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Research on Credit Governance Based on Ethereum Smart Contracts

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Abstract: *Credit is one of the cornerstones of modern society, and credit governance is an important means of maintaining economic and social stability. However, credit governance has always faced challenges due to problems such as information asymmetry, fraudulent behavior, and lack of trust. The emergence of blockchain technology has brought new hopes and opportunities to enhance the level of credit governance. It creates conditions for establishing a more transparent and trustworthy credit system through decentralized credit records, immutable credit history, the application of smart contracts, privacy and authorization management, and cross-border collaboration. For example, in the financial field, smart contracts can also enable automated financial contracts and transactions. Based on the Ethereum blockchain's smart contract platform, this paper aims to propose a reward and punishment mechanism that can be used for participant management in a credit scoring system. This mechanism rewards or punishes participants' behavior based on their scores through the "coin-day destruction" mechanism, incentivizing positive behavior and penalizing misconduct. This paper believes that blockchain technology has significant potential for application in credit governance. However, the application of blockchain technology also faces challenges in terms of technology, law, and regulation, requiring joint efforts from all parties to truly enhance the level of credit governance.*

Keywords: *Remix, Smart Contract, Credit Scoring System, Saxo Fintech Business School USY*

1. Introduction

With the advent of the digital age, credit has become a crucial factor in social and economic interactions. While establishing and maintaining credit has always been a complex issue, with problems such as information asymmetry, fraudulent behavior, and lack of trust still plaguing the credit system. This paper will delve into how blockchain technology can play a role in credit governance and the potential impact it brings.

Blockchain technology, as a decentralized and immutable ledger, has the potential to revolutionize credit governance. It can provide a transparent and tamper-proof system for recording and verifying credit-related information. By using cryptographic techniques and distributed consensus algorithms, blockchain technology ensures the integrity and security of credit data.

One of the key advantages of blockchain technology in credit governance is its ability to eliminate the need for intermediaries. Traditional credit systems often rely on centralized institutions to establish and verify creditworthiness. This introduces inefficiencies, delays, and costs. In contrast, blockchain technology enables direct peer-to-peer interactions, allowing individuals and businesses to establish and verify credit without the need for intermediaries. This can lead to a more efficient and cost-effective credit governance system.

Another advantage of blockchain technology is its potential to enhance trust and transparency in credit governance. The decentralized nature of blockchain ensures that all participants have access to the same information, reducing information asymmetry. Moreover, the immutability of blockchain records prevents fraudulent behavior and provides a reliable source of credit history. This can help mitigate the risks associated with credit transactions and improve overall trust in the credit system.

Furthermore, blockchain technology can enable the automation of credit processes through smart contracts. Smart contracts are self-executing contracts with the terms of the agreement directly written into code. They can automatically enforce credit agreements, facilitate credit transactions, and enable the execution of credit-related actions based on predefined rules and conditions. This automation can

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streamline credit processes, reduce manual intervention, and improve efficiency.

2. Literature Review

The blockchain-based individual credit governance mechanism is a novel credit mechanism that offers individuals a more secure, trustworthy, and efficient way of engaging in credit transactions through the decentralized and transparent nature of blockchain technology.

In terms of social network theory, Yang (2021) highlights the significance of network effects and trust propagation. Through widespread dissemination, a decentralized trust network is established. The credit behavior and reputation of individuals impact the credit evaluation of other individuals through the propagation of network effects[1].

Wang (2020) suggests that in a blockchain-based individual credit governance mechanism, smart contracts can be designed to enforce specific credit rules and contractual conditions[2]. The blockchain-based individual credit governance mechanism enables the automatic enforcement of credit rules and contractual conditions through smart contracts. Furthermore, Xiao(2022) concluded that individual credit information can be recorded on the blockchain and widely shared through the network. The transparency and verifiability of this information help mitigate information asymmetry and foster trust and cooperation among individuals[3].

The blockchain-based individual credit governance mechanism is theoretically grounded in social network theory and evolutionary economics. This mechanism, with its features of decentralization, transparency, smart contracts, and information sharing, has the potential to foster trust and cooperation among individuals, establishing a secure, trustworthy, and efficient way of engaging in credit transactions. Smart contracts, as a crucial component of the Ethereum blockchain, inherit the technical characteristics of blockchain, such as immutability, making them suitable for applications in scenarios involving mutual distrust. Current research on smart contract applications primarily focuses on scenarios characterized by decentralization and tamper resistance.

Regarding tokens in blockchain, He (2022) points out the transparency issue in the token burning process: some token burning mechanisms lack transparency and fail to provide sufficient information for verifying the token burning process[4]. This can result in distrust and suspicion, as participants cannot confirm if the tokens have genuinely been burned. Additionally, in some cases, the token burning operation is reversible, meaning that the tokens can be regenerated after being burned, thereby diminishing the effectiveness and significance of the burning. This may lead to an unstable token supply, affecting the value and credibility of the tokens. Zhang (2022) proposes a novel token burning credit evaluation model that introduces "token holding days" as a substitute for the cash flow indicator in traditional models, thereby avoiding credit forgery through multiple account transactions[5]. "Token burning" technology is an economic model based on blockchain that incentivizes holders to hold and use tokens for an extended period by burning tokens. In this technology, the value of tokens is directly proportional to the holding time, with longer holding time resulting in higher token value.

In individual credit evaluation, the "token burning" technology can be applied to optimize the credit evaluation index system and operational mode. Specifically, by utilizing the blockchain-based economic model, individual credit behavior can be combined with token holding time to construct a calculation model for individual credit scores. The longer the holding time, the higher the credit score, thereby incentivizing individuals to develop good credit behavior habits. Furthermore, as individual credit behavior changes, the holding time and value of tokens can be adjusted accordingly, facilitating real-time updates and adjustments in individual credit evaluation.

3. Smart Contracts and "Token Burning" - Credit Governance Model

This paper aims to explore a credit governance model based on blockchain smart contracts. By analyzing existing credit mechanisms and governance models and combining them with the characteristics of blockchain technology, a smart contract-based credit governance model is proposed and empirically studied and evaluated. The research findings indicate that the credit governance model based on blockchain smart contracts can effectively enhance the credibility of credit, providing a new solution for the establishment and maintenance of credit mechanisms.

In this study, a credit governance smart contract was developed using the Solidity language on the Remix platform. The core mechanism of this credit governance model is the interest calculation and

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penalty mechanism based on the "token burning" model. The complete code can be found in the appendix. In this model, participants' credit balances increase or decrease based on their deposit and withdrawal operations. Participants' credit scores and ratings are updated according to their behavior and evaluation results. If a participant's balance becomes negative, it is considered a default and marked as "defaulted". In each time period, the participants' credit balances are calculated based on the "token burning" model to determine the number of "token days" burned. "Token days" refer to the product of the number of tokens held by participants and the holding time. The purpose of the "token burning" model is to incentivize participants to hold tokens for a longer period while preventing them from abusing their balances.

In addition to the interest calculation and penalty mechanism, the model also includes a reward mechanism. A function called "reward Participant" is implemented, which calculates the reward amount based on the participant's credit score and the current exchange rate. The reward amount is then added to the participant's balance and their last update time is updated. This provides participants with economic incentives to maintain good behavior and credit ratings. However, if a participant engages in improper behavior, they can be punished through the "punish Participant" function, which serves as a penalty for their misconduct.

3.1. Model Design and Implementation

This paper first designs a structure called "Participant" to store the credit information of participants. The contract also includes some global variables such as total supply, interest rate, exchange rate, etc. The total supply refers to the total number of available tokens, and participants in the contract can purchase tokens to increase their balances, but it cannot exceed the total supply. The credit information of the contract creator is initialized with a credit score of 100, a rating of 1, a default status of false, a balance of the total supply, and the last update time as the current timestamp.

Secondly, this paper designs a function called "evaluate Credit" to evaluate the credit level of a participant. The function takes the address, credit score, and rating of a participant as parameters and updates the participant's credit score and rating to the given values. This way, the credit information of the participant is updated to the latest evaluation result. The function also embeds a validation to ensure that the caller must be the participant themselves, otherwise an exception will be thrown and the execution will be terminated.

Thirdly, this paper designs a function called "deposit" for depositing tokens. It takes a parameter called "amount" which represents the amount to be deposited. The function uses the "require" keyword to validate that the deposit amount must be greater than zero, otherwise an exception will be thrown and the execution will be terminated. Then, it uses the "require" keyword to validate that the participant must exist, i.e., the participant's credit information has been initialized. Next, it calculates the time interval before the deposit, which is the difference between the last update time and the current timestamp. Based on the participant's balance and the time interval, it calculates the "token days". "Token days" refers to the product of the participant's balance and the time interval, which is used to calculate the interest. It calculates the number of tokens to be burned based on the "token days" and the interest rate. The number of tokens burned is equal to the "token days" multiplied by the interest rate divided by 100. Then, it subtracts the number of burned tokens from the total supply. Finally, it updates the participant's balance by adding the deposit amount to their balance and sets the current timestamp as the participant's last update time. This way, the participant's balance and last update time are updated to the latest values. A similar principle is used to design the "withdraw" function to implement the token withdrawal operation.

3.2. Innovative Credit Evaluation and Incentive Mechanisms

In the blockchain-based credit governance model, credit evaluation and incentive mechanisms play a crucial role. By evaluating the behavior and transactions of participants, a reliable credit system can be established and maintained, promoting honest behavior and rewarding or penalizing default actions. The design of the credit evaluation mechanism can be based on the participant's historical records and transaction data. The immutability and transparency of blockchain technology make the credit evaluation of participants more reliable and accurate. The following approaches can be used for credit evaluation:

Historical Record Evaluation: Evaluate the credit level of participants based on their historical transaction records and behavior. For example, factors such as transaction frequency, transaction amount, transaction time, and the rating of transaction counterparts can be considered in assessing their credit level.

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Credit Rating Mechanism: Assign credit ratings to participants based on their credit levels, categorizing them accordingly. A rating system similar to credit rating agencies, such as AAA, AA, A, BBB, or a custom rating system, can be utilized. Incentive mechanisms are another important component of the credit governance model, used to encourage honest behavior and penalize default actions. Some common incentive mechanisms include:

Reward Mechanisms: Provide rewards, such as points, coupons, or discounts, to participants who exhibit good behavior. These rewards serve as incentives to encourage participants to maintain honest behavior.

Penalty Mechanisms: Implement certain penalty measures for participants engaging in default actions, such as deducting credit scores, restricting transaction privileges, or suspending accounts. These penalty measures serve as a deterrent, motivating participants to comply with rules and agreements.

Social Monitoring Mechanisms: Leveraging the transparency of blockchain and the consensus mechanism of the community, social monitoring can be achieved, allowing participants to supervise and report on the behavior of others. This social monitoring mechanism effectively prevents default actions and enhances the reliability of the entire credit system.

In conclusion, a blockchain-based credit governance model can establish a reliable credit system through credit evaluation and incentive mechanisms. By evaluating the behavior and transactions of participants and implementing corresponding rewards or penalties, it promotes honest behavior and maintains the reliability of credit. This model can be applied in various fields, such as supply chain management, financial services, e-commerce, providing an innovative solution for the establishment and maintenance of credit mechanisms.

4. Model Evaluation and Potentials

Due to space limitations, this section focuses on presenting the operational results of the smart contracts in the credit governance model, as shown in Figure 1. The model primarily designs four functions that reward or penalize participants based on their ratings. The reward and penalty amounts are calculated based on the rating and exchange rate, and then the participants' balances and last update times are updated. In practical applications, this code can be used in a credit scoring system to reward or penalize participants based on their behavioral scores. The reward and penalty amounts can be adjusted according to specific application scenarios and requirements.

However, this code still has some limitations. Firstly, it does not provide a detailed rating classification for the coin-day destruction theoretical model, which may result in inaccurate or unreasonable calculation of reward or penalty amounts. Detailed rating categories are crucial for accurate calculation of rewards and penalties. In the coin burn theory model, rating categories can be determined based on participants' behavior scores. For example, participants' behavior can be classified into positive actions and negative actions, and each behavior can be assigned a corresponding rating. Positive actions may include timely repayment and adherence to contract terms, while negative actions may include late repayment and violation of contract terms. By subdividing the rating categories, the degree of reward or penalty that each participant should receive can be determined more accurately. The lack of detailed rating categories may lead to inaccurate or unreasonable calculation of reward and penalty amounts. Without clear rating categories, the reward and penalty amounts may not be accurately calculated based on participants' behavior scores. This can result in reward and penalty amounts that are either too high or too low, thereby affecting the fairness and effectiveness of the credit governance model. Therefore, in order to ensure accurate calculation of reward and penalty amounts, it is necessary to provide detailed rating categories in the coin burn theory model. This will enable better assessment of participants' behavior and determination of corresponding reward and penalty amounts based on their behavior ratings, thereby enhancing the reliability and effectiveness of the credit governance model.

In the subsequent research, the authors will incorporate a community governance mechanism to engage community members in the design and enhancement of the credit governance model. This approach aims to better capture the community members' needs and feedback, thereby enhancing the credibility and acceptability of the credit governance model. Furthermore, in addition to reward and penalty amounts, alternative methods such as points and rankings can also be introduced for rewarding and penalizing participants. This will enable a more holistic assessment of participants' behavior and facilitate suitable rewards or penalties.

Secondly, it does not perform security checks on participants' balances, which may pose risks of

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overflow or negative balances. Lastly, this code has only been tested through simulation, and further validation of its effectiveness would require matching with external data transmission interfaces in practical applications. The authors will make the following improvements in the future:

1) Security checks and boundary controls: Incorporating security checks and boundary control mechanisms for participants' balances in the model to ensure that balances do not overflow or become negative. For example, participant balances can be checked during each transaction or operation to ensure they remain within reasonable limits.

2) Introducing exception handling mechanisms: Introducing exception handling mechanisms in the model to address potential exceptions such as balance overflow or negativity. When such exceptions are detected, appropriate measures will be taken, such as interrupting transactions, rolling back operations, or sending alert messages to participants.

3) Real-world application validation: In addition to simulation testing, further validation of the model's effectiveness will involve matching it with external data transfer interfaces in real-world applications. This can be achieved by comparing and validating the model against real data sources to ensure accuracy and stability in practical environments.

4) Security audits and vulnerability fixes: Conducting regular security audits to identify potential security vulnerabilities in the model and promptly addressing them. This helps protect participants' assets and enhances the overall system's trustworthiness and reliability.

5) Multi-party involvement and feedback: Inviting multiple participants and professionals to evaluate and provide feedback on the model. Their valuable insights and suggestions will help improve the model's security and effectiveness.

By implementing these improvements, the model's security will be enhanced, potential risks will be mitigated, and its effectiveness and reliability in real-world applications will be ensured.

In conclusion, the design approach of this code for rewarding and penalizing participants is feasible, but further refinement and optimization are needed to enhance security and flexibility.

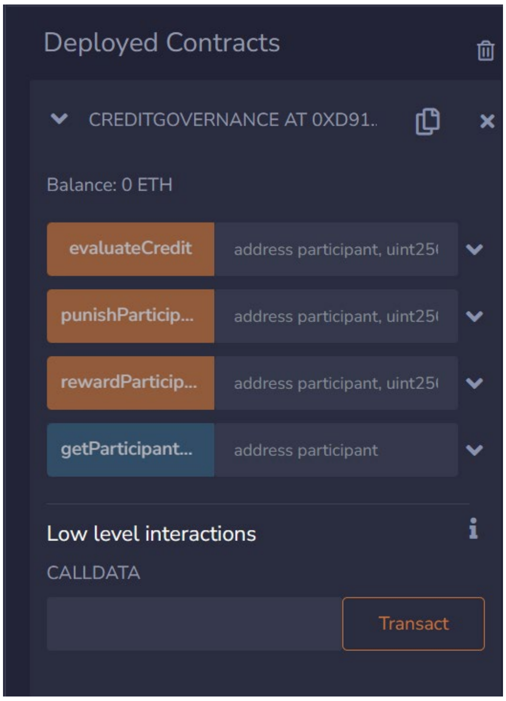

Figure 1: Smart Contracts - the main functions of credit governance.

5. Conclusion

This paper proposed a credit governance model based on blockchain smart contracts. By combining existing credit mechanisms and governance models with the unique features of blockchain technology, we developed a smart contract-based credit governance model and empirically evaluated its effectiveness.

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Our research findings demonstrate that this model can effectively enhance the credibility of credit, offering a new solution for establishing and maintaining credit mechanisms.

The core mechanism of our credit governance model is the interest calculation and penalty mechanism based on the "token burning" model. We developed a credit governance smart contract using the Solidity language on the Remix platform. Participants' credit balances are adjusted based on their deposit and withdrawal operations, and their credit scores and ratings are updated according to their behavior and evaluation results. If a participant's balance becomes negative, it is considered a default and marked as "defaulted". The "token burning" model calculates participants' credit balances periodically, determining the number of "token days" burned based on the product of the number of tokens held and the holding time. This model incentivizes participants to hold tokens for longer periods while preventing balance abuse.

Additionally, our model incorporates a reward mechanism to incentivize good behavior. Participants receive rewards based on their credit scores and the current exchange rate. These rewards are added to their balances, providing economic incentives for maintaining good behavior and credit ratings. Conversely, participants engaging in improper behavior can be penalized through the "punish Participant" function, serving as a deterrent for misconduct.

The design and implementation of our model involve the creation of a participant structure to store credit information, global variables such as total supply and interest rate, and functions for credit evaluation, depositing, and withdrawing tokens. The credit evaluation mechanism considers historical transaction records and behavior, while the incentive mechanisms include rewards, penalties, and social monitoring.

In conclusion, our blockchain-based credit governance model utilizes credit evaluation and incentive mechanisms to establish a reliable credit system. By evaluating participants' behavior and transactions and implementing corresponding rewards or penalties, it promotes honest behavior and maintains the credibility of credit. This model can be applied in various fields, offering an innovative solution for establishing and maintaining credit mechanisms in areas such as supply chain management, financial services, and e-commerce.

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