

On Rationomics: An Analysis into the Workings of a Bit Torrent Tracker's Economy and It's Composition

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1 Introduction

A lot of discussion has been made around the bit torrent world regarding the belief – or disbelief – in a functioning economic model of a tracker's activity. This discourse will examine this model and show how it applies, giving examples and models to explain each phenomenon in a tracker system, as well as give a suggestion for a new, improved method to ranking users, taking into account each individual's impact on the economy. Why bother? Because it's important to be able to generate statistics and analyze them, as well as trends, in order to maintain a tracker. If there is either too much or too little traffic, people quickly lose interest and the tracker dies and analyzing the economy is the most effectual way to create conclusions based on solid data and ensure a proper amount of traffic by taking measures to ensure a proper level of economic equilibrium. Furthermore, there is the rampant idea that “more is better” in regards to a share ratio, and education regarding the fallacy of this statement will serve to encourage its demise, or at least discourage its dissemination. The best way to model, explain and, more importantly, analyze a tracker's activity is the economic model and although t's certainly not flawless, it is effective and allows the “people behind the curtain” to make educated and informed decisions to ensure the health and longevity of their site.

2 The Economic Model Explained

The fundamental base of an economic model is currency (or lack of it, in a barter economy), so we first have to determine what to model as currency since a tracker is not barter economy because there is an economic middle-man (the tracker and site itself, keeping statistics). Something like gnutella would be effectively modeled as a barter economy, but there is a centrality to the bit torrent protocol that demands a monetary basis to a proper modeling. Because currency is demanded in a tracker's economy, it is both logical and pertinent to build a model upon this assumption. Accepting this, the economy only consists of a relatively basic currency-exchange. One user downloads from another user, thus transferring “credit” or “currency” to the other user, thus an exchange has occurred. However, there is no credit system, no banking system, or any of the features an advanced economy would have, so what is left is a pretty simple model of an economy based on currency exchanges and not much else, under the current ratio rules applied to most trackers. What, then, is the currency that is being swapped between users? On a ratio-based site, there are three numbers that apply to every user – uploaded amount, downloaded amount and their ratio. If downloaded amount is to be considered as currency, the person with the most would be the wealthiest, however, that person is most always banned, so there's a defect in using downloaded amount. If that person's upload, on the other hand, is deemed as the currency, on the surface it makes a lot more sense. The problem with using their uploaded amount is this: If upload is equitable to wealth, then the people with the most upload are the wealthiest; however, if someone has more downloaded then uploaded, they're considered “in debt” and can't be as active as someone with ten percent of their upload and barely any download. So, that leaves ratio to be considered as currency.

Now, if a user's ratio is equatable with their economic status, boundaries are necessarily required to determine where exactly that user stands. Obviously, the higher their ratio and the more disproportionate their upload and download stats are, the more wealthy they are. But we also need to establish at what level they become “in debt” and have to decrease their activity. So-called common sense would say that

a 1.0 ratio would be ideal – anything above and they have a “buffer” and anything below and they’re “in debt.” The fallacy in this logic lies in the fact that, temporarily discounting users that get banned with a ratio less than 1, the site’s overall ratio will always be exactly 1. If there are two users, both with no activity, and the first uploads a torrent and the second downloads it, their ratio (together) is still 1; there is just a new disparity between the two example users. Furthermore, the amount of “ratio buffer” someone has is rather irrelevant. It’s completely inconsequential to the amount of activity they can have. And that’s the definition of wealth – how much activity someone can have in an economy. So what does determine the amount of activity they can have?

Rather than a raw difference between a user’s upload and download amounts, the number that determines how much they are allowed to do is the difference between their ratio and a target ratio, expressed in gigabytes. An example: A user wants a 2.0 ratio because he has e-Penis issues stemming from not being loved as a child. He has 100GB download and 200GB uploaded. If we were to use his “ratio buffer” as a guiding point, we’d assume that he was a rather wealthy and active user. The problem, though, is that his target is 2.0 and he’s reached it and won’t do any more downloading until he uploads more and is, until that point, inactive. It’s impossible to determine a user’s personal target ratio – some like 1.0, some prefer to ride the line between being banned for a low ratio or not, some prefer to have as high a ratio as they can manage. Although we can’t determine exactly what each user is going to want to maintain, we can assume that it will always be above the limit before they get banned for having a too low ratio. Site staff can also do a lot to encourage particular numbers. If benefits for a “Power User” class are significant enough, people will strive for that power user mark (often set at 1.05) and, as a result, be less active.

At this point we can draw our first major conclusion from our analysis of a tracker’s activity in an economic model. Mathematically speaking, as the amount of download and upload increase, trends appear. If a target ratio is exactly 1.0, the difference between true “ratio buffer” and “target ratio buffer (TRB)” never changes. If the target ratio is above 1.0, downloading has a continuously deleterious effect as the target ratio increases (impact of 100MB downloaded on a target ratio of 2.0 – 200MB, impact of 100MB on a target ratio of 10.0 – 1000MB). If the target ratio is below 1.0, their TRB grows at a larger rate than their upload amount. So, we can safely say that the lower the target ratio is, the more activity there will be. Assume for a moment that activity is a good thing on a tracker (will be explained in more detail below), and we come to a startling conclusion: the more benefits and perks there are for people who are “ratio hoarding,” the worse it is for the site!

So far in our economic model we’ve established that the amount of TRB a user has is determinate of his stature in the site’s economy. We can know, however, that there are perks for users who have ratios greater than 1.0 and that users will seek to attain these goals, thus ensuring a permanently negative force on the economy.

3 Facets of the Economic Model

Earlier, we discounted the idea of users getting banned for low ratios to show that, overall, a site’s total ratio will always be 1.0. The assumption that a site’s total ratio will ever be 1.0, however, not true, because the site’s overall ratio is affected in various ways. When a tracker’s total ratio is 1.0, there is absolutely no “buffer,” but when a user gets banned for leeching too much, the difference between his downloaded amount and uploaded amount gets added to the site-wide pool of available buffer – previously 0. Now it is indeed possible for everyone to maintain a ratio that is greater than 1. There is more currency in the economy than there was before he got banned – regardless of each user’s target ratio – and inflation has occurred. There are a few other ways that a tracker’s economy is inflated – free leeches and seeding bonuses being the most common, but anything that increases the amount of upload for any user without decreasing the amount of download for another is a cause of inflation.

Let’s take a moment to analyze inflation. In a real-world economy, inflation is usually described as currency being less and less valuable. In a tracker-model economy, this is no different. As the amount of upload credit a person has becomes less and less significant (defined in our model as how hard it is to obtain), the amount they have to seed decreases. In an exemplary tracker, there is one annual free leech period – at the anniversary of the site’s founding. If it’s possible for every user to hoard enough TRB at the free leech period, they have no motivation to seed anything during the rest of the year and no torrents are seeded. This is, of course, an exaggerated example, but it does illustrate the effect inflation has on the economy. There is a correlation to the difficulty in maintaining a target ratio and the amount of torrents seeding, so the more inflated an economy is (the more free buffer there is floating around), the

lower the average amount of seeded torrents per user will be. Also, the more traffic there will be, as can be observed on any public tracker, where users have a target ratio of 0, therefore having no downloading limit. There is a significant amount more leeching and an even more significant amount less seeding. So, to control this, the economy has to be deflated, in some measure.

Deflation on a private tracker is a little bit less simple. Deflation would be defined as an increase in difficulty obtaining ratio buffer (thus making currency worth more as there is less). This occurs in a few ways, most of which are immeasurable. Low-download users with seedboxes that hoard ratio are effectively deflating the economy, as they are never going to be able (in theory) to download the terabytes upon terabytes that they often seed. Users that delete their account or stop using the site with a positive ratio deflate the economy. At what.cd, the tax on the bounty system deflates the economy. At sites like hdbits or x264, where there is a seeding bonus that can be traded for site features, that trading deflates the economy in a roundabout way, as it increases seeding and (once again, theoretically) downloaded amount without increasing the amount uploaded site-wide. Opposite of inflation, anything that increases the amount downloaded without increasing the uploaded amount (or decreases the uploaded amount) deflates the economy.

We've already shown that when too much inflation occurs, seeding starts to decrease and the site's health does as well. On the other side of that same coin, if there is too much deflation and seeding is too hard to do, users will be justifiably afraid to download and activity eventually stalls out and the site dies. So, there's an indefinable range that a tracker needs to operate at in order to stay alive – a balance between too much inflation and activity and too much deflation and seeding. Given this, it's theoretically possible to monitor a tracker's activity levels and determine the tracker's health and take measures to increase or decrease activity as necessary. In order to do that, we first must understand everything that can be done to affect a tracker's economy.

A ratio-based tracker is just that, based on ratio. Our economic model is based on ratio buffer (in a roundabout way because of target ratios), so it's pertinent to analyze the effect of ratio requirements on a tracker, as they are the foundation the economy is built upon. Let's look at two extremes, in theory: one, a tracker that wants everyone to maintain at least a 1.0 and two, a tracker that only wants a 0.1. In the first case, it's theoretically possible for this happen, if no one ratio hoards and everyone is always active, but this will never be the case, so eventually a lot of users get banned for having less than 1 ratios and seeding is nearly impossible and the site dies. On the other hand, the necessity to maintain a 0.1 ratio is purely hogwash and is easily done, so there is nonstop hit-and-running on nearly every torrent by nearly every user and the few users that seed their torrents eventually get tired of not being able to seed anywhere else and leave the site, which soon dies thereafter. When what.cd had ratio requirements ranging from 0.1-0.3, this effect was very noticeable, as hit and running was an issue that was brought up over and over again; since the advent of gazelle and with it new ratio requirements, there has been a noticeable drop in hit and run activity. So, the effect on an economy the minimum ratio requirements has is both hypothetical and observable. Changing the requirements has this effect because it directly alters the amount of inflation or deflation occurring at the tracker. Raise the minimum ratio and everyone's minimum target ratio increases, thus taking a significant portion of TRB out of the economy and greatly deflating the economy. Decrease the requirements and everyone has a new and larger buffer and inflates the economy by a huge margin, exponentially proportional to the amount of users and the amount of total activity. When the requirements are altered, a lot of risk is taken as well; when they are raised, a lot of users with low ratios could be banned, thus having the opposite of the desired effect – inflation! If they are lowered, the influx of new users could breed an entire “generation” of hit and runners, causing more inflation than desired, or even a larger amount of ratio hoarding, once again accomplishing the opposite of the desired effect and deflating the economy. Changing the ratio requirements is an incredibly powerful way to change the status of a site's economy – with the potential to permanently cripple the site, so while it remains an option, it should be considered only as a last resort, when all else has failed, because of the risk involved.

One of the most well-known, and certainly the most popular, ways to alter the state of an economy is the free leech period. In a typical free leech, activity is increased exponentially and an enormous amount of inflation occurs. Because of the “higher is better” mentality private tracker veterans have, a lot of trackers have an overall trend towards deflation. This is more evident at a larger tracker, as more users and more content equates to more activity, therefore making it easier to hoard ratio and more users to do it, which usually results in a site like scenetorrents or bitmetv, where the common sentiment is that it is “impossible to keep a ratio there.” Other things are more effectual as user count increases, as well, such as the amount of users on fast Swedish connection or users with seedboxes. So, in order to compensate

for this, a free leech period is given, which would give (in theory) the users enough time and activity to build a library and a buffer enough to continue to be as active as they want to be until the next period. So it appears that free leeches are an effective cure-all to deflation problems. However, the issue with freeleeches is that it is nearly impossible to determine how much inflation is going to occur as a result and the risk of over-inflating the economy and having a long period of nonstop hit and running after the period is over is taken. So, a more controlled sort of free leech would help alleviate some of this risk.

A controlled free leech period is not a new idea, not by any stretch of the imagination. A lot of trackers have selective free leeches – a few torrents that are free leech, but not the entire site. Hdbits has pilots and selected TV episodes, goem has particular movies, karagarga has movie/director of the month, what.cd has staff picks, scenetorrents has pre-time-less torrents, etc. It's not a foreign concept and usually works, but that's not to say it's without its own issues. The primary issue behind a site-wide freeleech was it encouraged a period of hit and running if the period was too long, because of people who compile huge ratios and spend it all soon afterwards without bothering to seed. When there are selective free leeches, it's possible for someone to “farm” the free leech torrents and upload enough from just the selected torrents to hit and run everything else on the site, especially when they are a low downloading user or have a fast connection. What makes this possible is the fact that they are free leech and so many users will download and seed them for the same reason – to increase their ratios, making them a perfect place to “ratio farm” for a buffer to prevent the necessity of seeding other torrents. This becomes increasingly insignificant as time passes because the amount of seeders increases, thus the percentage of the next snatch each user will seed decreases. Also, for most users it's not possible to maintain a site buffer from just free leech torrents, but users with exceptionally fast connections or users who do not download much are often able to and having selective free leech torrents increases the pool of users who are capable hit and runners. It's a double-edged sword, as the economy is inflated in an amount enough to matter, but the amount of hit and running will necessarily increase because of the free leech torrents. And that's something that has to be taken into consideration when selective free leeches are performed or decided on.

There are two systems that are often used in trackers to help create an economic equilibrium – hit and run detection and seeding bonuses. They are coupled together because they are so similar, both in idea and in effect. Both are built upon the idea of seeding time being a determinate factor in a user's status on the tracker. Hit and run detection is the negative-reinforcement method – penalize people for poor seeding times; whereas seeding bonuses are the opposite – the positive-reinforcement method used by rewarding users for extended seeding times. In theory, both of these have incredibly beneficial effects on their sites' economies – they control the effects of inflation by ensuring seedership, while also controlling the effects of deflation (in theory) by ensuring everyone is seeding enough to maintain their level of activity. In practice, things are a bit different. Both systems are built upon monitoring seeding times; however, the bit torrent protocol doesn't naturally account for the difference between actual seeding and simply reporting as a seed, which opens the door for exploitation. It's no great secret that it's possible to cheat a seeding bonus or hit-and-run system by setting a global upload cap of 1 kbps and “seeding” indefinitely and maintaining your activity based entirely on bonus points or seeding a few torrents. Not to imply that everyone does this, or that it's even common, but it does improperly inflate the seeding totals for a tracker, as the amount of faux seeds will make the reported seed count be incorrect. By this token alone, the effect of controlling both inflation and deflation can be discounted, as the results of exploitation are not predictable nor are they controllable. Furthermore, designing a system that has controllable effects is incredibly difficult and, given the cyclical nature of economies, would have a naturally varying effect on the economy, which might even be detrimental given a sufficient atmosphere. While the implementation is faulty at best, the idea of seeding time effecting economic status shouldn't be easily discarded, just implemented differently.

Given the simplicity of the ratio-based economy, there isn't much outside of these measures a well-intentioned staff can do. There are temporary and extreme measures – giving every user an extra 10GB of upload credit, a half-credit download weekend, etc. but the above are the only semi-permanent measures that currently (to the best of the author's knowledge) exist in the tracker world. So, continuing, these tools will be our “toolbox” in the current ratio system to ensure a successful economy.

4 Analysis of the Economic Model: Ensuring Longevity and Success

We've already established the methods that can be used to ensure the lifespan of a tracker, but we haven't discussed what exactly a healthy level of activity for a tracker is, or how to determine the health of an economy. Given what has been established about the effects of inflation and deflation, we've assumed that there is a range of activity that is preferable for a tracker, somewhere between too much deflation and too much inflation. In order to determine where this range lies, we need to look at the effects of both inflation and deflation. We've already established that deflation results in a non-sufficient level of activity and an "over seeding problem" that directly causes a sharp decrease in activity and a fear of downloading amongst the general tracker public. Contrariwise, inflation causes an "under seeding problem" with too much hit-and-run traffic.

If we want to establish boundaries between a proper amount of deflation and a proper amount of inflation, we have to look at first deflation and then inflation. To determine the amount of deflation, we analyze the effects – determine the amount of overall traffic in the site, which is rather simply done by looking at the average number of completed downloads done on a daily basis and then dividing that by the total userbase:

$$A = \frac{(\textit{snatches})}{(\textit{users})}$$

So, an incredibly low value for A (Average daily snatches) would be a pretty clear indicator that too much deflation has occurred and that a period of inflation is needed to "revive" the economy. To calculate inflation, we need to look at the amount of hit-and-running that has occurred in a given time frame, we'll look at the amount of seeders in comparison with the amount of snatches:

$$H = \frac{(\textit{seeders})}{(\textit{snatches})}$$

An incredibly high value for H (Percent that has hit-and-run) would indicate that too much inflation has occurred and measures to deflate the economy would need to be taken. Given that deflation and inflation are opposite forces in an economy, we can assume that there is a nearly direct relationship between A and H, being that A and H are inversely proportional to one another.

Being able to calculate A and H is rather useless without operating within a definite context. To define our context, we'll need to take into account some variables: the number of torrents available and the size of the userbase. A site with 1000 members and 1000 torrents is going to have a lot lower acceptable A value than a site with 10,000 members and 10,000 torrents. By the same token, a site with 1000 members can't afford to have as high an H value as a site with 10,000 members. At this point, to do further analysis, we have to make some assumptions about available bandwidth. Also, as we're monitoring total site-wide economy, we're assuming that all content is equally desirable and working with averages (as is the case in any study of macro-economics). Keeping in mind that:

$$\frac{(\textit{bandwidth needed})}{(\textit{bandwidth available})} > 1$$

In an ideal tracker economy, we can calculate bandwidth needed on a per-torrent basis as the product of the average amount of leechers per torrent and their average download speed. If the average amount of leechers per torrent is less than 1, we should assume 1 because having a value of less than the average maximum download speed is not a perfect economy, and the goal here is to move an economy towards perfection. Calculating available bandwidth is a bit more complicated:

$$\frac{\frac{(\textit{torrents currently being snatched})}{(\textit{total torrents available})} \times \frac{(\textit{users})}{(\textit{seeders})}}{(\textit{average upload speed per user})}$$

This formula calculates the average number of torrents seeding per user, and then takes the quotient of that number and the average upload speed of each user. So, for example, a tracker with 1000 available

torrents has 100 being snatched (so we have a useful figure of 1 leecher per torrent), and 1000 users and 5000 registered seeds, with each user having 1mbps of available bandwidth yields an average of .5 mbps available per torrent, which is less than ideal. At this point, we've not taken into account the fact that leechers contribute to the total pool of available bandwidth as well, so, taking that into consideration, we can modify our formula to look like:

$$\frac{\frac{(\text{torrents currently being snatched})}{(\text{total torrents available})} \times \frac{(\text{users})}{(\text{seeders+leechers})}}{(\text{average upload speed per user})}$$

This, in the same model, would yield an available amount of bandwidth per torrent of 0.51mbps, which is realistically more accurate. Furthermore, taking into account bandwidth swapped among peers and non-users, this formula doesn't break as the amount of leechers per torrent increases upwards towards infinity.

We've established at this point that the goal is to have more available bandwidth than necessary, to ensure that every torrent is seeded well, while also ensuring that there is enough activity to prevent "over-seeding." At what point, then, are there not enough leeching and too much seeding? Remember, the total amount of traffic for a tracker on a daily basis is always 1.0, so the amount of data leeched each day will be equal to the amount uploaded. When the total amount of available bandwidth for a day (the product of each user's average upload speed and the number of seconds in a day) is more than the total required for a day (the product of the amount of leeched torrents that day and the average download speed of users) there is "over-seeding." However, because of the hydra model, we can't assume each user is only dedicating his connection to our tracker, so we have to assume that he is splitting it amongst several. It's completely impossible to determine how many different ways a user is splitting his upload bandwidth, so we have to accommodate for this somehow, and we could do this simply by assuming some number and dividing the total available bandwidth for that day by that number and from there, make observations about the average time spent downloading a torrent and adjust our guessed number from there. Because of this, it's impossible to extrapolate a formula that expresses a proper range for A accurately across all trackers. At this point, it would be the responsibility of site staff to monitor their traffic and speeds and draw conclusions on their guesstimate for bandwidth availability modification.

If we want to determine the correct amount of Hit-and-Run traffic, we have to take into account the amount of bandwidth available from the seeders per torrent and the amount of time (and thus bandwidth) available per torrent while the leecher is leeching. If, disregarding leechers, there is enough available bandwidth per torrent, it's completely acceptable for H to be 1.0 (100% of snatched torrents are hit and run). Otherwise, H would ideally have a value of 0; however, this will never be the case, regardless of any measures taken to discourage it. Since we can't ever effectively achieve a value of H near 0, we have to determine at what point hit-and-running becomes a deleterious force in the economy. If we are to acknowledge that there is a problem, we are really saying that the site is under-seeded to the point that speeds are too low and, therefore, downloading takes too long, on average. This is a result of an over-extension of the existing seeders as the hit and run traffic drains from the pool of available bandwidth without more than immediately temporarily increasing it (which is a negligible overall effect on trackers that have an average of leechers less than the total amount of torrents). In order to calculate the effect of hit-and-running, the following formula can be used (remember we defined available bandwidth already):

$$T = \frac{(\text{average size of torrent})}{(\text{available bandwidth})}$$

Where T is the amount of time spent downloading each torrent on average. This formula, by itself, isn't very useful. However, in theory, T should decrease over time as torrents are leeched and seeders are added into each swarm. If we were to take a polynomial regression of several points generated by this formula, we should notice a steady decline of T as a function of time, as available bandwidth is increasing. If, on the other hand, we notice that the T'(x) is greater than 1, or that T'(x) is zero, than hit and running is having an obviously deleterious effect. If T'(x) is too close to 1, a judgment call by the site's staff, then too much hit-and-running is occurring. Because of the nature of trackers, an average time of 5 hours for a download might be okay at a tracker specializing in movies, but at a tracker specializing in e-books, that's obviously unacceptable, so once again, given the tools to calculate the effect of hit-and-running, it becomes a call by the site staff to determine at what range H is okay to operate, with proper observations and experimentation.

Once the staff of a site has monitored and determined proper values for A and H depending on their sites' content and user-base, several tools that we have discussed earlier are available for them to use to force inflation or deflation on their economy. Purposefully deflating a tracker's economy is significantly more difficult than inflating it, but it is rarely a problem as private trackers have an overall tendency towards deflation due to ratio hoarding (curiously opposite of a real world economy – but that's another subject altogether).

5 Comments and Conclusions Drawn From the Ratio-Based System

We've analyzed the ratio-based system pretty thoroughly, as far as economics goes. It's simple and it works and, even more importantly, it's very simple to understand. The economics of the system, on the other hand, are a bit more complicated, but the end-user rarely considers (or has to) them. As such, there is a pretty venerable point to saying that it works and should be used, for the simple fact that it's easy to understand and use and “just works.” However, even though it works, it's not flawless. One thing that is very apparent after an analysis of the tools given to moderate a ratio-based economy is the amount of chaos inherent in such a system. Efforts to mandate seedership or seeding-time or increase the amount of activity have a high possibility of back-firing and achieving a directly opposite effect other than what was intended.

Because of the structure of the bit torrent protocol, there isn't another way to properly (and non-exploitably, discounting cheat clients) create an economy based on any real data. So it seems that we, as torrent users, are forced to use the ratio system. But the ratio system doesn't necessarily mean a simple composite of total data amounts, as it exists on most trackers right now. Instead, another system, still based on real data, that takes into account things other than total statistics.

First, to do this, we need to list all of the available and useful data that we have access to under the torrent protocol. We, of course, have download and uploads statistics for both individual torrents and for all time. We also have, per torrent, a seeding time, as used in the seeding bonuses/hit and run detection systems. And, also obviously, we have access to the age of the user's account. Outside of this, we can keep track of the total number of torrents he's been active on, but not much else. So, if we were to replace a ratio-based system with instead a “sharer” system that ranks each user on how “good” for the tracker they are, we'd need to take all of these into consideration.

Before I dive into the mathematics, I want to take a moment to describe the theory behind this system. First of all, under the current system, a tracker's staff has no “economy throttle” to accurately and instantly control the amount of traffic on their site, similar to the way the Fed in the USA has control over bank-loan interest rates. So, a better system would have this. Also, the current system, in any flavor, is incredibly exploitable, whether by cheat clients or ratio-farming or bandwidth-capping or any of a million possible methods of exploitation available to a normal user. Any system, however good, will have holes and will never be flawless, but reducing the loopholes is the effort of any security team and running a tracker is no different. Widespread ratio abuse is just as negative for a tracker as an SQL injection, if not as immediate. Furthermore, the current ratio system is not an accurate representation of how positive a user is to the economy. If someone has uploaded two terabytes, but only downloaded ten gigabytes, he's considered a great user under the current system, whereas in reality he's a permanently deflatory force and becomes part of a greater problem that eventually has to be resolved with forced inflation. Under my system, he'd be more accurately represented with a lower sharer rank than a better user who has uploaded a significantly large amount of torrents yet still only has a ratio of 0.7.

The idea behind the sharer rank system is that there are more things to take into account than data transfer amounts to determine a user's impact on the economy. The largest factors, and thusly the ones I account for, are the amount of torrents he has uploaded, his average seeding time, the amount of torrents he has snatched, his total amount of data transfer in relation to the site, and (of course) his share ratio. It would be calculated as such:

$$\text{Share Rank} = 10(B_r) + B_u + 2(B_t) + \frac{B_s}{100} + B_a$$

$$B_r = \sin\left(\frac{3(x - \frac{\pi}{3})}{2}\right), \text{ where } x = \text{ratio}, 0 \leq x < \pi. \text{ If } x > \pi, B_r = 0$$

$$B_u = 1 + \frac{\sqrt{(user\ uploads) - (0.2812x^{3514})}}{(0.2812x^{3514})}, \text{ where } x = \text{total number of torrents on site}$$

$$B_t = \frac{(\text{average percent of time seeding each torrent})}{100}$$

$$B_s = \text{number of torrents snatched}$$

$$B_d = \frac{(\text{uploaded amount} + \text{downloaded amount})}{\frac{(\text{total site transfer})}{(\text{number of site users})}}$$

Now, before anyone gets intimidated, let's examine these. First, let's look at the Share Rank function. It takes into account 5 sets of "Bonuses" to determine a user's SR: Br being ratio bonus, Bu being uploaded torrents bonuus, Bt being time bonus, Bs being snatch bonux, Bd being data transfer bonus. Br is calculated as a piecewise function, partially consisting a simple trigonometric function that allows for users to be increasingly penalized as their ratio decreases from 1, while offering significant bonuses between 1 and approximately 2, at which point they receive diminishing returns until 3, at which point they receive no modification to their Sharer Rank. While this may seem harsh, it's goal is to discourage the permanently deflatory force of seeding without downloading anything. A lot of people that have insane ratios only do because, of their connections; however, users that have uploaded a significantly large amount of torrents and have a ratio for this reason are compensated by Bu, which has no upper limit on the effect it has on sharer rank. I chose to weigh it so heavily because of the emphasis currently on ratio, which is based on the fact that ratio is, indeed, the most important thing to an individual swarm's health. But, which is perhaps the most intimidating function of the lot, is composed of the base function $0.2812 \times x^{3514}$ which looks like incredibly random numbers, but it is a power regression of a table of values: (100, 1) (1000, 5) (10000, 8) and (15000,15) structured as (total torrents on the tracker, minimum uploads required to get a bonus). This table was created as "sane" values for each user to prevent people from be required to upload something like 100 torrents to get a bonus, because that's a value rarely met. Once the minimum amount is required, the distance formula is used to determine the disparity between the amount uploaded and the minimum, giving a proper bonus for that disparity. It would, of course, return a non-real result for someone who has uploaded less than the minimum required, so in code, it would be necessary to encapsulate the calculation in an if statement: if (uploads \geq minimum). But is simply the average amount of time spent seeding each torrent and will only ever vary between 0 and 1 for two reasons: it has very little effect on overall sharer rank, but still encourages seeding without giving poor users a decent reason to exploit it (not that they won't any way, but it will be significantly less harmful). Also, by having it have such a small effect, it's not entirely necessary for sites that don't wish to spend the resources necessary in calculating it and could be completely removed and the system would still function. Bd is a comparison of a user's total data transfer compared with the average for the site. Since we've already established that activity, to a point, is good for the site, it makes sense to reward high activity users for doing so. It also offsets a negative value for Br (somewhat) for users that have trouble maintaining a positive ratio, with an increasingly large effect as the amount increases to account for the fact that it is significantly harder to maintain a 1.0 ratio when someone has downloaded 100GB as opposed to 100MB.

The Sharer Rank formula returns a number, the sharer rank, which can then be used to create user classes and a lower ban limit. At ratio 0.53, the value for Br is about -7, so to account for bonuses given for snatching and data transfer, a minum sharer rank of -4 would seem logical. As far as classes go, I do not have access to enough empirical data to calculate them, but if I get access to them, I will be more than happy to create a suggested level of values for them.

The beauty of the Sharer Rank system, in my own opinion, is the fact that it gives a site's owner the ability to change very specific things about their economy to create the utopian economic equilibrium. Modifying the bonus level modifier for each specific sub-function allows the staff to ensure activity, seedership, etc. and if they were to put a digressional formula between the old value and new value, the shock effect of a free leech would never happen.

As far as the end user is concerned, it makes it immediately more possible for users with slower connections to maintain a positive standing and decreases the disproportional effect someone “born into wealth” has by owning a fast connection. A full study on its effects would require an implementation and an entirely new discourse. But that’s another month’s work.

6 Conclusion

We’ve examined a tracker’s economy and the facets that create economic effects. From this, we’ve derived a new system, that takes into account the full study of rationomics, rather than base everything on a simple arbitrary data set. Understanding how rationomics works is logical both for the end user and for the staff. It is most definitely not bullshit, as has been claimed, and completely disregarding it is not even possible.