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Article

A New Approach to Create Sustained Ponzi-Like Systems by Incorporating Perpetual Liquidity and Time Epochs

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***Abstract**: This paper leverages the transformative capabilities of blockchain technology to introduce a new approach to developing Ponzi-like systems by integrating perpetual liquidity and time epochs within immutable smart contracts. Blockchain's transparent nature establishes a foundation for trust in the ecosystem. Departing from the unsustainable nature and inevitable collapse associated with traditional Ponzi schemes, the proposed framework ensures continuous token availability, mitigating supply depletion and thus minimizing system failure risk. The introduction of time epochs is a key feature that enhances the sustainability of our system. It enables continuous rebalancing, predictability, and transparency within the system. Through predetermined intervals, users can claim a percentage of tokens from previous epochs, ensuring a fair distribution mechanism and preventing stagnation. This predictable cycle fosters the user's confidence in the longevity of the protocol. The mechanics of the proposed system are designed to incentivize rational behaviour and trust among participants. Users are motivated to contribute to the ecosystem, knowing that their efforts will be reciprocated with proportional rewards. We design, implement and present the new model as a paradigm shift in Ponzi-like structures. Through a multidisciplinary lens encompassing economics, game theory, and sustainable development, this research aims towards fostering long-term viability and ethical financial practices.*

***Keywords**: Ponzi scheme; sustainability; smart contracts; blockchain.*

1. Introduction

Ponzi schemes are fraudulent investments that lure investors with promises of high returns with little or no risk. In a typical Ponzi scheme, returns are paid to earlier investors using the capital newer investors contributed rather than profits generated by the investment or business. This unsustainable model inevitably collapses when there are not enough new investors to support the returns owed to earlier ones.

Ponzi schemes are named after Charles Ponzi, an Italian immigrant to the United States, who executed the first documented Ponzi scheme in the early 1920s (Frankel, 2012). Ponzi promised investors exorbitant returns within months based on an arbitrage scheme involving postal coupons. His scheme became wildly popular, attracting millions of dollars from thousands of investors. However, Ponzi's system relied heavily on a constant influx of new investors, and it ultimately collapsed when his

fraudulent activities were exposed, leading to significant financial losses and Ponzi's imprisonment (Artzrouni, 2009).

Ponzi schemes can take on various forms, but they all share the same basic principle: using money from new investors to pay returns to earlier investors. Some common types include (Jory, Perry, 2011):

- **Classic Ponzi Schemes** are the simplest form, where a promoter promises high returns, attracts new investors, and uses their capital to pay earlier investors. Eventually, the flow of new investors slows, and the scheme collapses. Classic Ponzi schemes are possible even in today's world based on the innovative ways fraudsters are able to build and maintain trust over years (Carey, Webb, 2017).
- **Pyramid schemes** involve a multi-level structure, where participants recruit others to join, often with the promise of high commissions or returns for each recruit (Bosley, Knorr, 2018). Similar to Ponzi schemes, pyramid schemes often emphasize recruitment over actual investment. One of the most common confusions is between pyramid Ponzi schemes and multi-level marketing (MLM). These are two distinct business models with key differences (Krige, 2012). MLM is a legitimate business structure where participants earn money by selling products or services and recruiting new members into their downline. The focus is on direct sales, and commissions come from product sales and bonuses based on the sales volume of the team they build. Ponzi schemes, on the other hand, focus on recruitment and redistribute investors' money to create the illusion of profits. As the silver line between these is relatively narrow, there are ethical concerns related to the implementations of MLMs (Koehn, 2001). MLMs are subject to legal regulations to ensure they do not become pyramid schemes, where recruitment becomes more important than product sales. In contrast, Ponzi schemes are inherently fraudulent and unsustainable, often collapsing when they run out of new recruits.
- **Affinity Frauds** target specific groups, such as religious organizations, social clubs, or ethnic communities. The promoter exploits trust and common bonds within these groups to attract new investors (Blois, Ryan, 2013).

Numerous high-profile Ponzi schemes have made headlines over the years, highlighting the widespread impact of these fraudulent activities. Perhaps the most infamous modern Ponzi scheme, Bernie Madoff's operation lasted for decades and defrauded thousands of investors of billions of dollars (Manning, 2018). Madoff's scheme collapsed during the 2008 financial crisis, leading to his arrest and eventual conviction. Allen Stanford ran a massive Ponzi scheme through his Stanford International Bank, promising high returns on certificates of deposit (Deason et al., 2015). His scheme collapsed in 2009, resulting in significant financial losses and a 110-year prison sentence. Known for managing boy bands like the Backstreet Boys and NSYNC, Lou Pearlman operated a Ponzi scheme through his Trans Continental companies, defrauding investors of hundreds of millions of dollars. His scheme collapsed in the mid-2000s, leading to his imprisonment (Hatschek, 2009).

Blockchain technology, at its core, has revolutionized our understanding of data, transactions, and decentralized systems (Sarmah, 2018). It's a distributed ledger that enables secure, transparent, and immutable record-keeping without a central authority. This technology's potential to provide transparency and reduce fraud has led to its widespread adoption across several industries, from finance to supply chain management.

Smart contracts (SCs) are self-executing contracts with the terms of the agreement between parties written directly into lines of code. They run on blockchain networks like Ethereum, allowing automated and tamper-resistant execution of contractual agreements. Smart contracts can automate complex processes, reduce the need for intermediaries, and ensure that contractual obligations are met.

Due to their transformative potential, blockchain and SCs can be used for other purposes, including the creation of better Ponzi-like schemes. The use of blockchain and SCs in Ponzi schemes has opened up new avenues for innovation and raised significant ethical questions. In this context, blockchain's transparency can be harnessed to build Ponzi systems that are more resilient and longer-lasting. The immutability of blockchain ensures that once a scheme is deployed, it cannot be altered, providing a sense of reliability to participants. Smart contracts can automate the distribution of returns based on predefined rules, creating an illusion of predictability and fairness.

Nevertheless, this article aims to cover the theoretical aspects of using the possibilities brought by the emergence of the SCs to develop a "sustainable" Ponzi-like system. The very use of the two words ("sustainability" and "Ponzi") in the same sentence seems rather strange. However, our aim is to provide a theoretical framework focusing on the reconciliation of the two notions.

2. Ethical Considerations

Supposedly, in a theoretical situation in which every individual knows that they are participating in a Ponzi scheme, one could argue that there are no ethical issues. In this case, the main question is whether a Ponzi scheme is still considered a fraud. According to several studies (Raval, Va, Raval, Vi, 2019; Wilkins et al., 2012), a Ponzi scheme is, by its very nature, fundamentally unethical, regardless of whether participants are aware of its structure. One of the key ethical considerations is its unsustainable structure. Ponzi schemes inherently lack a sustainable business model (Rosca et al., 2017).

Another area for improvement is the inequitable distribution. Even if participants understand that a scheme is a Ponzi structure, there is an inherent inequity in how the returns are distributed. Those who join early may profit, but their gains are at the direct expense of later participants. This inequitable redistribution creates a zero-sum game (Boshmaf et al., 2020), which is inherently unethical. The fraudulent aspect of a Ponzi scheme goes beyond whether participants are aware of the structure. Even if participants willingly engage in a Ponzi scheme, it remains illegal in many jurisdictions. Laws against Ponzi schemes aim to protect consumers from fraud and financial harm (McDermott, 1998). Even with full knowledge, engaging in illegal activity carries significant ethical and legal risks. Ponzi schemes can have broader negative impacts on society. They undermine trust in legitimate financial systems and can cause widespread financial harm to individuals and their families (Hock, Button, 2023).

Leaving aside the ethical and legal issues surrounding Ponzi schemes, this paper explores the possibility of using a SC for creating a system that can change the fundamental nature of a Ponzi scheme, where early participants are at the expense of those who join later. Several older studies tried to accomplish a similar objective, but their practical implementation was difficile as they lacked the technology to implement such systems (Bhattacharya, 2003; Forslid, 1998).

3. Mathematical Modelling

The mathematical model of a classic Ponzi system has been described in (Artzrouni, 2009). According to this study, any Ponzi scheme can be defined based on the density of withdrawals W(t):

$$W(t) = r_w \left(K e^{t(r_p - r_w)} + \int_0^t s(u) e^{(r_p - r_w)(t-u)} du \right) \quad (1)$$

where r_w is the withdrawal rate, r_p is the rate of return, K is the initial capital amount, t is the current time, u is a time between 0 and t, and $s(u)$ is the amount invested at the time u. Considering adding an exponential growth s_0 with an investment rate r_i, eq. 1 is transformed to a differential equation:

$$W(t) = r_w e^{t(r_p - r_w)} \left(K + s_0 \frac{e^{t(r_w + r_i - r_p)} - 1}{r_w + r_i - r_p} \right) \quad (2)$$

The key aspect of these equations is the finality of the time, which flows in a single direction. However, we propose to eliminate the finality of the system by saving a portion of the capital and by restarting the system. Considering a multi-epoch approach with the numbering n and savings factor f_{sv}, we can alter the eq. 2, so that we can save some of the capital from current epoch n to be used in the following epoch, $n+1$:

$$W(t,n) = r_w e^{t(r_p - r_w)} \left[K_n (1 - f_{sv}) + s_0 \frac{e^{t(r_w + r_i - r_p)} - 1}{r_w + r_i - r_p} \right] \quad (3)$$

4. The Development of the SC

In a tokenized closed system, the rewards are highly dependent of the price of the token used by the participants, which is subject to fluctuations that originate from the interaction between demand and supply. Thus, the rewards of the system can vary, usually favouring the first participants.

One of the first measures that can be taken to mitigate this situation is to peg the token to the value of constant coin, a tether such as USDT. This peg gives users confidence to transact and hold the system token, assuring them that the value of their rewards will remain consistent. Given the deterministic nature of the SCs programming languages, this can be achieved using an oracle, a service that gets information from the world outside the blockchain (Pasdar et al., 2023).

An additional feature that can add predictability is a fixed Annual Percentage Yield (APY), also pegged to the specific fiat currency rate. This ensures that users are guaranteed a steady APY, as long as the token price stays stable. Taking these 2 actions basically transform any ERC-20 token (the standard for fungible tokens on EVM chains) into a replica of a real-life monetary system (Bauer, 2022).

An treasury (a SC) can maintain and manage the rewards autonomously. Inflows into the treasury occur when users decide to participate in the system, while outflows occur when users withdraw rewards. Based on the flexibility brought by SCs, the system can be set to allow users to withdraw rewards after fixed periods of time (e.g. daily). Additionally, using a programmatic language such as Solidity or Rust allows the system to consider the introduction of random factors. For example, withdrawing funds from the treasury can have a success rate lesser than 100%. This means that there is a chance that users may not receive their allowance, thus releasing some of the pressure brought by the increase of the $W(t,n)$.

Another interesting concept is the use of trading fees. SCs can be programmed to infer a trading fee on each autonomous market maker trade (Xu et al., 2023), whether it is a market sell or a market buy. These funds can be used to further strengthen the sustainability of the system.

Moving on, we introduce the concepts of perpetual liquidity and system epochs. These 2 new features change the nature of a Ponzi scheme. By introducing perpetual liquidity, the protocol ensures that there is always a supply of tokens available for users to claim, even after the initial treasury has been depleted. The term "perpetual liquidity" refers to the fact that at the end of each epoch, there will always be a certain liquidity part that will ignite the next epoch. This prevents the system from collapsing once all tokens have been claimed (once the Ponzi scheme reaches finality). With the start of each new epoch, users are given the opportunity to claim a portion of the tokens from the old protocol epoch. Such a mechanism ensures that the protocol remains balanced and sustainable over time, as users are incentivized to continue participating in each new epoch to claim their share of tokens. This continuous rebalancing mechanism prevents the protocol from stagnating, providing ongoing opportunities to engage with the system.

The introduction of epochs brings predictability to the system, as users know that a new epoch will begin once the previous one ends. This predictability allows users to plan their participation in the protocol accordingly, enhancing trust in the system. From a game theory perspective, the perpetual liquidity mechanism incentivizes rational behaviour among users. Users are motivated to participate in each epoch to claim their share of tokens, knowing that their rewards are directly proportional to their participation in previous epochs. A graphical description of this mechanism is presented in Fig. 1.

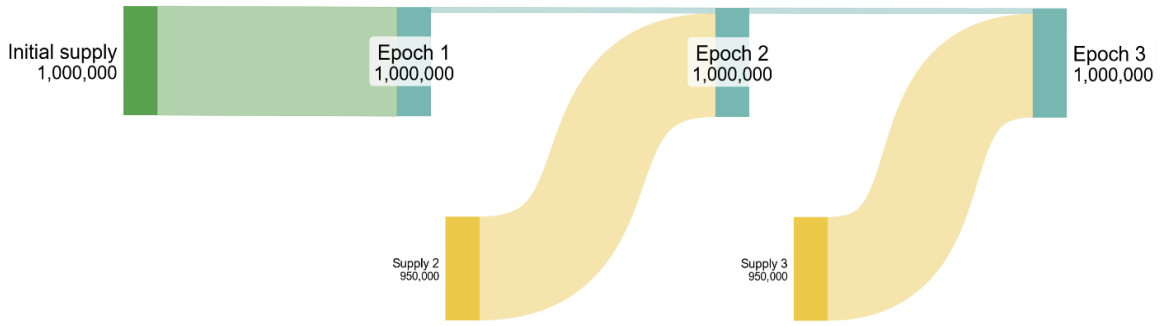

Figure 1. Example of a system based on 1 million tokens, which only the first 3 epochs being drawn

Having an amount of tokens that are set aside until the new epoch is activated adds an innovative dimension to the ecosystem, providing a framework for community engagement. For example, for each

new epoch, users can select a central narrative to focus on. This narrative serves as a thematic focal point for the community and guides the allocation of resources within the protocol.

For example, when selected the narrative "AI" in the first epoch, a certain percent of the fees collected during trading activities within the protocol is earmarked for investment in projects related to the selected narrative. These investments, strategically chosen to support the development within the chosen thematic area, play a crucial role in the evolution of the broader ecosystem. The funds allocated for narrative-related investments are made available for liquidity pool formation upon the launch of the next epoch. This ensures that the resources collected from trading fees are productively used and contribute to the protocol's stability in subsequent epochs. The narrative feature is presented in Fig. 2.

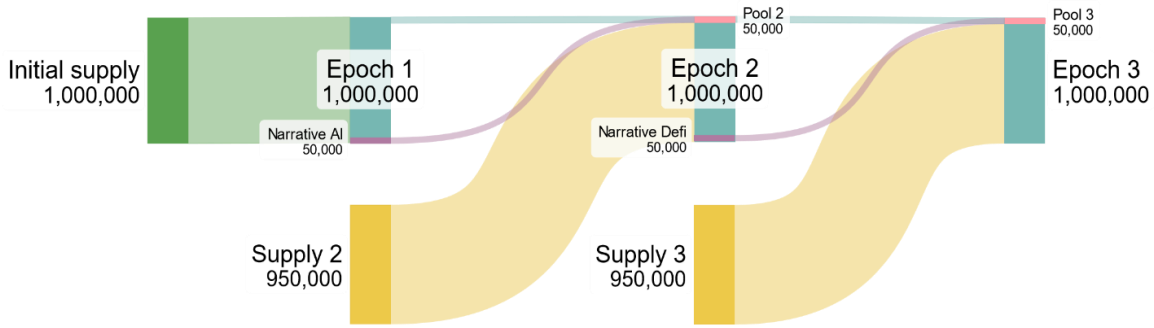

Figure 2. The use of the narrative feature

Due to the particularities offered by programmatic SCs, there are additional factors that can be used to further release the pressure brought by withdrawing accumulated rewards. One of the first functionalities is to allow users to use the tokens from treasury to increase their participation in the system. Introducing waiting times is a prudent strategy to prevent users from engaging in short-term speculation and reduce systemic risks (sudden influxes or outflows of funds which could disrupt the equilibrium of the system).

Another idea would be to implement a cool-off period during which users are discouraged from withdrawing their initial capital. This cooldown period incentivizes users to commit their funds to the protocol for longer periods of time. The first cool-off period for the Ponzi scheme set up by Charles Ponzi himself was 90 days. During this period the funds were completely locked. Given the flexible potential of the blockchain, the behaviour of this factor can now be modified. For example, the system can use penalty rates that will still allow users to withdraw their initial capital, but with a loss percent, if they are withdrawing too soon. Given that the “health” of the system can be checked live by the SC, the cool-off period can also be implemented as dynamic. Additionally, after withdrawing regular recurring rewards, another idea would be to extend the cooldown period by an additional time.

Last but not least, an affiliate program can encourage an active system promotion.

5. Conclusions

This paper explores a novel approach to Ponzi-like systems using blockchain technology, emphasizing mechanisms designed to improve sustainability, transparency, and fairness. The integration of perpetual liquidity and time epochs within immutable SCs creates a unique framework that addresses some of the traditional vulnerabilities of Ponzi schemes. By employing various strategies, such as pegging tokens to stable fiat currencies, introducing perpetual liquidity, and implementing time-based epochs, the proposed system attempts to offer a more robust and predictable environment for participants.

One critical aspect is pegging the system's token to a stable currency, which mitigates the inherent volatility in tokenized systems. This step gives users confidence that the value of their rewards will remain relatively constant, contributing to a sense of stability and encouraging long-term participation. Using a fixed APY for calculating rewards further enhances this predictability, providing users clear expectations for their returns.

The concept of a treasury, managed by a smart contract, plays a pivotal role in maintaining perpetual liquidity, a key feature of the proposed system. This treasury, funded by participant inflows and trading fees, ensures a continuous supply of tokens, thereby preventing the system from collapsing due to token depletion, a common failure point in traditional Ponzi schemes.

Additionally, the time epochs create a structured cycle within the system. At each epoch's end, users can claim a portion of the tokens, providing a clear and transparent mechanism for reward distribution. This approach also fosters rational behaviour among participants, as they can plan their activities based on predictable cycles. Time-based mechanisms, such as cooldown periods and fixed waiting times, further discourage short-term speculation and ensure that participants commit to the system over more extended periods.

Furthermore, introducing a narrative feature within each epoch opens opportunities for community engagement and thematic development. This feature allows the protocol to invest in projects that align with a central theme, contributing to the evolution of the broader ecosystem while providing additional stability and purpose.

Here are some potential areas for future research and development to enhance the sustainability, transparency, and ethical considerations of such systems. Given the immutable nature of smart contracts, ensuring robust security is critical. Future work should focus on enhancing the security and auditing mechanisms for smart contracts used in these systems. This may involve rigorous testing, vulnerability assessments, and integrating automated monitoring tools to detect and mitigate potential security threats. We will explore advanced economic models to understand the dynamics of perpetual liquidity and time epochs, identifying potential vulnerabilities or stress points. This analysis can guide the design of new measures to improve system robustness. Ponzi-like systems inherently face legal and regulatory challenges. Future work should also focus on exploring the legal implications of these systems in various jurisdictions, assessing how they align with existing financial regulations, and identifying compliance requirements. Ethical considerations remain central to the discussion of Ponzi-like systems. Future research can explore ethical frameworks that align with the system's structure, aiming to create a fair and transparent environment. This might involve establishing principles that promote accountability, transparency, and user protection, as well as addressing the inherent risks of these systems. Finally, future research should examine real-world applications and societal impact. This includes exploring how the proposed system can be used to support specific causes or projects, assessing the broader implications for financial systems, and investigating the potential for positive social impact. Analysing case studies and gathering empirical data will help evaluate the actual effects and identify areas for improvement.

While this new approach to Ponzi-like systems incorporates innovative features designed to improve sustainability and mitigate risks, it is crucial to underscore that the fundamental structure of these systems still relies on recruiting new participants to sustain earlier rewards. Therefore, the inherent risks and ethical considerations associated with Ponzi schemes persist, highlighting the necessity of caution and regulatory oversight in these types of systems. Deploying these proposals on the blockchain offers a new perspective on the complexities and potential for innovation in these schemes. However, it does not eliminate their underlying vulnerabilities or their ethical concerns.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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