DOI: https://doi.org/10.15276/ict.01.2024.24
UDC 004.942

On Waterfall's cryptoeconomic forecast

Sergii S. Grybniak[1)]
PhD, Head of Research at Waterfall Network
ORCID: https://orcid.org/0000-0001-6817-8057; s.s.grybniak@op.edu.ua. Scopus Author ID: 57962557300
Yevhen Y. Leonchyk[2)]
PhD, Associate Professor, Department of Mathematical Analysis
ORCID: https://orcid.org/0000-0003-1494-0741; leonchyk@onu.edu.ua. Scopus Author ID: 57192064365
Igor Y. Mazurok[2)]
PhD, Associate Professor, Department of Optimal Control and Economic Cybernetics
ORCID: https://orcid.org/0000-0002-6658-5262; mazurok@onu.edu.ua. Scopus Author ID: 57210121184
Oleksandr S. Nashyvan[1)]
Master, Software Engineering, Tech Lead at Waterfall Network
ORCID: https://orcid.org/0000-0001-8281-4849; o.nashyvan@op.edu.ua. Scopus Author ID: 57963260000
Alisa Y. Vorokhta[3)]
PhD student in Computer Science at the Interdisciplinary Centre for Security, Reliability, and Trust
ORCID: https://orcid.org/0000-0002-2790-1517; alisa.vorokhta@uni.lu. Scopus Author ID: 59184524100
[1)] Waterfall DAO, 141, Baarerstrasse, Zug, 6300, Switzerland
[2)] Odesa I. I. Mechnikov National University, 2, Dvoryanskaya Str. Odesa, 65082, Ukraine
[3)] University of Luxembourg, 2, Ave. de l'Université Esch-sur-Alzette, 4365, Luxembourg

ABSTRACT

This work presents a system dynamics modeling approach to evaluate critical economic metrics on the Waterfall platform, a decentralized public network. The constructed model serves as a significant tool for understanding the intricate economic processes within the platform and supports informed decision-making by stakeholders. By using input parameters such as the number of network validators and transactions per second (TPS) over time, the model projects key metrics like the inflation rate and total supply of coins, providing insights into the platform's economic stability.

The Waterfall platform is designed as a scalable smart contract ecosystem, underpinned by cryptoeconomics, to ensure a self-sustaining and self-regulating environment that maximizes stakeholder benefits. The platform's mainnet, launched in June 2024, has shown consistency between testnet results and theoretical calculations, demonstrating the robustness of the underlying economic model. However, as with any economic system, forecasting is essential for decision-making and improving efficiency. The system dynamics model allows for the exploration of different scenarios, considering various growth assumptions for validators and TPS, to project future economic conditions of the platform.

Three scenarios – pessimistic, realistic, and optimistic – are considered, each with distinct growth trajectories for the number of validators and TPS. The outcomes highlight that while the initial stages of the network are characterized by high reward rates due to a smaller number of validators, these rates decline as more validators join, affecting the inflation rate over time. The relationship between the minting of new coins (as validator rewards) and the burning of transaction fees determines the system's inflationary dynamics. Under certain conditions, an increase in TPS could lead to deflation, enhancing the platform's economic sustainability.

The results suggest that Waterfall's cryptoeconomic model has a strong potential for long-term stability and growth. The model's flexibility allows for adjustments based on real-time data and expert judgments, making it a valuable tool for both internal stakeholders and external analysts. This approach could also be applied to studying the cryptoeconomics of other decentralized networks, providing a broader understanding of their economic stability and long-term viability.

Keywords: Waterfall platform; decentralized network; cryptoeconomics; system dynamics; long-term forecasting.

Introduction. Public decentralized networks are complex socio-economic systems that combine traditional economic principles with computer technology, so-called cryptoeconomics, to enable digital user interactions [1]. Their emergent properties are defined by business logic and economic policies embedded in software.

Waterfall is a scalable smart contract platform supported by cryptoeconomics for creating a self-sustaining and self-regulating ecosystem that intends to maximize benefits for all stakeholders [2-5].

The mainnet was launched in June 2024. The results previously obtained on the testnet and mirroring the current state were fully in line with theoretical calculations made by the formulas [6]. However, as in any traditional economy, some forecasting and predictions over time must be made to empower decision-making and enhance efficiency. In addition, cryptoeconomic modeling contributes to the understanding of complex systems, revealing both their advantages and disadvantages, in keeping with the spirit of openness and transparency of distributed ledger technologies.

The main goal of this work is to project the key economic metrics of the Waterfall platform on the basis of some assumptions about the growth of the network validator number and transactions per second (TPS). This primarily applies to inflation and deflation processes for understanding and managing economic stability. For these purposes, a few possible system evolution scenarios were considered in this work using system dynamics modeling. Further, as the platform evolves and new data is received, this model should be refined.

It is worth noting that while economic models are powerful, they are not without limitations. They rely on assumptions that may not hold true in all situations, and the complexity of the real world can never be fully captured. There will always be some uncertainty in the input data. On the other hand, economic policies embedded in software cannot be modified without community consent, which provides more robustness of forecasting in comparison with traditional economic modeling.

General provisions. The design of Waterfall's cryptoeconomics is fully described in [7], including minting and burning processes, the rewards system, coin flows, etc. However, its analysis was carried out only with fixed parameter values. In this work, we consider the number of network validators and TPS as input parameters changing by certain growth laws over time.

Logistic Growth. Growth equations are a powerful tool for simulations across many fields and can provide valuable insights into the dynamics of complex systems over time. In mathematical modeling, they can be used as starting assumptions, e.g., for the growth of the numbers of network nodes, users, and transactions, amounts of staked and transferred coins, etc.

Logistic growth is usually applied to simulate various network phenomena. This is a mathematical function characterized by increasing growth in the beginning period but decreasing growth at a later stage [8]:

$$L(t) = \frac{L_{max}}{1 + \exp\left(-q(t - t_0)\right)}, t \geq 0,$$

where L_{max} is the supremum of L -values, $q > 0$ is the curve's steepness, and t_0 is the inflection point (the curve's midpoint).

In particular, a logistic function can be used to describe the growth of a new technology customer number [9]. When a new product or service is introduced, the rate of new customer acquisition usually rises at first. However, as the market saturates, that rate slows down as the product or service reaches its full potential (e.g. see [10, 11]). In this work, the logistic growth law is applied for the projection of model time-dependent input parameters.

Evaluation scenarios. As static configuration parameters of the model, we will use the current values set in the mainnet [7] including:

- Initial total supply – 25 billion coins.
- Stake per validator – 32 thousand coins.
- Slot time – 6 seconds.
- Blocks per slot – 8.

To describe the growth in the number of validators and TPS over time, we will consider three hypothetical scenarios presented in Table. The values for starting projections were obtained from the mainnet. For illustrative purposes, the realistic scenario is depicted in Fig. 1.

Table. **Parameters of logistic growth curves**

Scenarios	TPS			Number of validators		
	Start	Inflection, year	Supremum	Start	Inflection, year	Supremum
Pessimistic	0	3	10	2.048	3	50.000
Realistic	0	3	1.000	2.048	2	300.000
Optimistic	0	2	2.000	2.048	2	500.000

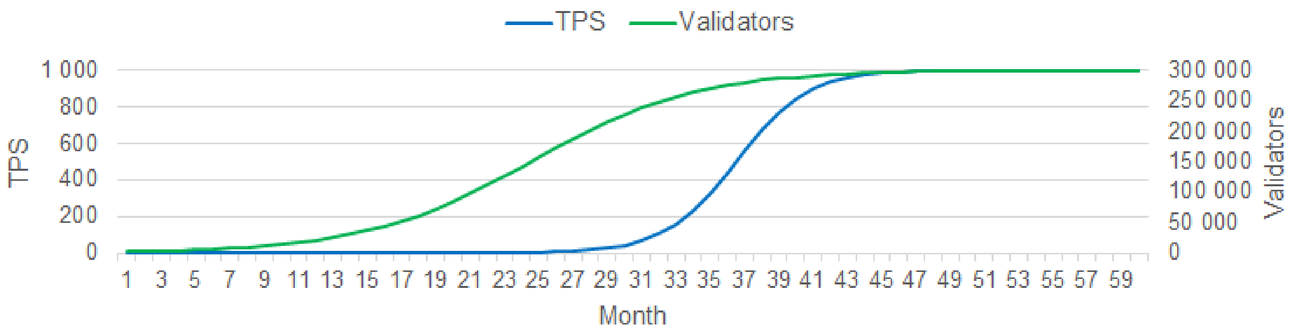

Fig. 1. **Number of validators and TPS over time: the realistic scenario**

Outcomes of Modeling. The designed model allows us to obtain projections of key network economic metrics, such as the annual reward and inflation rates, the total staked amount and total supply of coins, transaction fees, etc. In this paper, we take an in-depth look at the reward and inflation trends.

In cryptoeconomics, increases in the circulating coin supply are called inflation. Consequently, the dynamic relationship between the quantity of newly minted coins as validators' rewards, and the reduction of coins through the burning of base transaction fees, defines the current inflationary rate within the system. The results of modeling for each scenario are displayed in Fig. 2.

The initial stage of the system is characterized by a high annualized reward rate due to the small number of validators. As the number of validators increases, this reward rate declines sharply. At the beginning, despite the high reward rate, the inflation rate remains low because the total amount of minted coins is minimal. However, as more validators join, the inflation rate gradually rises, eventually reaching 6 %. Transaction throughput meanwhile impacts the inflation process significantly. Therefore, the ecosystem growth and the corresponding increase in TPS can potentially lead to deflation, as more coins are burned as transaction fees.

These results confirm that the platform has good potential for long-term operation and development, since a low inflation rate increases user confidence in the system. The reduction in rewards provided for in the platform's economic model will reduce the income of participants. However, the reward will remain at an attractive level compared to other decentralized platforms, which will continue to attract new users and maintain the activity of existing participants.

Conclusion. The constructed model allows us to explore various scenarios for the evaluation of the Waterfall platform considering different hypotheses. In turn, independent experts can adjust the static and dynamic input parameters of the simulation according to their expert judgments and generate other projections of metrics that are more appropriate in their view. In addition, this model can be customized by adding user behavior patterns based on real data obtained from the mainnet, e.g., by specifying the average percentage of faulty network nodes that receive penalties instead of rewards.

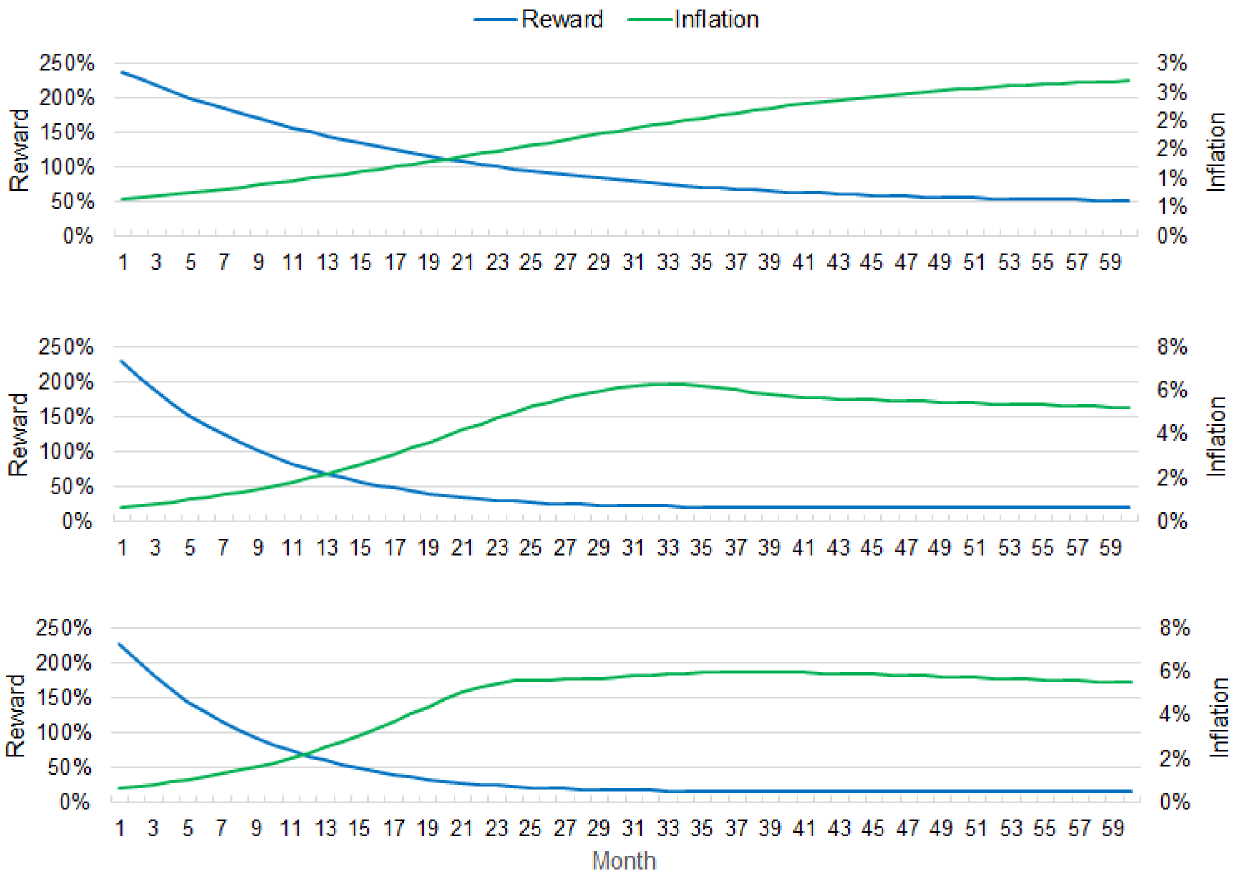

Fig. 2. **Annualized reward and inflation rate over time: pessimistic, realistic, and optimistic scenarios are on the top, middle, and bottom panels respectively**

The presented simulation shows that the economic sustainability of the platform is at a high level.

This means that Waterfall is able to maintain stability and efficiency under various scenarios, ensuring sustainable growth and development. However, any cryptoeconomics operates within the framework of the socio-economic system, and the influence of external factors cannot be discarded. Therefore, to obtain a reliable long-term forecast, model projections should be combined with expert judgments to account for additional information and nuances.

ACKNOWLEDGEMENT

We would like to express our deepest gratitude to our colleagues and mentors who have contributed significantly to this work. In particular, we wish to honor the memory of our esteemed colleague, Ruslan Masalskyi. His invaluable contributions to our previous works have laid a solid foundation for this research. His dedication, passion, and intellectual rigor continue to inspire us, even as we mourn his untimely loss in the war. His legacy lives on in the work we continue to do. We dedicate this paper to him, in recognition of his profound impact on our work and our lives.

REFERENCES

1. Voshmgir S., Zargham M. “Foundations of cryptoeconomic systems”. *Working Paper Series*, *Institute for Cryptoeconomics*, *Interdisciplinary Research*. *WU Vienna University of Economics and Business*. 2020; 1. DOI: https://doi.org/10.57938/10d8b646-3266-4ec9-b94d-810b528c40a9.

2. Grybniak S., Leonchyk Y., Masalskyi R., Mazurok I., Nashyvan O. "Waterfall: Salto Collazo Tokenomics". *IEEE International Conference on Blockchain, Smart Healthcare and Emerging Technologies (SmartBlock4Health),* 2022. DOI: https://doi.org/10.1109/SmartBlock4Health56071. 2022.10034521.

3. Mazurok I., Leonchyk Y., Grybniak S., Nashyvan O., Masalskyi R. "An incentive system for decentralized DAG-based platforms". *Applied Aspects of Information Technology,* 2022; 5 (3): 196–207. DOI: https://doi.org/10.15276/aait.05.2022.13.

4. Mazurok I., Leonchyk Y., Grybniak S., Vorokhta A. & Nashyvan O. "Multi-objective optimization of committee selection for hierarchical byzantine fault tolerance-based consensus protocols". *Herald of Advanced Information Technology*, 2023; 6 (1): 39–53. DOI: https://doi.org/10.15276/hait.06.2023.3.

5. Grybniak S., Leonchyk Y., Mazurok I., Nashyvan O., Vorokhta A. "Waterfall: Salto Collazo. High-Level Design of Tokenomics". *Advances in Science, Technology and Engineering Systems Journal.* 2023; 8 (3): 231–243. DOI: https://dx.doi.org/10.25046/aj080326.

6. Waterfall Statistics. – Available from: https://stats.waterfall.network [Accessed: 02.09.2024].

7. Waterfall Economics. – Available from: https://docs.waterfall.network/overview/economics. – [Accessed: 20.08.2024].

8. Weisstein, E. W. "Logistic Equation". *Wolfram MathWorld..* – Available from: https://mathworld.wolfram.com/LogisticEquation.html. – [Accessed: 20.08.2024].

9. Rogers E. M. "Diffusion of innovations". *5th edition. Simon and Schuster.* 2003.

10. de Best, R. "Number of Bitcoin block explorer blockchain.com wallet users worldwide". *Statista*, 2023. – Available from: https://www.statista.com/statistics/647374/worldwide-blockchain-wallet-users. – [Accessed: 20.08.2024].

11. Dixon S. "Number of monthly active Twitter users worldwide". *Statista,* 2022. – Available from: https://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users [Accessed: 20.08.2024].

DOI: https://doi.org/10.15276/ict.01.2024.24
УДК 004.942

Про криптоекономічний прогноз Waterfall

Грибняк Сергій Сергійович[1)]
Доктор філософії з комп'ютерних наук, керівник відділу Досліджень проекту Waterfall
ORCID: https://orcid.org/0000-0001-6817-8057; s.s.grybniak@op.edu.ua. Scopus Author ID: 57962557300
Леончик Євген Юрійович[2)]
Канд. фізіко-математичних наук, доцент кафедри Математичного аналізу
ORCID: https://orcid.org/0000-0003-1494-0741; leonchyk@onu.edu.ua. Scopus Author ID: 57192064365
Мазурок Ігор Євгенович[2)]
Канд. техніч.наук, доцент кафедри Оптимального керування та економічної кібернетики
ORCID: https://orcid.org/0000-0002-6658-5262; mazurok@onu.edu.ua. Scopus Author ID: 57210121184
Нашиван Олександр Сергійович[1)]
Магістр Програмної інженерії, керівник відділу Розробки проекту Waterfall
ORCID: https://orcid.org/0000-0001-8281-4849; o.nashyvan@op.edu.ua. Scopus Author ID: 57963260000
Ворохта Аліса Юріївна[3)]
Аспірант з комп'ютерних наук Міждисциплінарного центру безпеки, надійності та довіри
ORCID: https://orcid.org/0000-0002-2790-1517; alisa.vorokhta@uni.lu. Scopus Author ID: 59184524100
[1)] Waterfall DAO, 141, Байрішештрасе, Зуг, 6300, Швейцарія
[2)] Одеський національний університет ім. І. І.Мечнікова, вул. Дворянська, 2. Одеса, 65082, Україна
[3)] Люксембурзький університет, пр. де л'Універсіт, 2. Еш-сюр-Альзетт, 4365, Люксембург

АНОТАЦІЯ

У цій роботі представлено підхід до моделювання системної динаміки для оцінки критичних економічних показників на платформі Waterfall, децентралізованій публічній мережі. Створена модель служить важливим інструментом для розуміння складних економічних процесів на платформі та підтримує прийняття обґрунтованих рішень зацікавленими сторонами. Використовуючи вхідні параметри, такі як кількість валідаторів мережі та транзакцій за секунду (TPS) протягом певного часу, модель проектує такі ключові показники, як рівень інфляції та загальна пропозиція монет, надаючи розуміння економічної стабільності платформи.

Платформа Waterfall розроблена як масштабована екосистема смарт-контрактів, що базується на криптоекономіці, щоб забезпечити самопідтримуване та саморегульоване середовище, яке максимізує вигоди для зацікавлених сторін. Основна мережа платформи, запущена в червні 2024 року, продемонструвала узгодженість між результатами тестової мережі та теоретичними розрахунками, демонструючи надійність базової економічної моделі. Однак, як і в будь-якій економічній системі, прогнозування має важливе значення для прийняття рішень і підвищення ефективності. Модель системної динаміки дозволяє досліджувати різні сценарії, враховуючи різні припущення про зростання для валідаторів і TPS, щоб спрогнозувати майбутні економічні умови платформи.

Розглядаються три сценарії – песимістичний, реалістичний і оптимістичний, кожен з яких має чіткі траєкторії зростання кількості валідаторів і TPS. Результати підкреслюють, що хоча початкові етапи мережі характеризуються високими ставками винагороди через меншу кількість валідаторів, ці показники знижуються, коли приєднується більше валідаторів, що з часом впливає на рівень інфляції. Взаємозв'язок між карбуванням нових монет (як винагороди валідатора) і спалюванням комісій за транзакції визначає інфляційну динаміку системи. За певних умов збільшення TPS може призвести до дефляції, підвищуючи економічну стійкість платформи.

Результати свідчать про те, що криптоекономічна модель Waterfall має потужний потенціал для довгострокової стабільності та зростання. Гнучкість моделі дозволяє вносити коригування на основі даних у реальному часі та експертних оцінок, що робить її цінним інструментом як для внутрішніх зацікавлених сторін, так і для зовнішніх аналітиків. Цей підхід також можна застосувати для вивчення криптоекономіки інших децентралізованих мереж, забезпечуючи ширше розуміння їх економічної стабільності та довгострокової життєздатності.

Ключові слова: платформа Waterfall; децентралізована мережа; криптоекономіка; системна динаміка; довгострокове прогнозування