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# *Blockchain-Based Incentive Mechanisms: Single Incentive Mechanism and Compound Incentive Mechanism*

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***Abstract.*** With the wide application of blockchain in data sharing scenarios such as smart healthcare, the Internet of Things, and federated learning, how to maintain trusted collaboration and motivate nodes to continuously participate under the premise of privacy protection has become a key issue. The blockchain incentive mechanism builds a closed loop of "behavior - reward - continuous participation" through methods such as income rewards, reputation feedback and permission allocation, providing a reliable operation foundation for decentralized systems. This paper systematically reviews the relevant research in recent years based on the "incentive source structure" and "behavioral constraint logic", classifies the existing mechanisms into four categories: revenue-based, reputation-based, revenue-based and reputation-based, and rights-based, and conducts comparative analysis from aspects such as incentive processes, governance structures, and applicable scenarios. Research shows that a single incentive is difficult to balance efficiency, fairness and steady-state participation, while compound incentives have more advantages in enhancing incentive intensity, curbing free-riding and strengthening governance resilience. However, there are still challenges such as insufficient revenue confirmation, unstable reputation quantification and abuse of rights.

***Keywords:*** Blockchain, Single incentive mechanism, Compound incentive mechanism.

## 1. Introduction

Since Bitcoin utilized cryptography to achieve distributed consensus, the application of blockchain has expanded from digital currency to various parts of the digital world such as supply chain governance, privacy computing, the Internet of Things, and federated learning. It has become one of the most important infrastructures supporting the digital economy and the Web3 era. The security, efficiency and scalability of a blockchain system all depend on whether each node involved can work in coordination with one another and operate honestly and credibly. Therefore, how to involve more nodes and maintain long-term coordination and trustworthiness is one of the most notable issues in all current blockchain technology research.

The blockchain incentive mechanism utilizes economic rewards, reputation feedback, governance rights distribution, and penalty constraints to influence the behavioral choices of each node, ensuring that nodes are always within the incentive closed loop of "behavior - feedback - continuous

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participation". And it enables the system to achieve the maximization of personal interests and the consistency of system goals, avoiding the problem of insufficient cost compensation during network operation, and maintaining a dynamic balance among system participation enthusiasm, security and system efficiency.

However, different incentive mechanisms are applicable to different scenarios, and the reward and punishment structure also has significant differences from governance requirements. In implementation, it is necessary to take into account efficiency, security and fairness. In particular, there are still many difficulties in the process of cross-domain collaboration, heterogeneous participation of multiple subjects and long-term competition. In response to this situation, it is necessary to categorize and organize the existing blockchain-based incentive mechanisms, extract effective patterns and identify the existing problems, clarify the advantages and disadvantages as well as the reasons for the problems, and point out the direction for how to build a more complete incentive system in the future. Therefore, this paper aims to take the classification system of incentive mechanisms as the main line,

## 2. Incentive types

### 2.1. Single incentive type

Single-type incentives are a relatively simple mechanism that achieves the motivation of participants through standardized rules, mainly reflected in the rewards and enhancements of earnings or reputation.

#### 2.1.1. Reputation-based incentive mechanism

In the blockchain, converting the behavior of nodes into quantifiable values is known as the reputation mechanism. Its function is to record the behavior of nodes and reflect whether a node is trustworthy based on this value. In the system, the trustworthiness of each node can be determined by calculating its behavior score. The more standardized the behavior, the more benefits it can obtain and the greater the right to participate. If there are any violations in the behavior, the credit score will be reduced and corresponding penalties will be imposed, forming a virtuous cycle system of "behavior - reputation - incentive", which is not only conducive to ensuring the smooth operation of the blockchain system, but also beneficial to exploring the application prospects in broad fields such as federated learning, the Internet of Things and medical services.

The blockchain incentive mechanism based on contract theory and dynamic reputation assessment proposed by Zhou et al. has strong representative significance [1]. The main process is to formulate a long-term working contract for different Internet of Things devices based on the contract theory, and each node needs to select a contract that matches its own strength and mortgage a certain amount of assets to the system to register as a validator. After each round of tasks is completed, the comprehensive reputation value will be determined based on the scores between each node and other nodes as well as the weighting algorithm of the scores. Then, the smart contract dynamically allocates corresponding rewards to nodes with high reputation values based on this comprehensive reputation value. At the same time, it will appropriately punish nodes with low reputation values or those that are untrustworthy (reducing their earnings) or even expelling expelled. In this way, a closed-loop incentive mechanism of "reputation driving earnings and earnings supporting reputation" is formed. This mechanism has significant advantages in ensuring the fairness of long-term cooperation and the credibility of the system, effectively solving the problem of information asymmetry encountered in distributed collaboration.

Compared with Zhou et al. 's scheme, Liu et al.'s BtRaI medical service system incentive mechanism introduces review factors and a trusted reputation evaluation model to enhance the security and fault tolerance of medical data interaction. However, it does not take into account the issue of incentive attenuation and is more complex [1,2]. Furthermore, the federated learning incentive models of Fu et al. And Xiong et al. Respectively, from the perspectives of long-term incentives and authenticity, based on reputation renewal and reverse auction mechanisms, have increased fairness and enhanced credibility [3,4]. The DriveFL federated learning incentive model proposed by Chang et al. is based on the framework of Zhou et al. 's scheme. It optimizes the reputation update frequency and reward distribution method in light of the high-density characteristics of the Internet of Vehicles, thereby enhancing the timeliness and accuracy of incentives [5].

Overall, the reputation-based blockchain incentive mechanism is shifting from the initial static evaluation to the current dynamic, adaptive and cross-scenario integration approach. Under such circumstances, Zhou et al. propose a contract-based reputation framework, and an important theoretical basis for achieving long-term fairness and the sustainability of incentives. On this basis, A series of schemes have further enriched the practical forms of incentive constraints in related application fields. The core processes generally include steps such as behavior recording, reputation measurement, multi-node consensus, and trusted writing to the blockchain (as shown in Figure 1). Future related research can still be further deepened and explored from aspects such as cross-domain universality, incentive convergence, and reputation anti-counterfeiting aggressiveness [2].

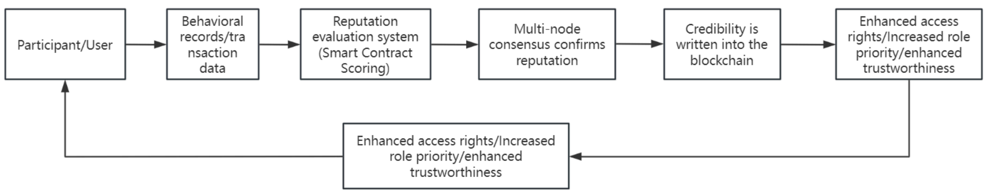


Figure 1. Reputation-based incentive mechanism (picture credit: original)

### 2.1.2. Incentive mechanism based on revenue

The revenue-based incentive mechanism in blockchain systems mainly uses tokens, points, and monetary rewards as economic incentives to prompt nodes to complete tasks such as computing, storage, and data sharing, maintaining the vitality and fairness of the system. A typical revenue-based incentive process generally includes steps such as participants submitting transactions, smart contracts executing reward rules, nodes verifying consensus, and revenue distribution (as shown in Figure 2). The basic idea of such incentive mechanisms is that "contribution determines revenue", meaning that the behavioral quality and contribution level of the incentive recipients determine the amount of incentives they can obtain.

The edge crowdsourcing incentive mechanism based on smart contracts proposed by Ying et al. is relatively typical. By taking advantage of the traceability of blockchain and the self-execution characteristics of smart contracts, indicators such as task quality, response delay, and data authenticity are added to the comprehensive computing model, and smart contracts are used to verify tasks and dynamically allocate benefits. If high-quality tasks are provided, more token rewards can be obtained. If low-quality tasks are provided, the earnings will be deducted, forming an incentive closed loop of "behavior - earnings - feedback" [6]. In addition, the incentive mechanism for real e-commerce reviews proposed by Le et al. mainly analyzes the behaviors of participants through a three-party evolutionary game model. Psychological incentives play a decisive role in the process of e-commerce evaluation. However, compared with the scheme proposed by Ying et al., it is slightly lacking in terms of automation and universality [6,7]. Sai et al. introduced NFTS to achieve medical data sharing, using NFTS to bind the ownership of data, track traceable incentives, and ensure the authenticity and privacy of data. However, due to the high complexity of the system itself and the relatively high construction cost, such a solution cannot be widely promoted at present [8].

Overall, revenue-based incentives have become one of the most universal incentive mechanisms in the blockchain ecosystem due to their simplicity, directness, transparency of information, and high degree of automation. However, they still have drawbacks such as weak incentives in the long term, increased operating costs, and security risks. Research on these issues still needs to be further deepened. There is still room for exploration in aspects such as the sustainability of incentives, cross-scenario adaptability, and integration with reputation mechanisms, in order to achieve a more reliable and stable blockchain incentive solution. A typical revenue-based incentive process is generally shown in Figure 2.

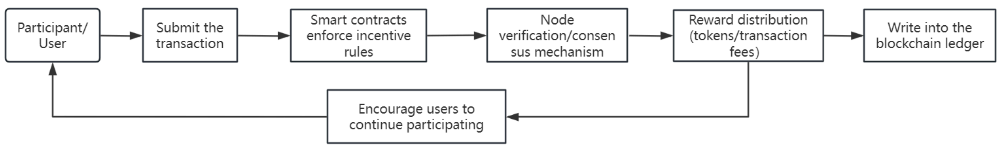


Figure 2. Incentive mechanism based on revenue (picture credit: original)

## 2.2. Compound excitation type

### 2.2.1. Incentive mechanism based on "revenue + reputation"

The key to achieving a compound incentive mechanism lies in ensuring that the fairness, sustainability and credibility of the system reach a balanced state through continuous dynamic adjustment. In this process, measurable economic benefits and a constantly evolving dynamic reputation value should serve as the basis for common constraints. To achieve the goal of maximizing long-term benefits and ensuring the efficient operation of the system as a whole, nodes should not only pursue immediate gains but also face the backlash of reputation. Its basic process is shown in Figure 3.

Among them, the hierarchical federated learning incentive mechanism proposed by Cai et al. is one of the most representative frameworks in the current composite incentive model [9]. It combines the two-way reputation system with the differentiated incentive structure based on contract theory, uses the two-way reputation value to generate the reputation evaluation of both the computing node and the server, and dynamically adjusts the revenue function according to this. This has further formed a feedback incentive system of "high reputation-high return-high priority" and "low reputation-return-restricted participation". This model can well achieve the co-evolution of revenue and reputation, and the incentive logic has also shifted from the original revenue-oriented approach based on individual nodes to the cooperative optimization of the system.

In contrast, Tang et al. proposed a mechanism that integrates economic incentives and reputation constraints, highlighting the credibility of task allocation and the fairness of auctions. Under the

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reverse auction mechanism, it is more likely to be selected as a trusted middleman, and at the same time, penalties will be imposed on malicious nodes, deducting their corresponding favorable reviews and rewards [10]. Meanwhile, due to the different contributions made by heterogeneous devices, the problem of different magnitudes of incentive offsets is thus triggered. To address this issue, Chen et al. incorporated a different-aware reward adjustment rule into the FDFL scheme and included the contents of contribution, resource input, and reputation bias in the dynamic reward function. This enables different devices to receive more reasonable returns. Incentives will then be fairer [11].

At present, the composite incentive mechanism is one of the trends in the evolution of the blockchain incentive system. It realizes the linkage and empowerment of reputation and revenue through smart contracts and has good applicability to scenarios such as cross-domain collaboration, federated learning, and heterogeneous nodes. However, there are still the following problems: (1) It is difficult to determine the reputation weight; (2) Short-term incentives are inconsistent with long-term returns; (3) Risks of privacy leakage and manipulation. In the future, issues such as stable incentives, game equilibrium, and verifiable mechanisms should be studied under the joint modeling of reputation and revenue, and a more trustworthy, secure, and autonomous on-chain incentive system should be established.

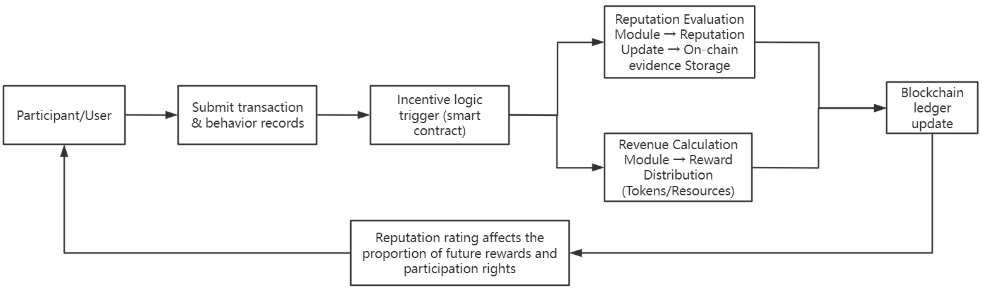


Figure 3. Incentive mechanism based on "revenue + reputation" (picture credit: original)

### 2.2.2. Incentive mechanism based on power

Right-based incentive mechanisms are typically regarded as an important form of compound incentive models. By quantitatively evaluating multiple indicators such as participants' contribution, reputation, and cooperative performance, they take authority allocation as the core incentive resource, covering task priority, key role authority, model or data access rights, as well as resource scheduling and governance voting rights, etc. This mechanism emphasizes the evolitability of rights and the realizability of value, that is, participants can achieve authority upgrades and benefit enhancements through continuous investment, thereby building an endogenous incentive closed loop that strengthens long-term participation willingness and collaborative efficiency. The typical process of power granting and dynamic regulation is shown in Figure 4.

In existing research, the blockchain federated learning framework proposed by Zhang et al. hierarchically manages node access and collaboration permissions based on reputation scores. Nodes with high credibility have higher priority participation rights, reflecting the governance attribute of rights as access incentives [12]. Ren et al. further coupled access rights with privacy control, constructing a permission hierarchy driven by both contribution and credibility, making data access rights a key incentive factor in the system [13]. Based on this, Lin et al. introduced contribution-sensitive resource scheduling strategies to achieve a step-by-step enhancement from access rights to control rights, endowing rights with dynamic evolution capabilities and differentiated utilities [14]. Furthermore, Yang's systematic empirical research indicates that compared with single economic

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incentives, on-chain systems with authority promotion and role incentive mechanisms are more effective in curbing free-riding behavior and enhancing the stability of long-term participation [15].

Overall, rights-based incentive mechanisms have significant advantages in increasing participation activity, strengthening the resilience of on-chain governance, and enhancing the self-organizing capacity of the system. However, such mechanisms still face challenges such as the increased risk of power centralization, insufficient identification of abuse of power, the lack of unified constraints on the mapping of authority and actual benefits, and the immaturity of dynamic and elastic distribution strategies. Future research can focus on: (1) Dynamic permission regulation mechanisms based on behavioral evolution; (2) Collaborative pricing model of governance rights and revenue rights; (3) Capacity constraint mechanisms for anti-monopoly and anti-collusion; (4) Verifiable reputation-rights mapping and retrospective auditing methods. This can further build a fairer, more stable and sustainably evolving blockchain incentive system, providing a trustworthy economic foundation for multi-domain collaborative applications.

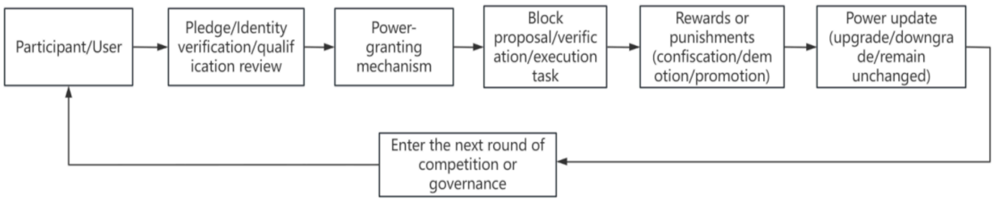


Figure 4. Incentive mechanism based on power (picture credit: original)

## 3. Conclusion

This article systematically reviews the research on the incentive mechanism based on blockchain from three perspectives: the source of the incentive mechanism, the incentive logic, and the governance constraints, and summarizes and generalizes four typical model classification frameworks represented by the revenue-based, reputation-based, compound, and rights-based types. It can be known from the literature review that the advantages of the revenue-based mechanism are easy implementation and direct incentive feedback. Reputation-based mechanisms are more suitable for long-term trusted collaboration. The compound mechanism can better balance the efficiency of incentives and behavioral constraints. Rights-based mechanisms can play a greater role in the governance and participation in decision-making of the system, providing the system with institutionalized incentive support for continuous evolution. Therefore, it can be seen that the current blockchain incentive mechanism is gradually evolving from a "single-dimensional resource incentive" to a "multi-dimensional, dynamic and governance-oriented incentive system".

From both theoretical and practical perspectives, the current research work has played a significant role in trusted collaboration, privacy protection, and data sharing across organizations. However, there still exist problems such as poor verifiability of incentive effectiveness, vulnerability of protection measures to attacks, difficulty in mutual recognition of the degree of incentives among different systems, and the increase in incentive costs as the system grows larger. Therefore, the next steps of work can be carried out in the following aspects. (1) Establish a privacy-friendly and verifiable contribution evaluation mechanism; (2) Explore a dynamic incentive model driven by the trinity of revenue, reputation and power; (3) Establish an auditable authority governance system and anti-manipulation mechanism; (4) Promote the establishment of unified standards and interoperability protocols for cross-chain/domain incentives, so that the incentives of blockchain can achieve a fairer, more just and more sustainable process, and further apply multi-source

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collaborative trusted computing and blockchain incentive systems to the infrastructure of the future digital society.

## Authors contribution

All the authors contributed equally and their names were listed in alphabetical order.

## References

[1] Z. Zhou, F. Ye, J. Gao, S. Zhang, X. Geng, Ensuring long-term trustworthy collaboration in IoT networks using contract theory and reputation mechanism on blockchain. IEEE Internet Things J. 11, 2420–2437 (2023)
[2] Y. Liu, et al., Blockchain and trusted reputation assessment-based incentive mechanism for healthcare services. Future Gener. Comput. Syst. 154, 59–71 (2024)
[3] Y. Fu, et al., An incentive mechanism for long-term federated learning in autonomous driving. IEEE Internet Things J. 11, 15642–15655 (2023)
[4] A. Xiong, et al., A truthful and reliable incentive mechanism for federated learning based on reputation mechanism and reverse auction. Electronics 12, 517 (2023)
[5] X. Chang, et al., DriveFL: A dynamic reputation incentive mechanism for federated learning in dense Internet of Vehicles. Knowl.-Based Syst. 114539 (2025)
[6] C. Ying, H. Jin, J. Li, X. Si, Y. Luo, Incentive mechanism design via smart contract in blockchain-based edge-assisted crowdsensing. Front. Comput. Sci. 19, 193802 (2025)
[7] C. Le, R. Zheng, T. Lu, Y. Chen, User real comments incentive mechanism based on blockchain in e-commerce transactions—A tripartite evolutionary game analysis. Entropy 26, 1005 (2024)
[8] S. Sai, V. Hassija, V. Chamola, M. Guizani, Federated learning and NFT-based privacy-preserving medical-data-sharing scheme for intelligent diagnosis in smart healthcare. IEEE Internet Things J. 11, 5568–5577 (2023)
[9] H. Cai, L. Gao, J. Wang, F. Li, Reliable incentive mechanism in hierarchical federated learning based on two-way reputation and contract theory. Future Gener. Comput. Syst. 159, 533–544 (2024)
[10] Y. Tang, Y. Liang, Y. Liu, J. Zhang, L. Ni, L. Qi, Reliable federated learning based on dual-reputation reverse auction mechanism in Internet of Things. Future Gener. Comput. Syst. 156, 269–284 (2024)
[11] Z. Chen, et al., FDFL: Fair and discrepancy-aware incentive mechanism for federated learning. IEEE Trans. Inf. Forensics Secur. (2024)
[12] F. Zhang, S. Guo, X. Qiu, S. Xu, F. Qi, Z. Wang, Federated learning meets blockchain: State channel-based distributed data-sharing trust supervision mechanism. IEEE Internet Things J. 10, 12066–12076 (2021)
[13] Z. Ren, E. Yan, T. Chen, Y. Yu, Blockchain-based CP-ABE data sharing and privacy-preserving scheme using distributed KMS and zero-knowledge proof. J. King Saud Univ. Comput. Inf. Sci. 36, 101969 (2024)
[14] H. Lin, et al., Refiner: A reliable and efficient incentive-driven federated learning system powered by blockchain. VLDB J. 33, 1771–1771 (2024)
[15] W. Yang, Incentivizing blockchain participation through task assignment mechanisms: Evidence from a natural experiment of consensus protocols on Ethereum. J. Oper. Manag. (2025)