equal or exceed that of an Uncommoditized premium feature.

To apply this concept, consider a generic Commoditized premium feature. This premium feature has two prices, one denominated in a real currency and another denominated in a virtual currency. At this particular set of prices, players may or may not be willing and able to pay the real currency price, and they may or may not be willing to pay the VC price. The matrix resulting from these binary classifications is exhibited by Figure 4.1 below:

For an Uncommoditized premium feature, the only source of revenue is the players who are willing and able to pay real currency. When the same premium feature is Commoditized, some of those players may elect to pay the VC-denominated price instead, but they still indirectly contribute to revenue by doing so since another player

---

62 The exchange rate is important, but the lot size is important as well. A player may be willing to pay $5 to receive ¥5000, but that same play may not be willing to pay $25 for ¥25,000 despite both lots using the same exchange rate.
had to directly purchase the premium feature. The opportunity for increased revenue through Commoditization lies in the players who would not pay for premium features with real currency, but will do so with VC. Again, although such a player purchases the premium feature with VC, revenue is raised indirectly since another player had to purchase it at the source.

The player who will not purchase premium features with either currency does not contribute to revenue. However, recall that the matrix is based upon a particular set of prices; if the VC price were lower, such players might be willing to purchase with VC. Conversely, if the VC price is too low, then potential suppliers may be lost. On the whole, this means that a VW’s owners have an interest first to Commoditize premium features and second to target a VC-denominated price which will maximize revenue.

**Optimization of Currency Exchange Rates**

Given a Commoditized premium feature, the exchange rate between VC and a real currency can be determined.\(^\text{63}\) Consider that the revenue curve for a Commoditized premium feature, obtained by mapping revenue against the exchange rate, is not a linear-like function but shaped like a concave-down parabola with a global maximum and two minima as exhibited by Figure 4.2.\(^\text{64}\)

\(^{63}\text{Although this only captures exchange of real currency for VC, which may lead to some inaccuracy. Given that the commoditized premium status is traded in a competitive market, the estimated exchange rate can still be used for forecasting purposes. In essence, the single-channel exchange rate may serve as a proxy for the dual-channel exchange rate.}\)

\(^{64}\text{Multiple maxima and multiple minima may be possible, but this would be an abnormal case and we do not believe this is the case with Torn.}\)
In this model, consider two extremes: an exchange rate of zero and an exchange rate which approaches infinity. At an exchange rate of zero, VC is worthless since it is available in infinite quantity. At an exchange rate of infinity, the value of VC approaches zero and thus becomes worthless as a medium of exchange. In these extreme cases, no additional revenue is realized from Commoditization; revenue equals the revenue of an Uncommoditized premium feature. Revenue can be increased between these two extremes, and a revenue-maximizing rate may be able to be targeted.

4.5: Additional Case: Revenue Maximization Approach on Torn

My theory of revenue maximization was recently implemented on Torn, using Donator Pack prices to determine the exchange rate. Players who want Donator Status need to consume a Donator Pack at most once a month, so exchange rate and revenue data will be
observed on a monthly basis. The exchange rate can be determined by dividing $5 USD by the average in-game price, as exhibited by Figure 4.1.

\[
\text{USD – TCD Exchange Rate} = \frac{\$5 \text{ USD}}{\text{TCD Price of a Donator Pack}}
\]

\textit{Equation 4.1: Calculation of the USD-TCD Exchange Rate}

A number of revenue-maximization approaches were feasible on Torn. The chosen approach was to target exchange rates by allowing the VW to purchase Donator Packs from players. In effect, any player was made able to sell Donator Packs to the VW, the VW itself did not actively purchase Donator Packs from the players. This mechanic did, however, establish a price support; if any player were to price a DP below the VW’s price, another player would likely buy it to sell to the VW (or more profitably, back to the market at a higher price).

The second attempt to systematically increase Torn’s revenue stream, like the unsuccessful approach of raising the Points Market price ceiling in Chapter Three, attempted to specifically target the revenue-maximizing USD-TCD exchange rate. This approach was implemented on March 1st 2013, so empirical results are limited to March and April 2013.

\textbf{Linear Revenue Forecast}

In order to determine the relationship, if any, between the USD-TCD exchange rate and Torn’s revenue, a linear regression is utilized. Utilizing Excel’s linear forecast for 2012 revenue data, exhibited by Figure 4.3, there was a clear negative relationship between
average monthly single-stream exchanges rates and monthly revenue. The SAS results in Figure 4.4 confirm this; the exchange rate (XR) is significant at the 5% level after correcting for heteroskedasticity.\textsuperscript{65}

\textbf{Figure 4.3: Torn’s Linear Revenue Forecast}

\begin{itemize}
\item Monthly revenue data is certainly heteroskedastic. Systematically, months have a variable quantity of days; since Donator Packs are required only every 31 days rather than every month, there is inherent error observing it in this manner. Analyzing average daily revenue for each month may be a suitable alternative, but psychological error (such as some players following a routine of paying every month or every other paycheck) can emerge. A second source of heteroskedasticity is the ever-changing nature of Torn’s VW design as well as its player base. More advanced statistical techniques could be pursued to gain more accurate insight into the relation of Torn’s revenue and the USD-TCD exchange rate.
\end{itemize}

\textsuperscript{65} Monthly revenue data is certainly heteroskedastic. Systematically, months have a variable quantity of days; since Donator Packs are required only every 31 days rather than every month, there is inherent error observing it in this manner. Analyzing average daily revenue for each month may be a suitable alternative, but psychological error (such as some players following a routine of paying every month or every other paycheck) can emerge. A second source of heteroskedasticity is the ever-changing nature of Torn’s VW design as well as its player base. More advanced statistical techniques could be pursued to gain more accurate insight into the relation of Torn’s revenue and the USD-TCD exchange rate.
These results suggest that decreasing the USD-TCD exchange rate would increase Torn’s monthly revenue. The linear relationship is not a complete picture however; it tells us that we can marginally increase revenue by marginally decreasing the exchange rate; the forecast provides no information on exactly how low the exchange rate should drop in order to maximize revenue. To gain this intuition, and to adhere to the theory that the revenue curve is shaped like a concave-down parabola, a quadratic revenue forecast is utilized instead.

**Quadratic Revenue Forecast**

Following theory, a quadratic forecast is utilized to more accurately model Torn’s revenue with respect to exchange rates. In order to effectively model this forecast, the
minimum revenue (i.e. the Y-axis intercept) must be determined. Torn’s minimum
revenue is estimated to be $35,000. The addition of the quadratic forecast to the linear
forecast is exhibited by Figure 4.5:

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**Figure 4.5: Torn’s Quadratic Revenue Forecast**

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66 The $35,000 figure is based upon revenue data in early 2011, when Donator Status was Decommoditized. Additional support for the $35,000 is based on the quantity of players who currently directly purchase Donator Packs, plus a quantity of players who I believe would start purchasing with real currency if they could not with VC.
Note that the linear forecast is tangent to a point on the quadratic forecast—the linear forecast can inform whether exchange rates are above or below the revenue-maximizing exchange rate. Factoring in the estimated minimum monthly revenue, the quadratic forecast constructs a more realistic revenue curve where revenue drops off when the exchange rate is too low.

**Targeting the Revenue-Maximizing Exchange Rate**

Utilizing the quadratic forecast, the revenue-maximizing USD-TCD exchange rate was determined to be 0.0000001938, which corresponds to a Donator Pack price of almost T25,800,000. According to theory we would want to target the T25,800,000 price,
however a measure of caution was taken to ensure the true revenue-maximizing exchange rate was not overshot; since we are making assumptions off the basis of the data, we cannot be certain ₯25,800,000 is the true revenue-maximizing exchange rate, or even close to it.

The exchange rate targeting approach established an explicit price support through VW demand intervention. That is, Torn was made able to indefinitely purchased Donator Packs from players in any quantity. Torn’s initial purchase offer was ₯17,000,000, the approximate player-to-player competitive price at the time, which increased in multiples of ₯100,000 every day based on how much higher the player-to-player price was. A maximum offer of ₯20,000,000 was imposed because a gap between the price support and the player-to-player market price was expected; again, we did not want to overshoot the true revenue-maximizing exchange rate.

**Results**

The effect of this revenue-maximization approach has been extremely successful, although only two months of post-update data is available for this thesis. March 2013, the month the price support was implemented, was Torn’s most profitable month on record. April 2013’s revenue was among the highest as well. The revenue and exchange rates for March and April are superimposed on the original quadratic forecast in Figure 4.7 below:
March’s data seems to follow either forecast; slightly below the linear but slightly above the quadratic. April’s revenue seems to more closely follow the quadratic forecast, however, suggesting the quadratic model is a better fit. In additional support of the quadratic forecast, I would expect March’s revenue to be above, not below, the forecasted revenue; the days immediately following the update are likely to attract more revenue than if the update had been implemented some months prior.

As for the approach itself, Figure 4.8 exhibits how Torn’s offer price for Donator Packs quickly rose to ₪20,000,000 by March 15th. The resulting rise of the player-to-player market price is exhibited by Figure 4.9, which has stabilized at ₪23,000,000 (The wide date range is included to exhibit the market’s original stability at ₪17,000,000, save for some anomalous market pressure from November through January). There is some evidence of speculation, which explains the minor downward pressure on prices near the end of April.⁶⁷

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⁶⁷ Observe the changes in the quantity of Donator Packs exchanged to the VW. Once players caught on that prices were rising every day, the quantity exchanged decreased significantly. However, once players
Additional data is necessary to more clearly determine whether the quadratic forecast is indeed valid. Data from a wider range of exchange rates, specifically exchange rates lower than the estimated revenue-maximizing exchange rate, are needed to accurately estimate the true revenue-maximizing exchange rate. This project is ongoing, but unfortunately additional data is not available for this thesis.

realized ₹20,000,000 was the VW’s maximum offer, a large selloff occurred and quantities exchanged are now limited.
Following the same forecasting method as before, March and April 2013 are introduced to the linear and quadratic forecasts. The resulting forecasts, exhibited by Figure 4.10, are much stronger than the previous models.

![Figure 4.10: Updated Quadratic Revenue Forecast](image)

**Note:** Restrictions have been applied to parameter estimates.

**Note:** Restrictions on intercept. R-Square is redefined.

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**Root MSE** 3868.50725 **R-Square** 0.9967

**Dependent Mean** 6304.4 **Adj R. Sq** 0.9963

**Coeff Var** 6 13619

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* Probability computed using beta distribution.

![Figure 4.11: SAS Results for Updated Quadratic Forecast](image)
The R² values for the linear and quadratic regressions increased by 0.19 and 0.22, respectively. Of particular note is the quadratic model’s R² increased from 0.25 to 0.43, while the linear model only rose from 0.26 to 0.41. While R² is not a reliable model selection criteria, such a shift suggests the quadratic relation does more accurately estimate Torn’s revenue with respect to exchange rates, as expected. Again, data from a wider range of exchange rates is necessary to validate the quadratic forecast.
Chapter 5: Findings, Conclusions, and Additional Points of Interest

5.1: Contribution to Existing Literature

This thesis has strengthened the concepts in existing literature, and has introduced a number of additional concepts which had not been explored in detail. In particular, the theory and empirical practice of my revenue-maximization approach with Torn adds to the few private sector applications of Synthetic Economics in existing literature. This section will review and wrap up my contributions which I deem significant.

The Generalized Faucet-Drain Model of Synthetic Economics

The Generalized Faucet-Drain Model, adapted from Simpson’s Ultima Online-targeted model, had not yet been explicated in the academic world. This model is fundamental to Synthetic Economics and a critical concept to understand for any VW-related project, be it designing experiment-purposed VWs, designing multiplayer videogames, determining suitable monetization approaches, or attempting to maximize revenue. Many VWs unnecessarily fall victim to poorly balanced Faucet-Drain mechanisms, despite the model and its derivative concepts of Artificial Scarcity and Trivialization being relatively easy to grasp.
The Significance of BIMMOGs

3D VWs are the most popular VW format for MMOGs, and understandably 3D MMOGs have been the focus of existing literature. Breaking the paradigm that VWs are inherently 3D, this thesis’ BIMMOG framework and case histories bring to light the subset of MMOGs which do not utilize 3D simulated environments. This explication is perhaps most important for social scientists who wish to conduct experiments with a VW: the relatively lower cost and superior participant accessibility of BIMMOGs may be preferable to 3D MMOGs.

Revenue Maximization Methods

This thesis is the first work in Synthetic Economics to explore, let alone mention and put into practice, specific approaches to MMOG monetization and revenue maximization. While Synthetic Economics is interesting and important to the study of Economics, its potential applications to the private sector are significant. My theories on Commoditization and revenue-maximization approaches represent two such applications. Torn’s historical shift to Commoditize its primary premium feature validates the Commoditization theory, while my revenue-maximization approach is validated by its recent implementation on Torn, which appears to have sustainably increased annual revenue by at least 10%.
5.2: Potential Future Complications

**Encroachment of Law**

It is claimed that VWs are real, and that avatars, avatar capital, and avatar assets represent real value to players. Therefore it is perhaps inevitable that the legal system will come to assimilate VWs under their jurisdiction to settle cases of theft, harassment, defamation, etc. One famous case of theft was a scam on EVE Online, which netted the scammer approximately £42,000 worth of VC; although this scammer faced no legal repercussion, is it likely that litigation in response to such actions, illegal in the “real world,” will eventually become viable.

Also under the umbrella of law is the Unlawful Internet Gambling Enforcement Act (UIGEA) of 2006. The UIGEA could potentially give the US Department of Justice jurisdiction over US-based VWs on the basis of gambling as a gameplay element; since we make the argument that VC has real value, then perhaps gambling with VC could be considered real gambling. Every BIMMOG based on the MCode engine, for example, comes with basic code for roulette, blackjack, and craps, and many MMOGs do allow players to gamble in some fashion.\(^6\)

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\(^6\) Also on Torn, there is poker. Based on a reasonable TCD-USD exchange rate, ₹1,000,000,000 is worth approximately $30. With this valuation, poker tables with ₹5,000,000 big blinds are effectively 15 cent big blinds, with a standard buy-in (100 Big Blinds, ₹500,000,000) being worth about $15.
5.3: Additional Topics of Interest

**Optimal Value of Currency**

In essence, the value of currency is mostly arbitrary. If the money supply doubles, the value of every dollar is halved and prices will double. There is a potential problem, however, if the value of a currency is too high. For example, if a Dollar is the lowest currency denomination, and a particular product’s equilibrium price would be 0.75 Dollars, then equilibrium can never be achieved unless individual consumers purchase the product in multiples of four for a total of three Dollars (4*$0.75=$3). VWs may be the best environment to experiment with different levels of currency value and divisibility, due to the multiplicity of VW shards and the ability to directly control currency divisibility. Allowing player to trade as little as a quadrillionth of a virtual dollar should be feasible in VW for example; the only limitation of divisibility is the capabilities of the VW’s server.

**Sticky Prices**

The theory of sticky prices could be suitable to study in a VW. Having extensively studied the Points Market on Torn, there certainly seems to be a trend for prices to stick to multiples of ₱10,000. Prior to raising the Points Market price ceiling, prices seemed to be stabilizing at ₱40,000. After raising the price ceiling, prices stabilized at ₱70,000, then crashed and stabilized at ₱60,000. While data is available to gain insight into sticky prices, this subject is outside of this thesis’ scope. Regardless, it should be possible to test
the application of sticky prices by analyzing VW market data, perhaps in conjunction with an existing MMOG.

**Applying the Faucet-Drain Model to Real Economies**

The Generalized Faucet-Drain Model of Synthetic Economies, while developed in the context of virtual worlds, has some application to the real world. While our universe is theoretically a closed system, the local level (i.e. Earth) seems to follow the F-D Model. For example, energy at the Earth level is not a closed system, since we are constantly bombarded by energy from the Sun. A less nebulous example is the Faucet-Drain mechanic of US Dollars as controlled by the Federal Reserve. In particular, the market effects of an unbalanced Faucet-Drain mechanism, such as inflation, could be studied in the context of the Faucet-Drain model.

**5.4: Final Remarks**

Synthetic Economics is an emergent subset of Economics; existing literature is fragmented and incomplete in scope. By introducing the BIMMOG subset and private sector applications, I have helped fill these gaps. In addition, the included case histories and sub-case histories have solidified the fundamental framework of Synthetic Economics. Regardless, much more research must be pursued to strengthen the field—its applications to the video game industry, social science research, and human life in
general are extensive. The entire field of Economics can be strengthened by the in-depth study of Synthetic Economics.
Works Cited


Castronova, Edward, Dmitri Williams, Chuihua Shen, Rabindra Ratan, Li Xiong, Yun Huang, and Brian Keegan. 2009a. "As Real as Real? Macroeconomic Behavior in a Large-Scale Virtual World." New Media & Society.


Appendix A: Interview with Black Market Participant on Torn

Questions which were asked by the interviewer are bolded. Responses are plain text.

1. **When did you start trading in Torn’s black market?**
   probably one year into the game I thought I would test it see if anyone I knew would be willing to sell me a few 100 million

2. **Why did you start trading in Torn’s black market?**
   I didn’t have much time to actually generate money through the game

3. **What do you buy? What do you sell?**
   nothing I just get cash when I need it and just buy stocks coupons

4. **What is your occupation in real life?**
   pretty much a wholesaler of car parts easiest way to put it
   a. **How much disposable income do you have?**
      depends at the moment me and my girlfriend are going on holidays probably once or twice every 6 months but yeah money is not a issue im not poor and im not rich just well of
      i. **How much do you spend on Torn, Torn’s black markets, and other games?**
         id say all up 5 grand when that whole faction scamming became legal I lost around 90 billion of game cash which set me back so 3 grand down the drain I could not recover

5. **How many Torn players do you think buy or sell in black markets?**
   maybe 100 people in total I don’t think it is that many considering how many people play the game

6. **How much USD do you think is traded in Torn’s black market?**
   I know of some accounts selling for 1-2k and I know 1 billion torn dollars sells for 45-75 dollars depends on the seller

7. **How do you find players to buy from or sell to?**
   its pretty easy seems to be the same people within my friends group then course you get introduced into other people from friends and friends etc
   a. **How many players have you traded with?**
      probably 4-5 different people you sort of have to pick and choose who you trade with as it is a bit of a grey area

8. **How much money (USD, or other currencies) have you spent in Torn’s black market?**
   5 thousand dollars

9. **How do you decide how much USD (or other currencies) you will trade for Torn cash?**
depends on what country they live in I don’t deal with people in U.K exchange rate blows so I try to deal with U.S.A or other countries with a better exchange rate

a. How much real-life money would you pay for $1bn Torn City Dollars?

$100bn? A Dirty Bomb? Why?

1 billion dollars I only pay like 25-30 dollars U.S.D

10. How do you conduct trades in-game without being caught?

several ways its not as easy to track cash in such a big game and when so much money is going to and from players daily

a. How do you mitigate the trade risk of who will send first?

depends on who it is lot of these players have a lot more to lose then what I do as they are higher levels and have played for more years then me

b. How do you avoid being scammed by other players?

knowing who you are dealing with like I said before it’s a small group of sellers and buyers plus I knew the players for least 1-2 years before I decided to buy

11. How should Torn capitalize on this black market?

the owner ched probably shouldn’t as it would just make prices of everything skyrocket short term great for his pocket long term worse for the game

12. Have (or do) you traded in black markets on other games?

only other thing I have done is when I broke my leg I played world of warcraft for about 6 months decked it out in the top end gear and sold the account for 4.5k

Are there any other topics you would like to discuss?

nope

Do you have any questions for us?

nope

Just make sure this to anyone with in the game......if the lecture or anyone is to view this before they say loser LOL in real life I own 2 houses one fully paid of that is valued at 300 thousand dollars I own a second house valued at 295 thousand dollars that is half paid off I own my car I have very little debt overall don’t wanna seem stuck up but didn’t wanna seem like a loser at same time