Time-Weighted AML

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Abstract

This technical whitepaper presents the design and implementation of TapiocaDAO's ***tw***, otherwise known as ***Time Weighted Average Magnitude Lock***. ***tw*** is a mechanism proposed as a solution for promoting sustainable economic growth for a decentralized finance ecosystem, while maintaining economic alignment among its participants. ***tw*** addresses issues created by the prevailing practice of liquidity mining, which results in small groups of opportunistic capital providers motivated solely by profit capturing all benefits at the expense of all other actors. ***tw*** was designed with game theory concepts to reach subgame perfect Nash equilibria, in contrast with liquidity mining where Nash equilibrium cannot be reached due to the presence of a dominant strategy. Details on the history of liquidity mining can be found in a research paper created by Pearl Labs [1]. This technical paper will also discuss ***tw's*** potential use cases for *oTAP* and *twTAP*.

Introduction

The intended purpose of liquidity mining is to increase and retain the amount of capital within a decentralized finance applications custody. This is achieved by rewarding capital providers with token incentives that often grant voting power. While this approach can stimulate short-term economic growth, it typically creates a negative feedback loop in which small groups of opportunistic capital providers disproportionately receive and benefit from the incentives, leading to a misalignment of interests between actors and the system itself. Thus, this short term economic growth is generally unsustainable for the system to maintain. Additionally, due to the typical inclusion of voting power in the incentives, plutocratic control of governance systems is often observed.

From a game theory perspective, liquidity mining creates a dominant strategy, or a strategy that always wins. This dominant strategy consists of participants supplying capital for a short period of time, selling the incentives, then withdrawing the supplied capital. This not only rewards opportunistic capital providers, but incentivizes all other participants to adopt the same strategy. This results in suboptimal outcomes for any other strategies and the overall system itself. The aim of ***tw*** is to eliminate the dominant strategy, and reach a subgame perfect Nash equilibrium, where participants are incentivized to act in the best interests of the system itself.

With these considerations in mind, ***tw's*** two primary purposes are to *minimize the negative consequences of incentivizing economic growth of the system* (1), and *maximize the duration that liquidity is retained in it* (2). This paper will outline the motivations and mechanisms behind ***tw's*** design to address these challenges.

Time Weighted Average Magnitude Lock (***tw***) is the mechanism Pearl Labs has designed to address the issues outlined above. ***AML*** serves as the foundation for *oTAP*, where it is employed as a measurement tool for the rewards capital providers receive for their selected escrow duration. ***AML*** is separately employed to create a democratized governance system in regards to *twTAP.*

With *oTAP*, capital providers are offered the right, but not the obligation, to over-the-counter (OTC) purchase *TAP* tokens at a discount via American-style call option contracts. This discount has *min* and *max* boundaries of 0.05 and 0.50, and is computed based on user "votes". The system is constantly converging toward a point, while users' votes are in constant divergence against it. The divergence is the weight applied on the system by a single participant, while the convergence is the aggregation of the common belief of all participants.

The divergence power of each user depends on the weight applied, the convergence point at the time of interaction, and the total number of users.

The **AML** system is designed to promote economic growth, and has been structured to make it easier for it to converge toward high value targets, and more difficult to drive this target back down. This acts as a protection against manipulation by bad actors.

1. Problem Solving

To address (1) "*minimize the negative impact brought by the incentivization of the system*". In the case of a lending & borrowing platform such as *Tapioca,* the proposed solution was iterated from an existing system, call option contract based liquidity mining (OLM) [2]. However, this mechanism employed a fixed discount, which we regarded as not adequately addressing (1), or having any remedy for (2).

The proposed solution for (1) also solves for (2) *"maximize the time that liquidity is present in it",* in that users must compete with one another in an atomistic market with their accepted escrow durations. In a positive growth environment, users are motivated to accept longer and longer escrow durations in order to obtain the maximum discount amount, leading to a net increase in the duration of time liquidity is retained within the system. Even in times of sluggish or declining economic activity, participants will accept escrow durations longer than necessary to receive the maximum discount to receive call options at the maximum discount level for longer durations.

oTAP

oTAP, a LayerZero ONFT721 [3], is a weekly right or option, but not the obligation, to purchase *TAP* discounted against its spot market price which is determined by ***AML*** at the time of escrow. This purchase is done over-the-counter (OTC) from the DAO. This right is valid for the entire length of the escrow duration, thus rewarding participants equitably throughout the escrow, up until its completion.

It was concluded that setting a constant or DAO defined duration of time to determine the discount awarded to the user is an inefficient methodology and offers little improvement over its predecessor, liquidity mining. Therefore, we designed a mechanism that aims to dynamically modulate itself in response to the two major types of economic conditions:

- Negative Economic Growth: Effectuates larger discounts for shorter escrow arrangements if economic growth of the system is limited or declining (low usage, low demand = higher incentives)
- Positive Economic Growth: Longer escrow arrangements needed to receive larger discounts if the platforms participant pool is robust and performing well (high usage, high demand = lower incentives)

The discount available for a given escrow duration dynamically modulates based on the system's current weighting of escrow duration length, decided by ***AML***. Because of the nature of o*TAP* as an ITM (in-the-money) American-style call option contract, it serves as a strong economic stimulus agent. Additionally, being a call option that is redeemed OTC, the *Tapioca DAO* will receive “Protocol Owned Liquidity” (POL) from options being exercised, which it can use to function as its own capital provider. *oTAP* does not grant voting power, addressing the issue of plutocratic control in liquidity mining.

Even during times of diminished economic activity, participants are still motivated to escrow for longer periods of time than the maximum discount calls for. Besides the financial incentive provided by in-the-money (ITM) option contracts, the ability for a participant to lock in the maximum *oTAP* discount level for a long period of time serves as a secondary financial incentive which is propagated by the psychological effect of competition acting as an additional extrinsic motivation to the participant. Overall, the system should autonomously adapt to economic activity within it.

oTAP helps to establish a predictable floor price for *TAP* and mitigates sell pressure by restricting the injection of non-circulating TAP to only occur against escrowed capital. In addition, there is a limited amount of *TAP* that is able to be redeemed via call options. These measures help to ensure that the value of *TAP* is closely correlated to the intrinsic value within the system, rather than being influenced by external factors.

2. AML

The ***Time Weighted Average Magnitude Lock*** is a tool that can be used by any system to amplify the effect of positive economic growth, and flatten its decay. It has a converging mechanism when taking into account the system as a whole, or the cumulative, that drives growth or decay, and a diverging mechanism, when taking into account single points in the system, or "accumulators," to allow voting for growth or a decay.

Model Definition

The divergence force of a user $D\left(w\right)$, also called *magnitude*, at the time of interaction t and the *weight* of the user w is computed as such;

$$D\left(w\right)_t = \left(\sqrt{w^2 + C_{t-1}^2} - C_{t-1}\right) \quad (3)$$

Where C represents the *cumulative.*

The *average magnitude* M is the reaction of the system to the *magnitude* of the user $D\left(w\right)$, and can be computed by dividing the sum of the *magnitude* and *average magnitude* to the number of points L, also called participants, at the time of interaction.

$$M\left(w\right)_t = \frac{D\left(w\right)_t + M\left(w\right)_{t-1}}{L_t} \quad (4)$$

From (3) and (4), we can compute the *cumulative* C

$$C_t = \begin{cases} C_{t-1} + M\left(w\right)_t, & \text{if } w > C \\ C_{t-1} - M\left(w\right)_t, & \text{otherwise} \end{cases} \quad (5)$$

The result of $D\left(w\right)$ can be then used as an input for a transformative function $F(x)$, combined with C_{t-1} to get the output that the system needs.

3. Case study

3.1 oTAP

a. Application

We want to apply **AML** to a system that solves for (1) and (2). We will create a voting platform that rewards its users for participating in its growth. Users will receive a discount, based on their voting power w, which in this case is in the form of time duration of escrowed liquidity.

We will be using a transformative function $F(x)$ to get a discount, bound between *0* and *50*, in a percentage manner.

Let d_{max} and d_{min} be the maximum and minimum amount of received discount, respectively.

$$d_{max} = 50$$

$$d_{min} = 5$$

The transformative function will be as such

$$F(x) = \begin{cases} \frac{D(w)_t \cdot d_{max}}{C_{t-1}}, & \text{if } C_{t-1} > 0 \\ d_{max}, & \text{otherwise} \end{cases} \quad (6)$$

The output of given a lock time is given per $O(x)$

$$O(x) = \begin{cases} d_{max}, & \text{if } F(x) > d_{max} \\ d_{min}, & \text{if } F(x) < d_{min} \\ F(x), & \text{otherwise} \end{cases} \quad (7)$$

Defense Mechanism

To prevent a system spam attack vector, *oTAP* sets a minimum liquidity weight amount for a divergent vote to pass, which is currently set at $k_{min} = 10$, in basis points. This means that a participant needs to have at least *0.1%* in liquidity from the total that is being locked to be able to diverge the system.

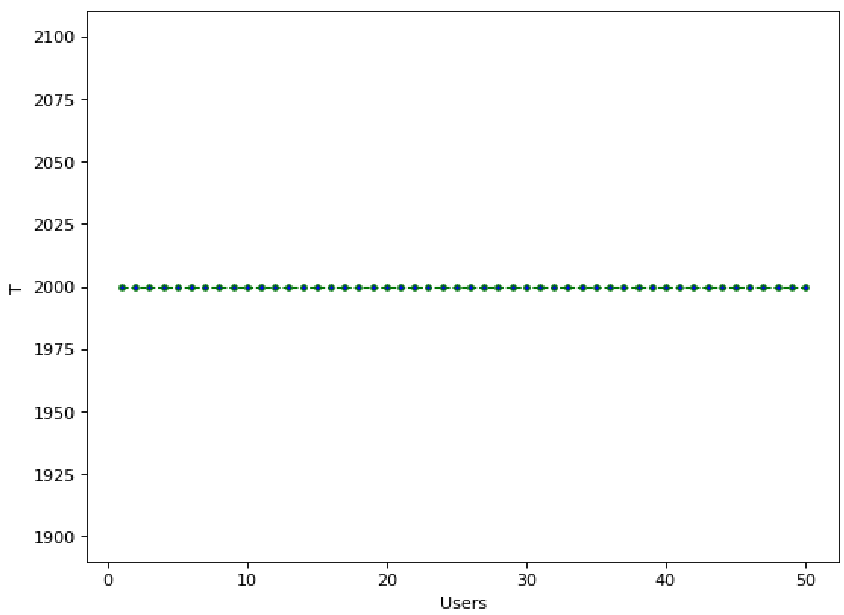
In a decaying scenario, the negative pressure on the *cumulative* is greatly reduced, as the *weights* of the system must be adjusted in a linear fashion to follow the trend. However, this can only occur if a significant portion of participants decide to forfeit their positions through lock-up expiry, and do not engage in new escrow commitments. This potential issue is mitigated by the diversity of escrow expiry dates among the participants.

b. Observations

Let's apply **AML** with the previous transformative formula to test multiple scenarios that could occur to the system.

Starting with a neutral scenario, where the system doesn't grow or decay. Users will commit to a constant weight, where the divergence effect of the users is negated and they simply choose to converge toward a single point.

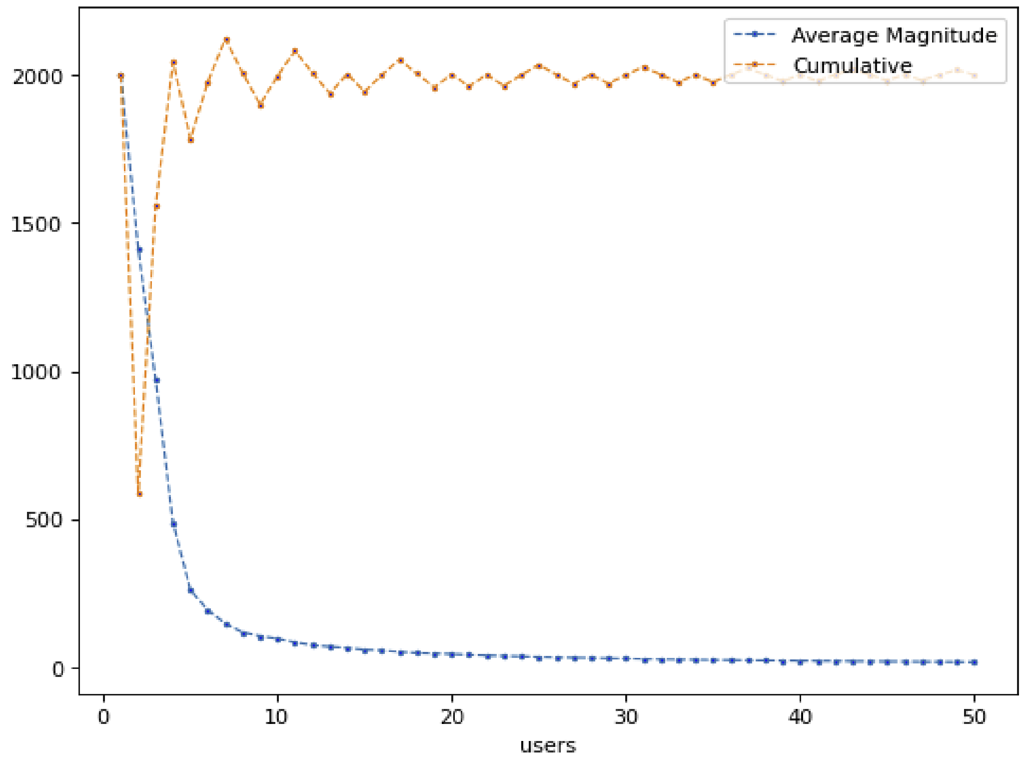
b.1 System Convergence with Non-Divergent Participants



(8)

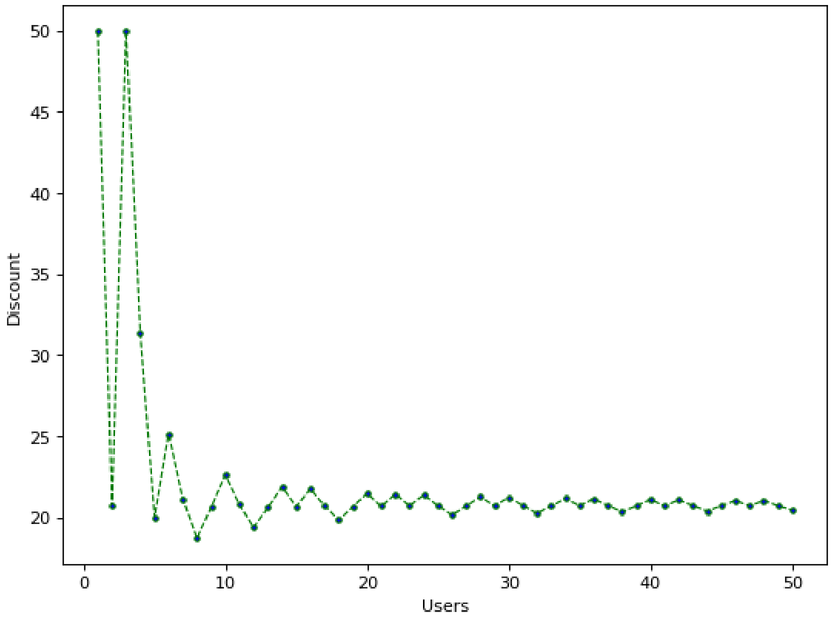
We have in this scenario a pool of *50* participants, which represents the *x-axis*, and a *y-axis* representing the locked time, denoted by T, which will represent the weight of a participant w, on an hourly scale.

The reaction of the system is the following.



(9)

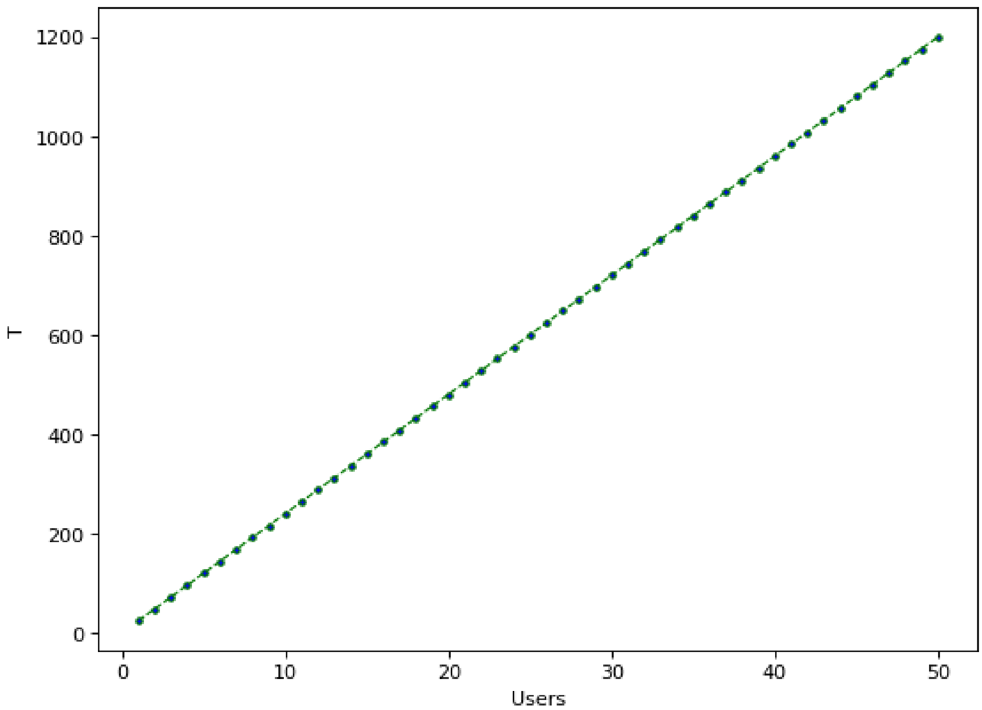
The *average magnitude* plays a key role in directing the system during each iteration. However, in this neutral scenario, the effects of the average magnitude are neutralized, resulting in a force that tends towards zero. This decrease in the divergence has a lessened impact on the *cumulative*. We note that the *average magnitude* represents a growth or decay, it is mathematically always positive, but will be impact either positively or negatively the *Cumulative* C, given *(5)*.



(10)

As the number of users increases, the system tends towards a collective goal and stabilizes itself more effectively. We observe on (10) that in a constant weight scenario, the received discount oscillates within a range of *20%*.

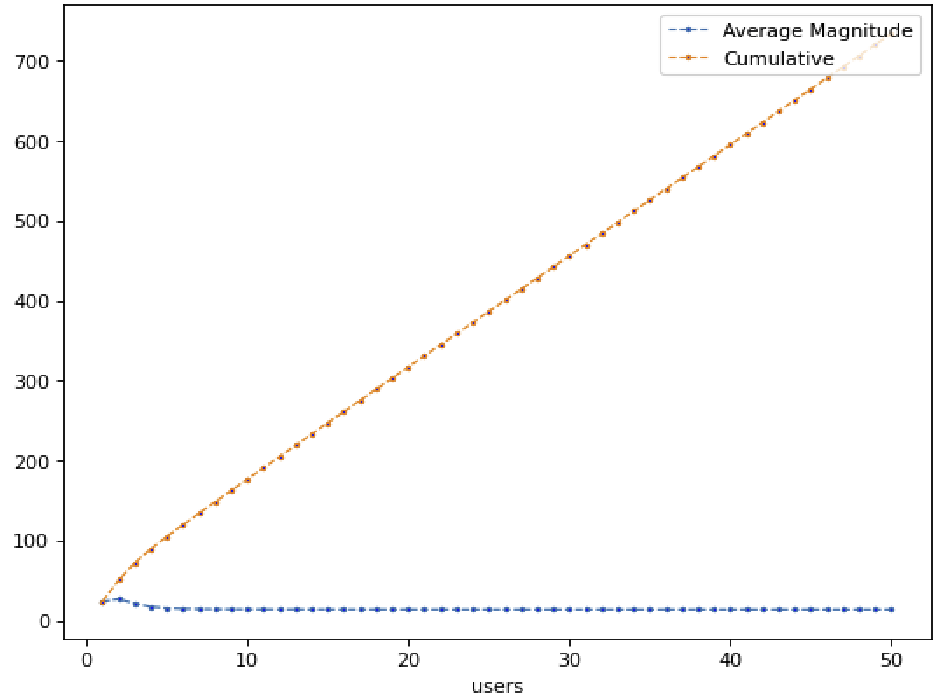
b.2.1 System Convergence with Growth Based Divergent Participants



(11)

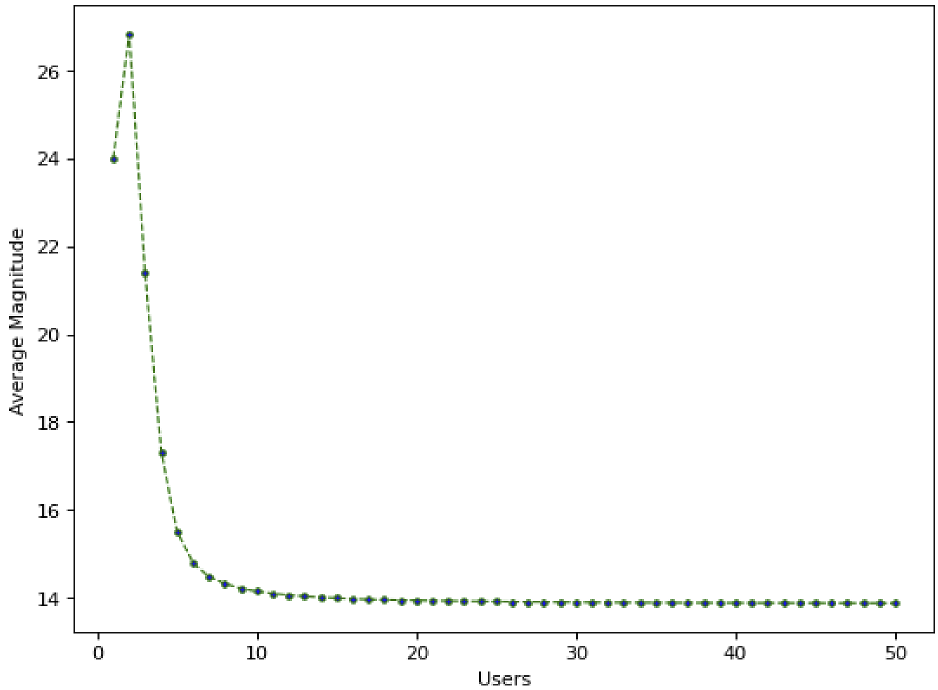
We have in this scenario a pool of *50* users, we start off with $T = 24$, each new user lock with a value $T = T + 24$, at the end we reach a value of $T = 1200$.

The reaction of the system is the following.

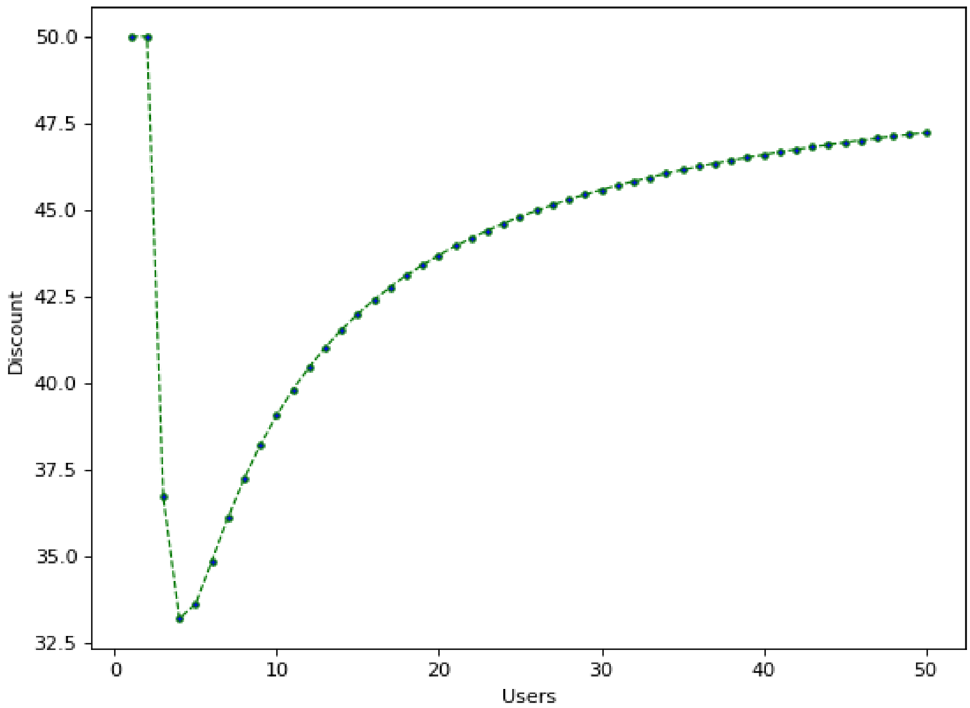


(12)

We observe a linear rise of the *cumulative* and a rather stable *average magnitude*, due to the linear lockup the participants are executing. We can zoom further to better see the average cumulative.

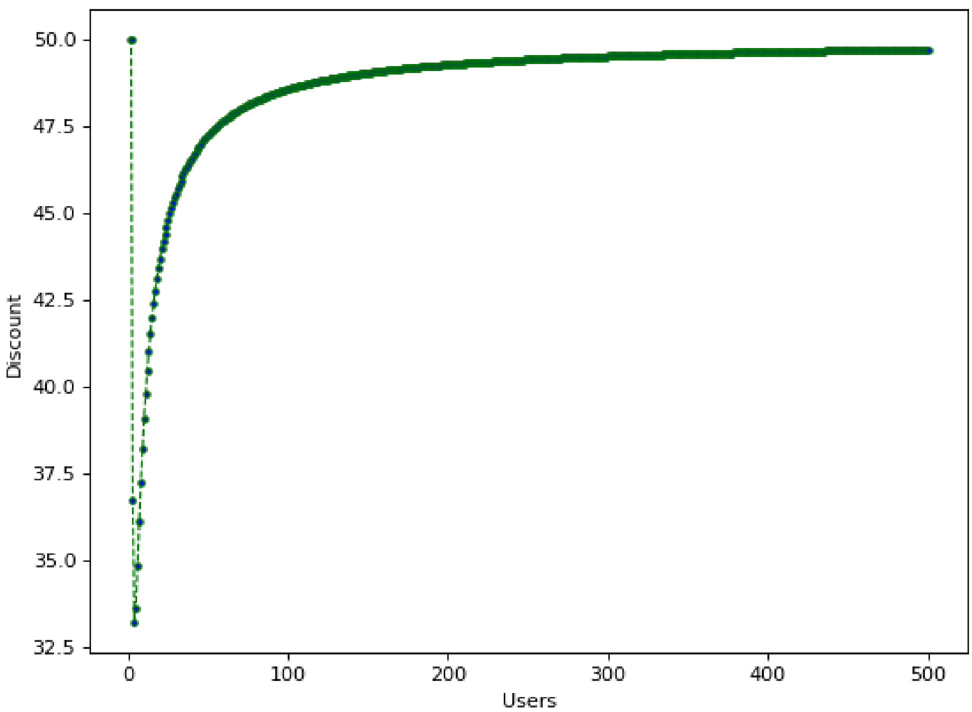


(13)



As per the discount on the y-axis, we observe it gradually reach the maximum of *50%*.

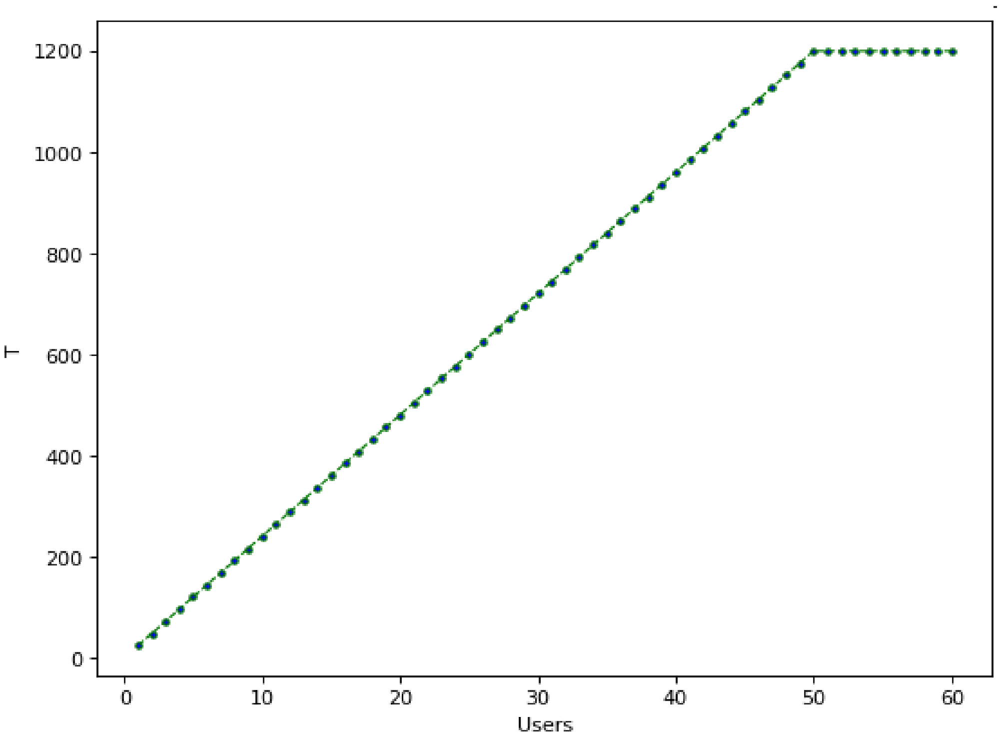
(14)



(15)

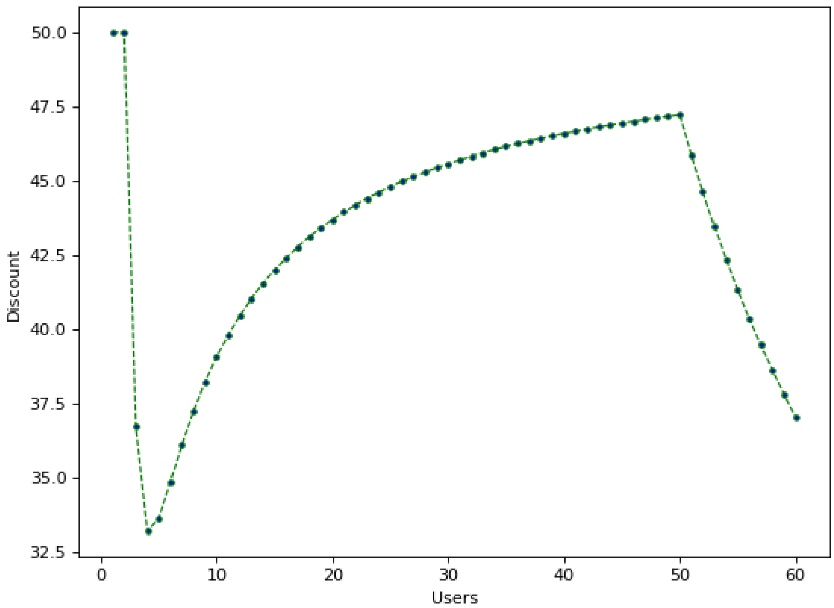
As the user base of the system increases, subsequent users are required to commit to progressively longer escrow durations to continue receiving the maximum discount. This encourages continued economic growth of the system.

b.2.2 Static Lockups



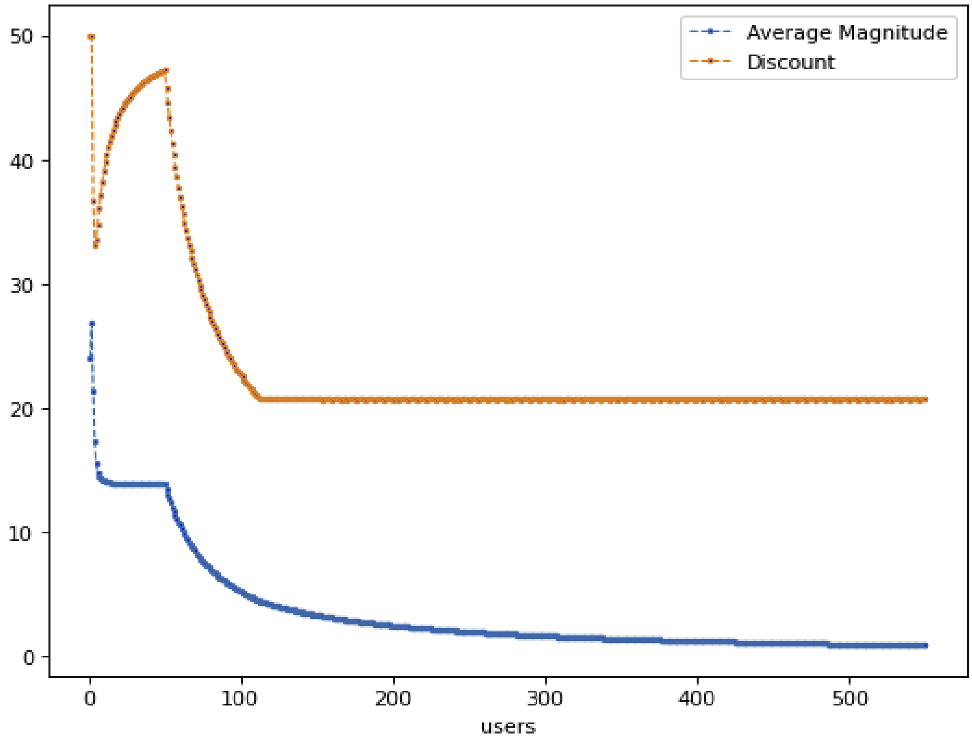
(16)

By following the previous scenario and applying a static lockup period where users only lock for $T = 1200$, which is the previous highest lockup period, it is observed to sustainably promote economic growth, as evidenced by the reduction in rewards as described in (17).



(17)

The presence of uncertain participants, who lock to a fixed value, leads to recalibration within the system. This process consists of transitioning from a state of growth, to decay, and ultimately, as more epochs occur, to a stable non-divergent system. The dynamics of this process are clearly illustrated in (18).



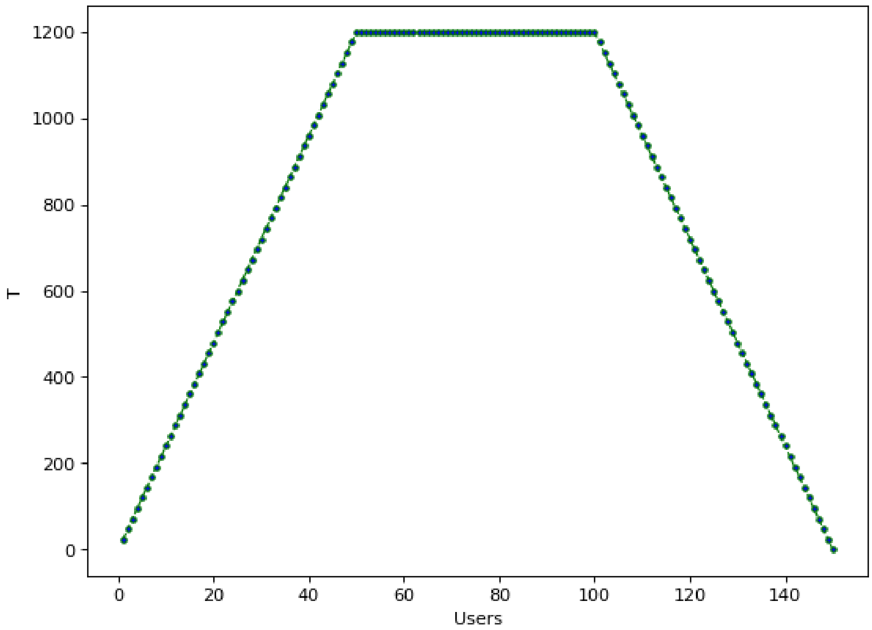
(18)

500 non-divergent users

The previous scenario results in a decrease in both *discount* and *average magnitude* for each consecutive user, as the system attempts to recalibrate and converge towards a common output for all subsequent participants (which happens at $users = 100$). This behavior is clearly evident when analyzing the system's output.

b.2.3 Decaying Divergence

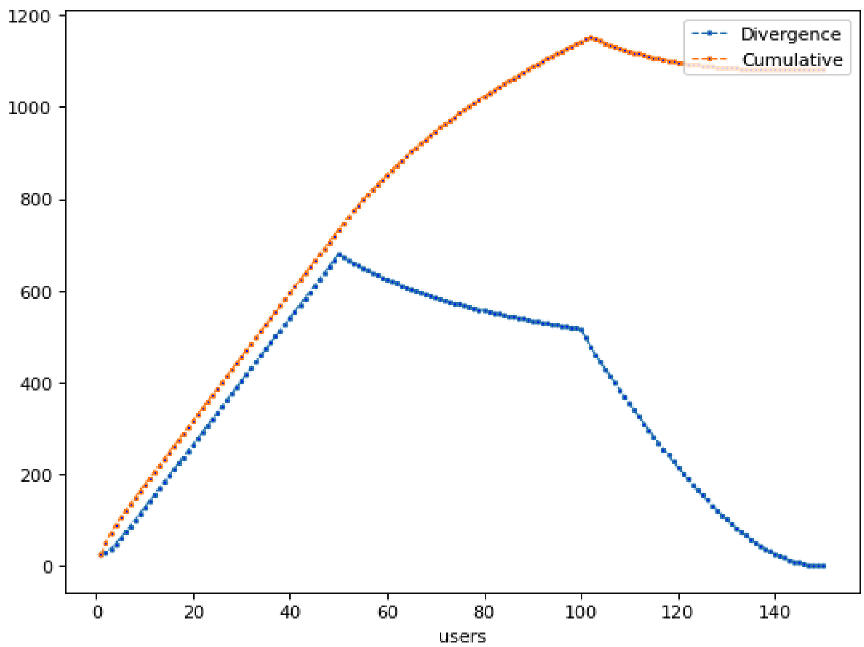
Let's follow with a negative growth scenario, where users will lock less and less time, we will start with $T = 1200$ and continue over *50* users decaying with $T = T - 24$.



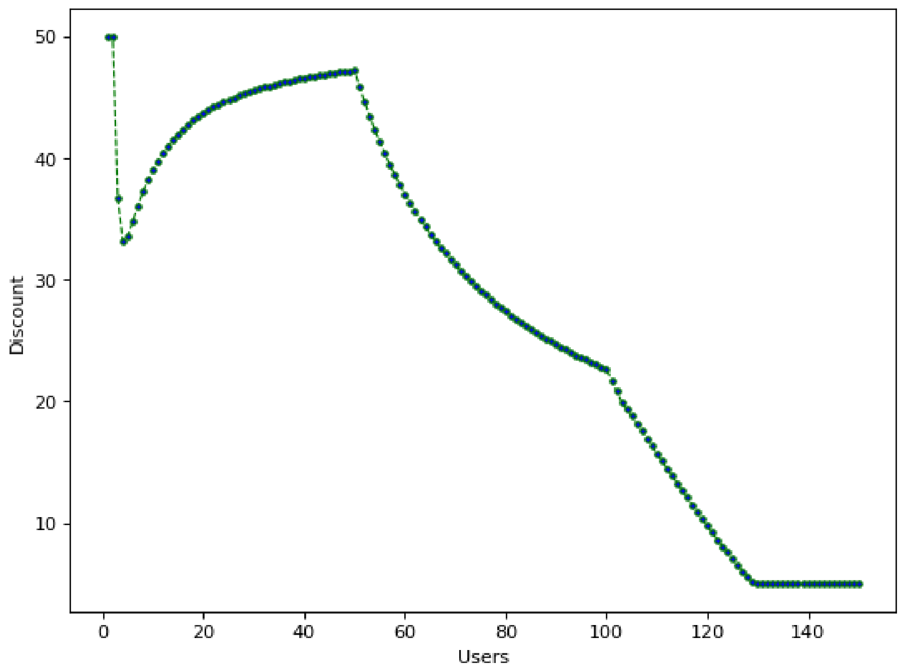
(19)

In this scenario we will observe in (20) that the *cumulative* will decay, but at a slow rate, this is due to the fact the farther the *weight* strays from the *cumulative*, the less it will impact its decay.

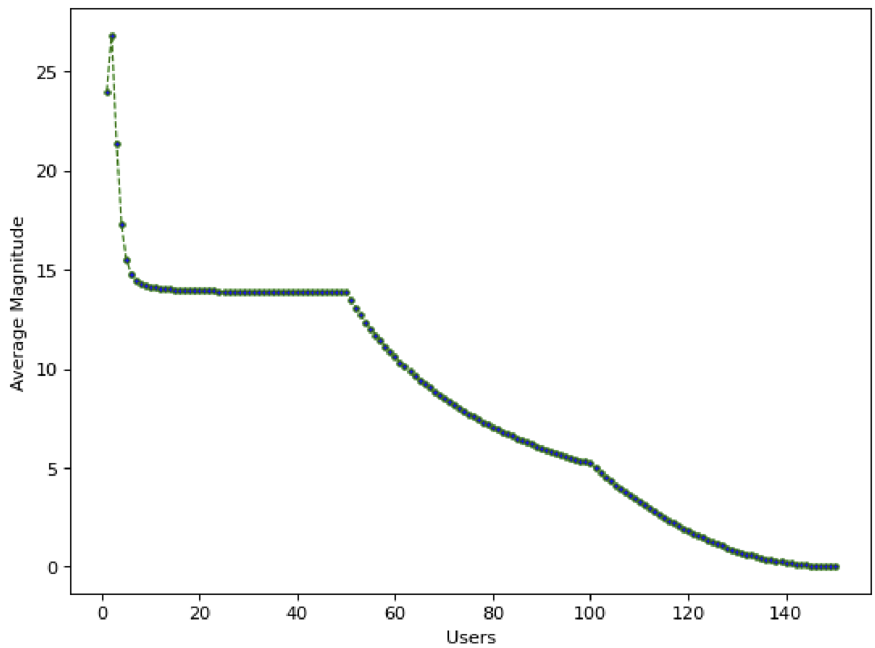
This choice of design creates "fast growth and slow decay". As such, the *discount* will gradually attain the flattened out value of *5%* as seen in (21).



(20)



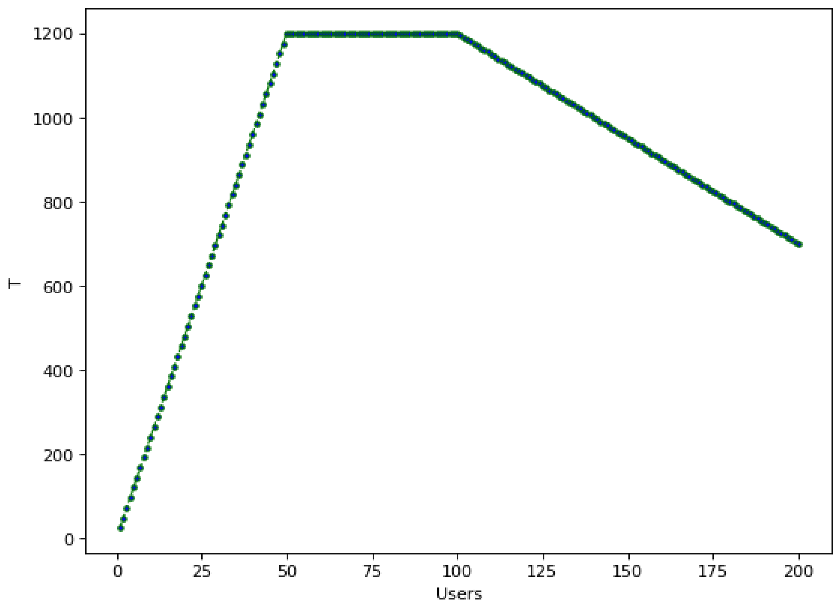
(21)



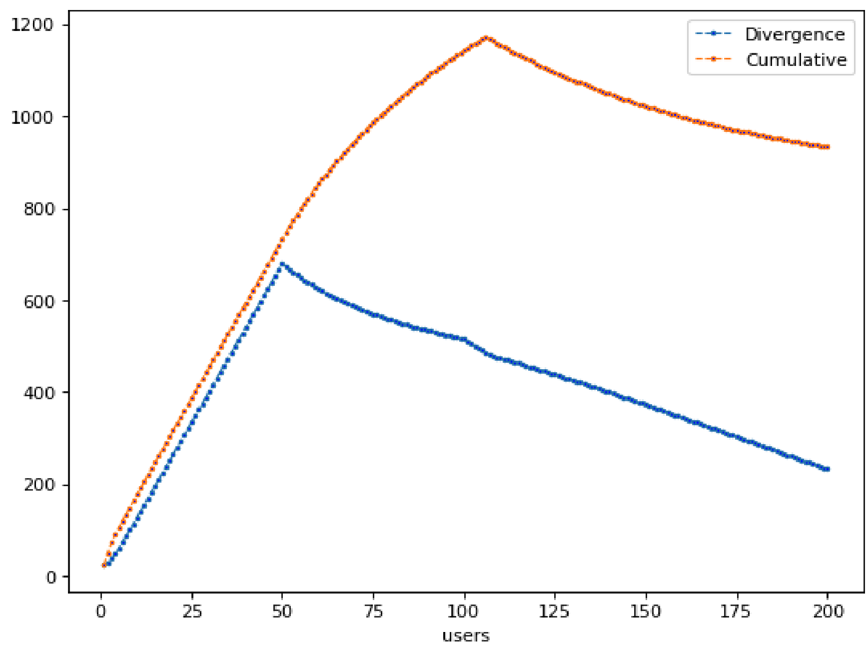
(22)

The *average magnitude* is the actual positive/negative change put on the *cumulative* as per (5). To apply larger pressure on the *cumulative*, we need a *weight* that is closer to the *cumulative*, due to the fact that (4) output can be influenced by either the number of participants L, or the *magnitude* as shown in (3).

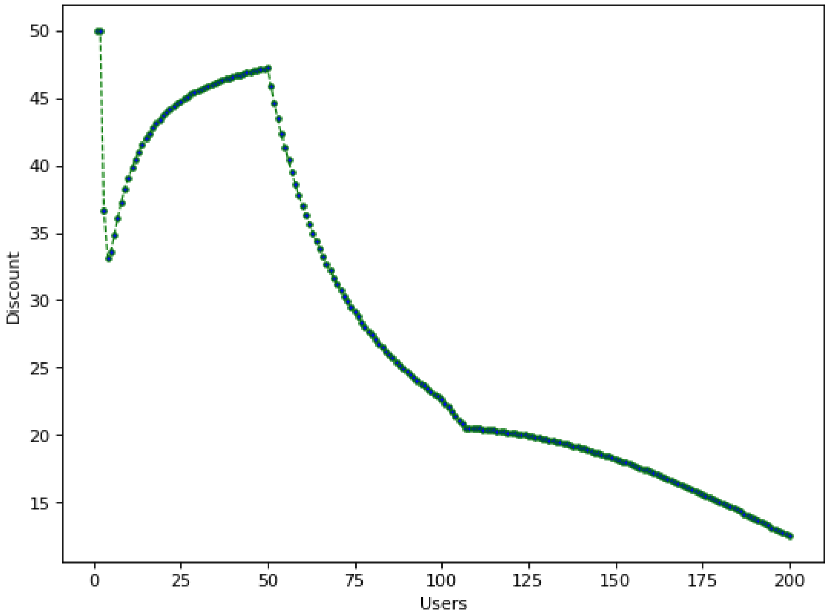
Let's try with $T = T - 5$.



(23)



(24)

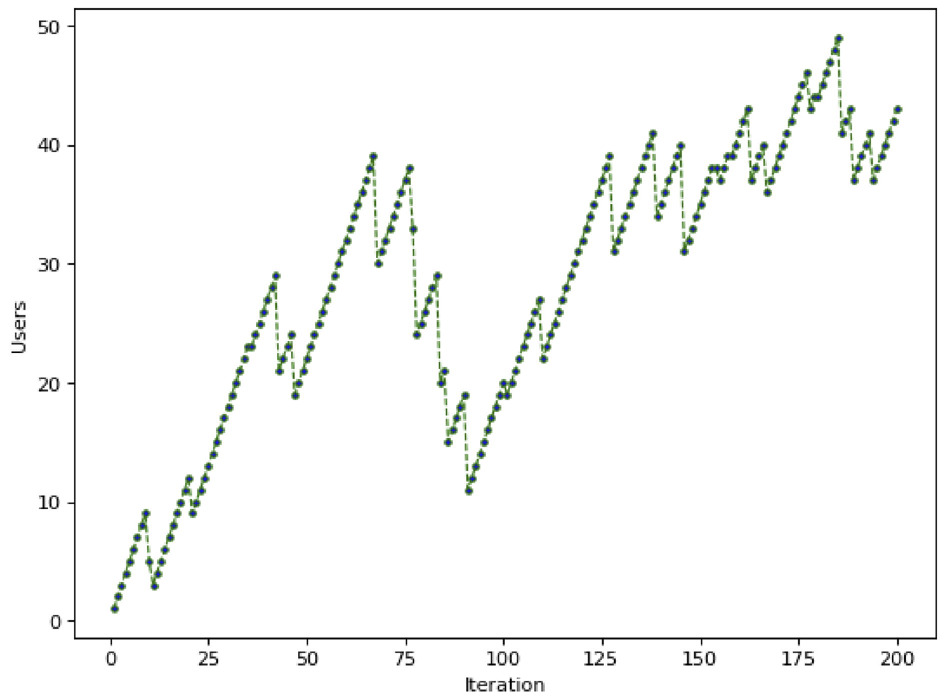


(25)

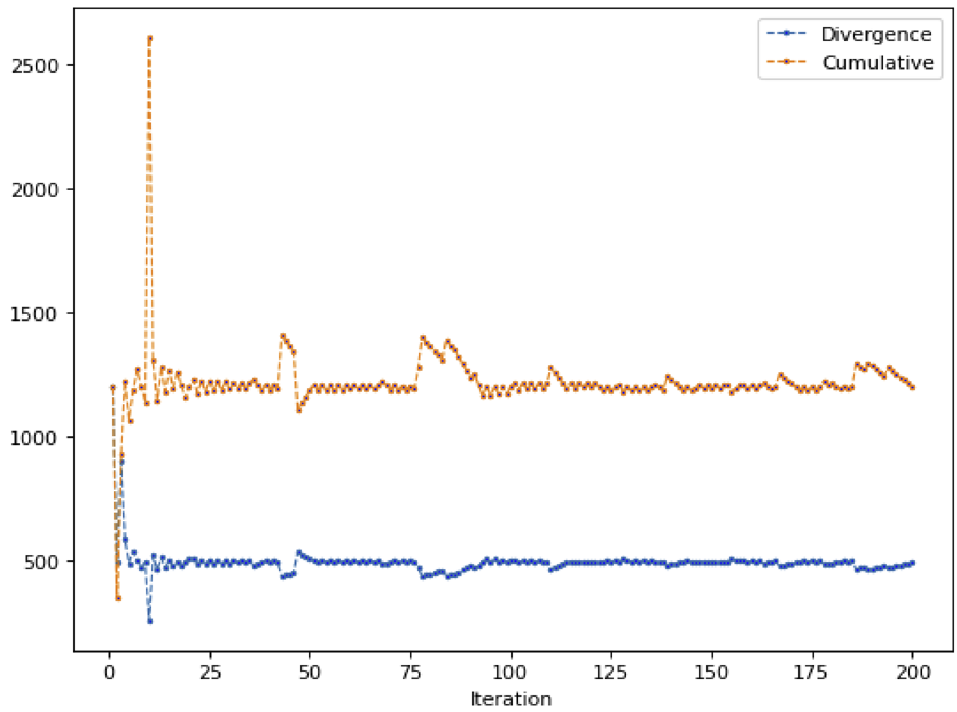
A more potent pressure is applied on the *cumulative.* The decaying effect was also reduced because of an epoch of growth, caused by the static lockups in **b.2.2**, which makes it harder to influence the *cumulative*.

b.2.4 Random Participant Forfeiture

The previous scenario employed linear changes in the number of participants, a more realistic approach involves reducing the number of participants during the epochs, as presented in (26). Instead of using the number of users as the independent variable on the x-axis, this revised scenario employs the term "iteration" and involves the random generation of user forfeiture. We will use the **b.1 System Convergence with Non-Divergent Participants** scenario to showcase this effect in place.

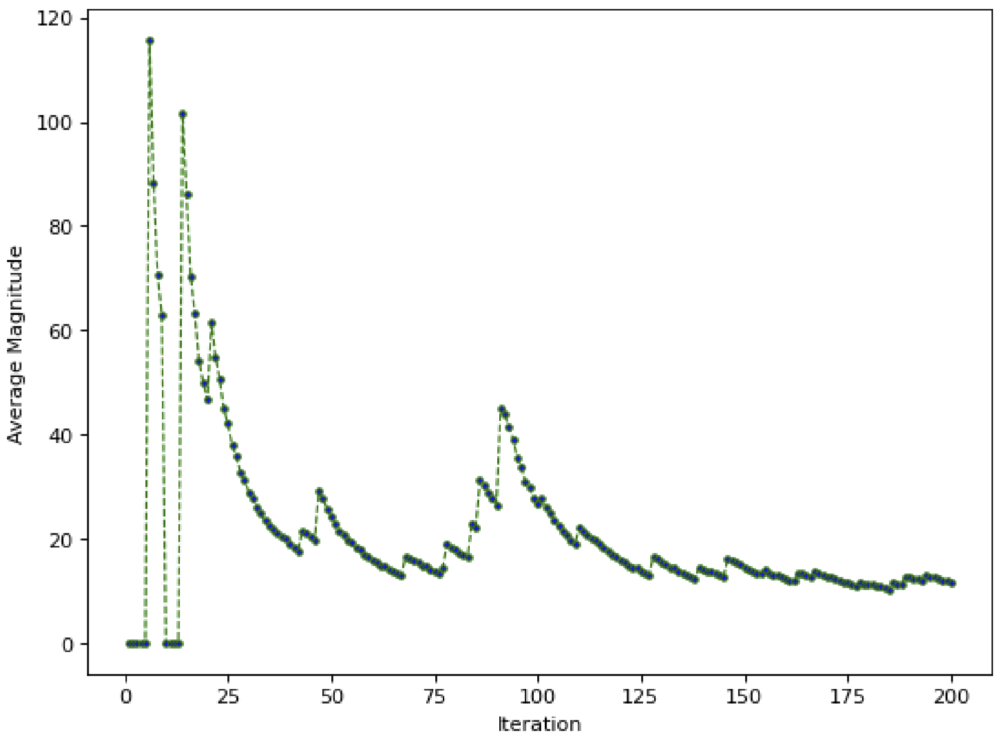


(26)



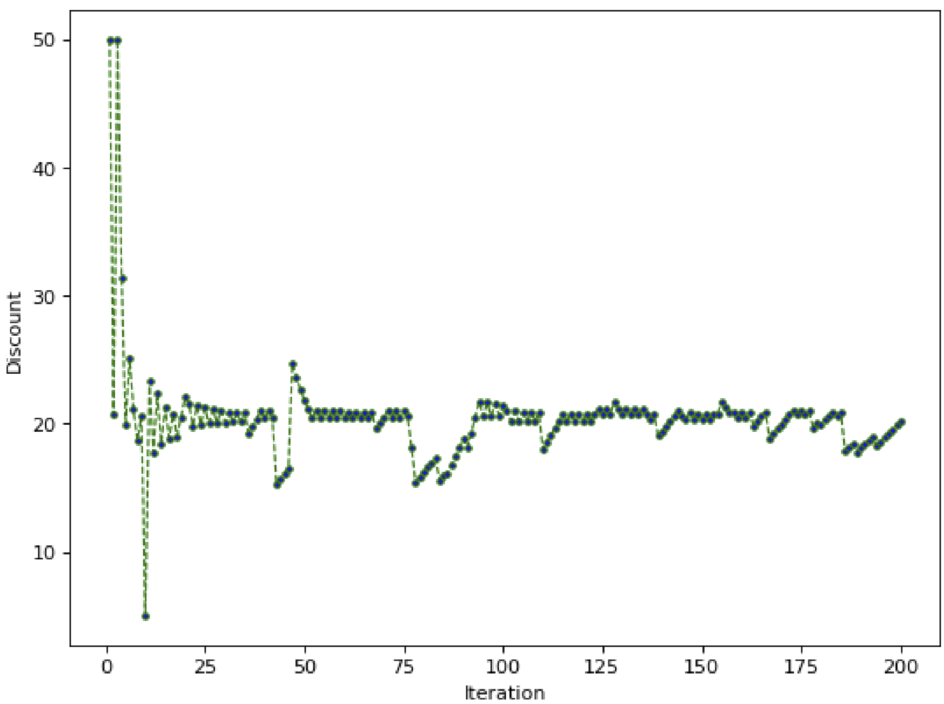
(27)

We can note that the *divergence* power of a user acts as intended as an inverse force against the *Cumulative*.



(28)

We set the first 5 values of the previous graph (28) to 0 so that the reader can observe the smaller changes in .



(29)

3.2 twTAP

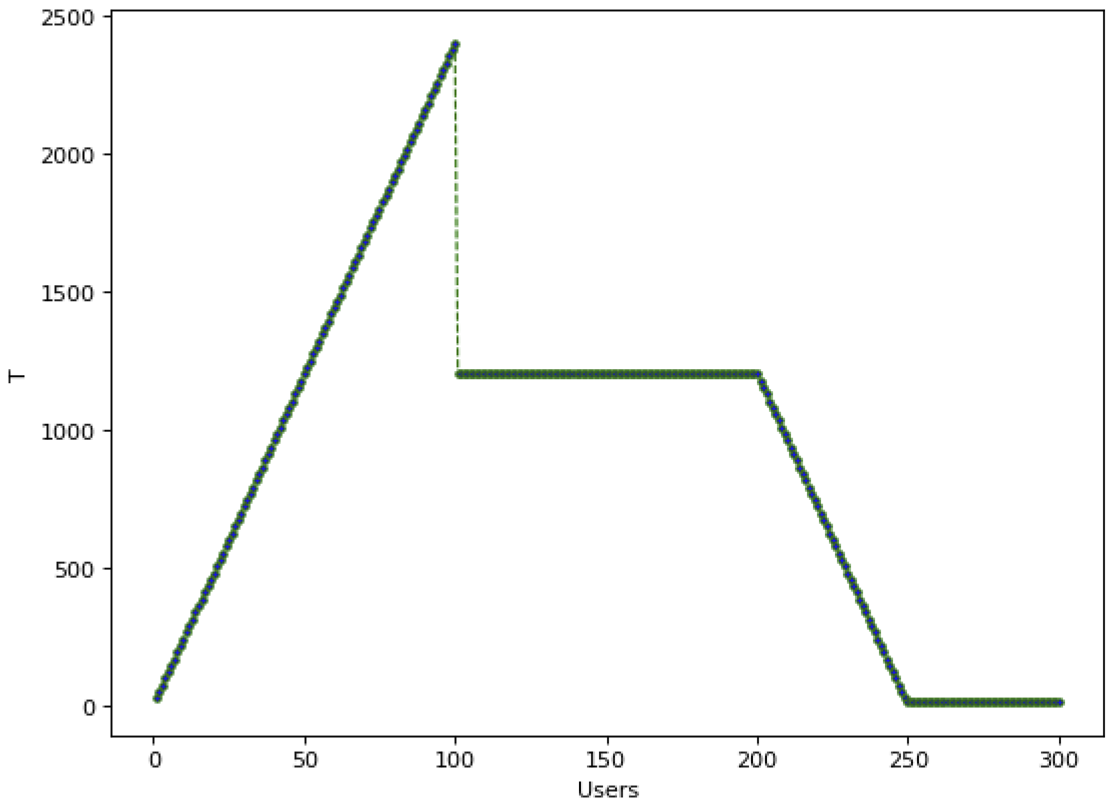
a. Application

AML will also be employed to create a new governance system for *Tapioca*. *twTAP* is a LayerZero ONFT721, and is used to determine each user's voting power in governance systems. This mechanism thus serves as a way to participate in DAO governance, and additionally for participants to receive shares of platform revenue. It receives *TAP* as an input, as well as a time *weight* to mint a certain amount of *twTAP* at a certain point in time t.

The transformative function (6) $F(x)$ will be the same as the one used for *oTAP,* with the exception of two variables, the $dmax$ and $dmin$ which will be set at *1.00* and *0.10* respectively. These variables act as the boundaries for the ratio that will determine the output of *twTAP*, given the specific input amount of *TAP*. As a result, there is no limit on lock time.

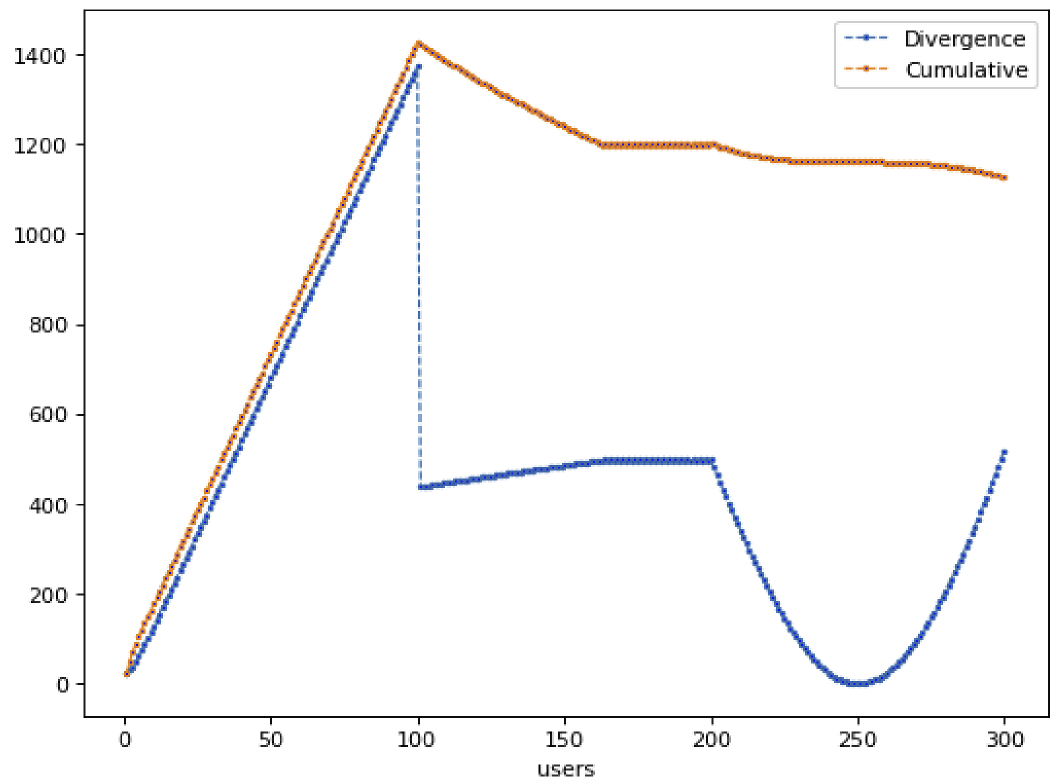
b. Observations

Let's observe growth, neutral, and decay scenarios:

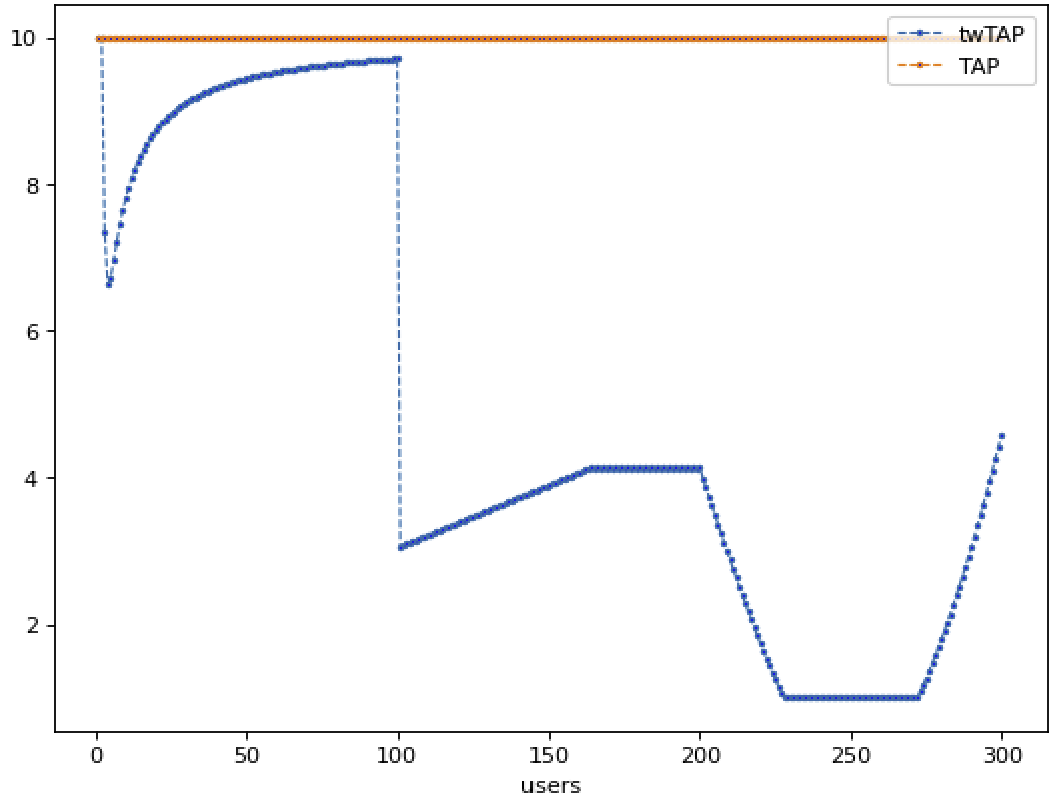


(30)

In various scenarios, the system must adapt to fluctuations in the duration of user lock time. For example, in the last phase when the user count surpasses 200, ***AML*** experiences a period of decay. Subsequently, it then enters a state of stagnation, before ultimately aligning with the trend of the magnitude to experience a rise.



(31)



(32)

In the scenario outlined (32), the multiplier ratio serves as a determinant of the quantity of *twTAP* that a user will receive. The quantity of escrowed TAP held constant, the resulting output varies in accordance with the time commitment and the current AML. During periods of economic expansion, the multiplier ratio decreases, making accumulation difficult and necessitating larger time commitments. Conversely, during periods of economic decline or stagnation, the multiplier ratio increases, thus facilitating accumulation and reducing the required duration of time commitment.

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