

Are Tokens Sufficient to Resolve Collective Action Problems in Decentralized Autonomous Organizations? A Model-Based Examination

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Abstract

Opportunism caused by conflicts of interest significantly impedes collaboration within decentralized autonomous organizations (DAOs). To address this issue, we develop a model to illustrate whether the unique aspect of tokens—the interest alignment effect—can mitigate collective action problems in DAOs. This model integrates the “rational cheater” framework with the interest alignment effects introduced by token rewards. It also examines the interaction between token rewards and members’ social motivation, particularly focusing on the dynamics of crowding-out effects. Our findings highlight that the constraints on opportunism in DAOs primarily include the interest alignment costs associated with token holdings and the psychological costs tied to members’ social motivation. These costs complement each other in reducing opportunism in DAOs. Additionally, the effect of increasing token rewards on opportunism depends on the balance between the current token value and how opportunistic actions potentially affect the organization’s value.

Keywords: Decentralized Autonomous Organizations, Opportunism, Blockchain-based Platform, Interest Alignment, Token Reward.

1. Introduction

With the rise of blockchain technology, blockchain-based online platforms, commonly known as decentralized applications (DApps), have gained widespread adoption. These platforms operate on blockchain-based peer-to-peer networks instead of centralized servers and have been applied to various domains, including decentralized finance applications, social media platforms, and non-fungible token (NFT) marketplaces. Some of these DApps are operated and managed by an innovative governance structure known as decentralized autonomous organization (DAO), which facilitates digital collaboration among decentralized online communities (Zhao et al., 2022).

DAOs are defined as “collectively owned human-machine systems deployed on a blockchain that self-govern through smart contracts and the voluntary contribution of autonomous community members” (Ellinger et al., 2023). DAOs utilize smart contracts to encode complex organizational procedures and contractual arrangements directly onto the blockchain. This enables a wide range of operations, such as token reward distribution and member voting, to be conducted automatically and accurately without the need for a central authority (Wang et al., 2019). This capability extends the utility of blockchain platforms beyond simply processing financial transactions, as seen in early-stage blockchain-based platforms, to achieve more complex and socially-oriented objectives that rely on the voluntary cooperation of DAO members (Dong et al., 2023). For instance, underlying the blockchain-based platform Steemit.com is a DAO with the aim to cultivate a vibrant social networking community, incentivizing participation by rewarding members for content creation and curation. Steem members can engage in decision-making and governance through voting on the Steem chain. Another notable example is Meeds DAO, which brings together a community of Web3 developers dedicated to enhancing internet infrastructure and technologies.

Despite the promising vision of DAOs, there may be a collective action problem, as individuals may benefit from the DAO irrespective of their own contributions (Ellinger et al., 2023). To address this issue, DAOs incentivize contributions by adopting token systems to compensate members for their contribution (Hsieh et al., 2018). These token rewards are autonomously allocated based on predefined rules encoded in smart contracts. In addition to serving as reward mechanisms, tokens also facilitate collective ownership within DAOs, resembling equities in traditional organizations (Ellinger et al., 2023). Token holders are delegated various economic or governance rights within the underlying blockchain-based platform and its associated DAO, such as ownership

stakes, voting rights, or entitlement to platform profits (Konashevych, 2020). This enables them to vote on daily operations, the use of funds, and future development. They can also benefit from the organization's growth through token value appreciation. In DAOs, token value is correlated with the platform's value and is co-determined by the collective efforts of DAO members (Zhao et al., 2022). This creates an interest alignment effect, where token holders with more ownership stakes are more incentivized to contribute to the common good of the organization, as their individual benefits are directly tied to the organization's success through token value appreciation.

However, aside from free riding, other forms of opportunism are also prevalent in DAOs and have been observed in many recent cases, making responsible blockchain development a key issue to discuss (Li et al., 2024). Firstly, there can be misuse of governance power and common funds. For instance, in November 2023, the Aragon team decided to dissolve the DAO's governing body and return most of its assets to token holders without holding a vote. This event highlights that many DAOs are not fully decentralized and may have a core team that often exercises significant discretion over decisions. This centralization of governance rights can lead to actions that prioritize the interests of powerful individual members over the common interests of the organization (Ferreira & Li, 2024). Secondly, attacks exploiting loopholes in smart contracts can have disastrous consequences for the underlying DAO. The most notorious example is "The DAO" incident involving "Proposal 59," where a hacker voted for an updated proposal with flaws that he later exploited (Beck et al., 2018). In June 2016, this exploit drained nearly \$50 million from The DAO's investment fund (Murray et al., 2021). Lastly, there are opportunistic behaviors of a more gradual nature. On the Steem platform, collusive transactions have been observed where members purchase votes from others to earn illegitimate token rewards without making the necessary efforts to create high-quality content. This behavior resembles employee shirking in traditional organizations (Li & Palanisamy, 2019).

In contrast to free riding, which may pose no direct negative influence, some opportunistic behaviors can create significant negative impact on the community by reducing trust, eroding social norms, or directly impacting other members by diminishing the property within the organization. These issues resemble the common resource management problem, where individuals may misuse or overexploit common resources to pursue their own private interests, potentially draining the common resources (Ostrom,

1999). As DAOs' legal status remains unclear, the lack of legal protection exacerbates these problems (Wang et al., 2019). Opportunism in DAOs can thus cause a downward spiral, ultimately leading to the failure of DAOs, and needs to be addressed appropriately.

Despite their importance, the underlying motivations for such opportunistic behaviors have rarely been explored in previous literature. In addition, as pointed out in the common resource literature, private property is an effective way to prevent resource abuse (Dietz et al., 2003). Tokens can serve the function of recognizing property rights in the context of DAOs, such that if token holders act opportunistically, their actions can directly impact the value of the organization, thereby reducing the value of the tokens they possess. Following this logic, some DAOs design their token systems to delegate more decision-making and governance rights to token holders with greater token holdings, thereby leveraging the interest alignment effect (Steem, 2017). However, the effectiveness of tokens in constraining opportunism in DAOs has not been thoroughly examined.

On the other hand, unlike cryptocurrencies such as bitcoins, DAOs are primarily community-based and socially driven, adopting a "more than money" spirit that is different from early-stage blockchain-based platforms. Through an interview with members of MakerDAO, Ellinger et al. (2023) confirmed the importance of social motivation in DAOs, especially the motivation to build reputation within the community. In addition, some DAO members may communicate and discuss on platforms like Discord (Ziegler & Zehra, 2023).

Social motivation can effectively constrain opportunistic and unethical behaviors. According to previous literature, individuals may experience disutility directly from inappropriate behavior due to feelings of guilt, which primarily stem from their social preferences (Bowles & Hwang, 2008). Additionally, individuals may exhibit conditional social preferences influenced by community norms and peers' behaviors, such as fairness, reciprocity, compliance, and reputational concerns, making them more likely to cooperate when others are cooperating (Fehr & Fischbacher, 2004; Frey & Meier, 2004; Kölle & Quercia, 2021; Rustagi et al., 2010). Thus, social motivation may complement the interest alignment effect of tokens to address opportunism in DAOs. Moreover, previous studies have also found an interaction effect between social motivation and economic incentives, suggesting that economic incentives may crowd out social motivation by reducing intrinsic motivation for prosocial behavior (Gneezy & Rustichini, 2000; Rustichini & Gneezy,

2000). Despite the potential significance, social motivation has rarely been addressed in previous DAO literature.

Thus, this paper aims to fill the aforementioned gaps by focusing on opportunistic behaviors that compromise the shared goals of DAOs and negatively impact their value. We address the following research questions: Are the interest alignment effects created by tokens sufficient to address the collective action problem in DAOs by simultaneously enhancing cooperation and constraining opportunism? What is the interaction between token rewards and members' social motivation, and how does this interaction potentially influence opportunism in DAOs? To illustrate the intertwined relationships among various types of incentives within DAOs, we build a theoretical model drawing from the framework proposed by Nagin et al. (2002). In contrast to their models, we not only consider the "rational cheater" perspective, which posits that individual members, as self-interested actors, will be opportunistic whenever the marginal benefits of opportunistic behavior outweigh the marginal costs, but also integrate it with the interest alignment effects introduced by token rewards and explore how the covariation between the platform value and the token value may potentially influence opportunism. Additionally, we consider a stream of social preference and conditional social preference models that posit individuals may experience disutility directly from inappropriate behavior and how token rewards interact with these motivation by considering the dynamics of crowding-out effects (Bowles & Hwang, 2008).

Our theoretical model illustrates a complex interplay of various motivations influencing members' decisions regarding opportunism within the DAO. It leads to the following conclusions. Firstly, interest alignment costs derived from token holdings and marginal psychological costs derived from members' social motivation are two primary constraints for opportunism within DAOs. The interest alignment effect becomes crucial when members lack strong social motivation to deter them from acting opportunistically, and such complementary effect is particularly salient for members with higher accumulated token holdings within the DAO.

In addition, our model further delineates that whether increasing token rewards will enhance opportunism depends on the relative relationship between the current token value and the relative impact of opportunism on the value of the organization. Holding all else equal, if opportunistic behavior substantially impacts community value, then increasing token rewards will not lead to an increase in opportunism. Moreover, the interrelationship

between token rewards and social motivation is also an essential factor to consider. If token rewards crowd out social motivation, for example, by changing the social meaning of acting opportunistically to be less immoral, providing token rewards will result in more opportunism within DAOs.

Our study contributes to the literature on blockchain-based platforms and to the emerging area of research on DAOs. Firstly, while previous studies have mainly focused on conflicts of interest among various parties, we examine the collective action problem in DAOs that arises from conflicts of interest between individuals and the collective. Specifically, we explore opportunistic behaviors in DAOs that may have severe negative consequences on their overall development, a topic rarely documented in previous studies. Secondly, we focus on the interest alignment effects of tokens and examine how this unique feature affects individuals' motivations for opportunistic behavior within DAOs — a question previously unexamined. Lastly, we incorporate social motivation into our model and examine how they interplay with tokens. In decentralized environments, social motivation is vital for encouraging prosocial behavior and limiting opportunism, particularly in DAOs where a central authority to enforce regulations against opportunism is absent. Overlooking these significant motivational factors may result in either the excessive or insufficient use of economic incentives.

Our study also presents several practical implications. Firstly, our model suggests that while providing sufficient token rewards may mitigate opportunistic behaviors with significant negative consequences, it alone may not be effective enough to deter opportunistic behaviors with minor and gradual impacts on the community. Secondly, our model underscores the importance of a lock-up period for trading token rewards and emphasizes the significance of encouraging "staking" within the organization. Increased token holdings can strengthen the bonds of members with the organization, making them less likely to undertake actions detrimental to the organization as a whole.

2. Literature review

2.1. Distinction between early-stage blockchain-based platforms and DAOs

Blockchain-based platforms are still relatively immature and often exhibit conflicts of interest among stakeholders. Several studies have identified tokenization as a novel approach to resolving these conflicts and coordinating platform user behaviors

across various settings (Chod et al., 2022; Cong et al., 2022; Gan et al., 2023; Sockin & Xiong, 2023a). For instance, Cong et al. (2022) examined how conflicts of interest between platform owners (insiders) and users (outsiders) often lead to underinvestment issues and how rule-based token supply enforcement on blockchains can mitigate this cooperation issue by resolving the time inconsistency problem of platform owners. Chod et al. (2022) investigated how token financing and decentralized governance influence conflicts of interest among founders, investors, and users within a blockchain-based platform. Their study reveals that token issuance, as opposed to traditional equity financing, can mitigate the problem of entrepreneurial effort underprovision because the value of tokens is often tied to transaction volume on the platform rather than profits, making it less dependent on the individual effort of an entrepreneur. Sockin and Xiong (2023a) found that tokenization can act as a commitment device by delegating control to users, thus preventing platforms from exploiting their users. This addresses inherent conflicts of interest by ensuring that the power dynamics do not favor the platform at the expense of its users. However, they also noted a significant trade-off: by removing an owner who might otherwise subsidize user participation to maximize network effects, the platform might underutilize its potential for growth and reach.

These studies mainly focused on conflicts of interest among various stakeholders in early-stage blockchain-based platforms, such as founders, investors, and users. However, even though the platform is built on blockchain, early-stage blockchain-based platforms are sometimes still backed by traditional organizations and use tokenization primarily as a way to raise funds. However, DAOs are a distinct organizational form. In the context of DAOs, which rely on a community of members to contribute and govern the organization, conflicts often arise from the misalignment between individual and collective interests. This misalignment occurs when the goals or incentives of individual members diverge from the broader objectives or interests of the organization, creating a collective action problem that has not been well addressed in previous studies.

Moreover, DAOs often embody a “more than money” spirit and leverage both economic incentives and social mechanisms to encourage contribution and cooperation (Ellinger et al., 2023). This approach distinguishes DAOs from earlier blockchain-based platforms or cryptocurrencies that primarily focus on financial transactions. Previous studies on blockchain-based platforms and cryptocurrencies typically portray actors as being driven solely by economic payoffs

(Halaburda et al., 2022). However, this may not be the case in DAOs. DAOs are employed to facilitate the collective pursuit of socially-driven objectives. An interview conducted by Ellinger et al. (2023) also revealed that, alongside financial incentives, the ability to grow personal reputation at MakerDAO through amassing social capital in the platform’s highly public setting, is also important. Some DAO members may frequently communicate and discuss on platforms like Discord (Faqir-Rhazoui et al., 2021; Ziegler & Zehra, 2023). Despite their importance in DAOs, social factors have been overlooked in previous blockchain governance literature. This oversight suggests a significant research gap, emphasizing the need to examine DAO members’ social motivations.

2.2. Opportunism in decentralized autonomous organizations

DAO literature is still in its infancy. Most studies focus on conceptually distinguishing DAOs from other organizational forms and examining their potential opportunities and challenges (Beck et al., 2018; Singh & Kim, 2019; Wang et al., 2019). DAOs are defined as “collectively owned human-machine systems deployed on a blockchain that self-govern through smart contracts and the voluntary contribution of autonomous community members” (Ellinger et al., 2023). As DAOs rely on voluntary contributions from their members to create and sustain value, these contributions that help the DAO achieve its shared goals and long-term growth can be defined as cooperative behaviors. Previous studies on DAOs have also focused on understanding the corresponding impact of cooperative behaviors, such as engaging in governance voting, on the DAO’s operational results (Zhao et al., 2022). However, there is limited research on the various incentives and underlying motivations of DAO members.

Collective action problems are also common in DAOs. As noted by Ellinger et al. (2023), members may engage in free riding, where they benefit from the DAO without making proportional contributions. Besides free riding, various other forms of opportunism are widespread in DAOs, as evidenced by several recent cases (Beck et al., 2018; Ferreira & Li, 2024; Murray et al., 2021). Such behaviors can impose significant negative externalities on the community by undermining trust, eroding social norms, or directly harming other members by depleting shared resources. Opportunism, by definition, refers to the pursuit of private interests at the expense of the collective good. A similar issue is observed in common resource management, where

individuals may exploit shared resources for personal gain (Ostrom, 1999). Additionally, the lack of legal protection, as DAOs' legal status remains unclear, exacerbates these problems (Wang et al., 2019). Opportunism in DAOs can thus cause a downward spiral, ultimately leading to the failure of DAOs.

Despite the importance of this issue, there is limited understanding of opportunism in DAOs. To address this gap, we build a model of opportunistic behaviors in DAOs, focusing particularly on those that may have negative consequences for the community. In our model, we distinguish opportunistic behaviors by the extent of their negative impact on the organization.

2.3. Token-based interest alignment effects

Token incentives are a key feature of DAOs. Token rewards in DAOs can serve as an interest alignment mechanism akin to profit-sharing schemes in traditional organizations. Profit-sharing is an organizational strategy where employees receive a share of a firm's profits in addition to their regular salary. It aims to align individual employees' interests (agents) with those of the company (principal), thereby resolving conflicts of interest. For instance, traditional firms might award performance-based bonuses tied to specific performance targets (Florkowski, 1987), aiming to enhance employee productivity, increase shareholders' returns, and foster organizational growth (Florkowski, 1987; Jones & Kato, 1995; Kim & Ouimet, 2014).

Following the same logic, token value in DAOs also comes from the underlying value of the organization, which is cumulatively co-determined by DAO members' collective efforts. As illustrated by Zhao et al. (2022) using MakerDAO as an example, MakerDAO members offer DAI, a stablecoin, as a product and charge a stability fee from DAI loans for profit. However, the stability of DAI is maintained by the collective efforts of MakerDAO members, who hold MKR as a governance token. These members are responsible for designing, adjusting, and implementing mechanisms to prevent significant price fluctuations in DAI. The profits of MakerDAO are distributed to MKR token holders through token value appreciation. Thus, a token's value is similar to company shares (Faqr-Rhazoui et al., 2021), relating to the long-term development of its corresponding decentralized application, which is collectively maintained and owned by its members. DAO members can profit from this development by either reaping dividends or benefiting from token price appreciation. In this way, token holders' private benefits are closely

bonded with DAOs' collective interests, motivating them to contribute to the collective good.

Similarly, Bakos and Halaburda (2022) proposed that platform tokens, even utility tokens, exhibit equity-like qualities, as early adopters of these tokens essentially receive a share in the potential success of the platform through token value appreciation. Tsoukalas and Falk (2020) further noted that members holding more tokens are likely to benefit more from the future payoffs of the platform, incentivizing them to enhance the accuracy of their information and make more informed voting decisions in platform governance. However, the basic rationale of the token-based interest alignment mechanism has only been briefly touched upon by previous studies without delving into its dynamics and complex impacts on individual members.

In addition, as pointed out in the common resource literature, private property is an effective way to prevent resource abuse (Dietz et al., 2003). Tokens can serve the function of recognizing property rights in the context of DAOs, such that if token holders act opportunistically, their actions can directly impact the value of the organization, thereby reducing the value of the tokens they possess. Following this logic, some DAOs design their token systems to delegate more decision-making and governance rights to token holders with greater token holdings, thereby leveraging the interest alignment effect (Steen, 2017). However, the effectiveness of tokens in constraining opportunism in DAOs has not been thoroughly examined. Our model will examine how does the token-based interest alignment effect influence individual members' incentives to engage in opportunism and its potential for tokens to address the collective action problems in DAOs.

3. Theory

This section presents a model of opportunistic behavior that considers various motivational factors in DAOs. Our model adopts the framework proposed by Nagin et al. (2002) who used the rational cheater models in a traditional organizational setting. To better incorporate the unique features of DAOs, we also consider the interest alignment effects of token rewards, and social motivation as another driving forces in DAOs. Additionally, we adopt the model of Bowles and Hwang (2008) to relax the non-separability assumption present in previous models, allowing social motivation to interact with token rewards.

3.1. Rational Cheater, Social Motivation, and Interest Alignment Effects

The rational cheater model is a theoretical framework for understanding the driving forces behind opportunistic behaviors. Within this framework, rational decision-makers are depicted as self-interested actors who continuously weigh the costs and benefits of their actions to determine the most advantageous strategy. Diverging from conventional rational choice models, the rational cheater model posits that individuals may actively seek opportunities that even defy norms, moral principles, or rules to maximize their benefits. Consequently, in the analysis of individual decisions, the rational cheater model can also integrate considerations of deception and unethical conduct into the modeling process (Nagin et al., 2002).

Within DAOs, individual members may pursue private gains by taking actions that ultimately impede collaboration and the long-term success of DAOs, defined as opportunistic behaviors. Thus, opportunistic behaviors such as collusive transactions, which enable members to obtain illegitimate token rewards without exerting necessary efforts, can be more accurately captured by the rational cheater model. According to this model, DAO members will act in an opportunistic way whenever they perceive that the marginal benefits of opportunistic behaviors are greater than the marginal costs.

Furthermore, we draw from a body of literature that examines profit-sharing schemes in traditional organizations, where employees' supplemental income is tied to the performance of selected subunits or the entire organization (Florkowski, 1987). However, different with Nagin et al. (2002) and other profit-sharing literature in traditional organizations, where employees' contracts are designed based on profit, the value of a DAO is co-determined by the collective efforts of its members, and this value is shared in proportion to the token holdings, as token holders can benefit from the DAO's growth through token value appreciation (Zhao et al., 2022). Thus, in our model, we assume that token value is proportional to the organizational value, thereby capturing the interest alignment effect of tokens.

Building upon the rational cheater model, we further extend our analysis to incorporate the social motivation of members. Social motivation includes aspects such as altruism, reflecting the innate tendency of members to act in a prosocial manner (Bowles & Polania-Reyes, 2012). Moreover, recent economic studies suggest that individuals' social motivation may also be shaped by conditional social preferences, which are influenced by the behavior of others. These

conditional preferences encompass concerns such as fairness, reciprocity, norms, and reputational concerns (Fehr & Fischbacher, 2004; Frey & Meier, 2004; Kölle & Quercia, 2021; Rustagi et al., 2010). In instances where individuals engage in opportunistic behavior by violating social norms or prioritizing their own interests by sacrificing others, they may incur psychological costs stemming from feelings of guilt or fear (Fehr & Fischbacher, 2004). In our model, we integrate this as psychological costs associated with opportunistic behaviors.

Moreover, rather than assuming that economic incentives have no impact on social motivation, we explore the crowd-out effects of token rewards on social motivation. These effects arise due to various reasons. Firstly, economic incentives may crowd out social motivation in previous studies by framing decision settings as situations where self-interested optimization is deemed more appropriate rather than ethical behavior. In DAOs, when members receive token rewards, they may perceive the organization's purpose solely as a means for members to earn money rather than fulfilling collective objectives such as fostering a sustained online community. Secondly, economic incentives can alter members' perceptions of one another. For instance, adopting token rewards may lead members to view others as primarily pursuing personal economic gains rather than collective benefits (Bowles & Hwang, 2008).

3.2. A model of opportunistic behavior

Consider a DAO as an organization aiming to maximize the value it provides to all its members, where the value of the DAO at time t is denoted as:

$$(1) V_t = c(e_t) - (mg(o_t) + \alpha(o_t))$$

The value of a DAO at time t is determined by $c(e_t)$, representing the cooperative behaviors collectively made by its members with collective effort $e_t = \sum_{i=1}^n e_{it}$. Cooperative behaviors refer to collaborative efforts or actions made by individuals to contribute value to the organization. These contributions are aimed at achieving the collaborative goals set by the DAO. For different types of DAOs, cooperative behaviors can take various forms. For instance, in a social or service DAO, cooperative behaviors might include activities such as creating valuable content or providing essential services. In contrast, for a protocol or governance DAO like MakerDAO, where the primary goal is to govern the DAI stablecoin, cooperative behaviors involve members participating in proposals and voting on decisions. A commonality among all DAOs is their reliance on users' cooperative behaviors to achieve their collective goals. Consequently, there is a positive

correlation between cooperative behaviors and the DAO's value. For example, in MakerDAO, maintaining the stability of the DAI stablecoin can help the protocol earn more service fees from its users, thereby increasing the overall value of the organization. The parameter $\theta \in [0,1]$ represents the degree to which members' cooperative behaviors contribute to the organization's value.

The term $mg(o_t) + \alpha(o_t)$ represents the aggregate impact of opportunistic behaviors conducted by DAO members on the DAO's value. Opportunistic behaviors can directly diminish a DAO's value. Different types of DAOs may impose distinct constraints on various forms of opportunistic behavior. For example, in a protocol DAO, the risks of opportunistic behaviors are more related to the misuse of common funds, though such opportunities may not be available to most members. In contrast, in service DAOs or social DAOs, collusive transactions are more common, allowing members to earn illegitimate token rewards without making the necessary contributions. The parameter $m \in [0,1]$ reflects the extent to which these opportunistic behaviors diminish the organization's value. Additionally, opportunistic behaviors may generate negative externalities. For instance, in a social DAO, spam posts or fake news can reduce the utility of other participants browsing the site. We represent these negative externalities by $\alpha(o_t)$. Thus, $\frac{\partial v}{\partial e_t} = c' > 0$ and $\frac{\partial v}{\partial o_t} = -m - \alpha' < 0$, which means cooperative behaviors are positively correlated with the value of the DAO while opportunistic behaviors are negatively correlated with the value of the DAO.

We then express the current period utility, denoted as U , of a risk-neutral member as follows:

$$(2) U = b(e + o) - e - \chi(o, b)$$

where $b(e + o)$ represents the number of tokens received by individual member. The parameter e signifies the disutility associated with making efforts for cooperative behaviors. The term $\chi(o, b)$ accounts for the subjective psychological cost of opportunistic behaviors, such as feelings of guilt or remorse after engaging in unethical actions. This psychological cost is primarily influenced by members' social motivation shaped by two factors. Firstly, individuals may possess an innate desire to consider the benefits of others over their own interests, defined as a tendency toward social preferences when making decisions. These preferences include aspects such as altruism, reflecting the innate tendency of members to act in a prosocial manner (Bowles & Polania-Reyes, 2012). Secondly, recent economic studies suggest that individuals' prosocial tendencies may be shaped by conditional social preferences, which are influenced by the

behavior of others. These conditional preferences encompass concerns such as fairness, reciprocity, norms, and reputational concerns (Fehr & Fischbacher, 2004; Frey & Meier, 2004; Kölle & Quercia, 2021; Rustagi et al., 2010). For instance, in communities with strong cooperative norms, the psychological costs of acting opportunistically may be higher due to more severe social punishments or damage to one's reputation. All these factors can significantly impact the psychological costs associated with opportunistic behavior.

Thus, following the approach of Bowles and Hwang (2008) and Benabou and Tirole (2011), we model $\chi(o_i, b)$ explicitly as: $o_i(\kappa_i + \rho\bar{m} - \lambda_i b)$, where κ_i represents the baseline level of social preference for refraining from opportunistic behavior, reflecting the innate nature of the members. $\rho\bar{m}$ represents the psychological costs associated with members' conditional social preferences that are depend on others' behaviors such that if others are acting cooperatively (e.g., higher \bar{m}), the psychological costs of opportunistic behavior will be higher. By doing so can incorporate the influence of community norms and peer influence. $\rho \in [0,1]$ indicates the extent to which members are influenced by such kind of norms. Lastly, the term $\lambda_i b$ represents the crowd-out when $\lambda_i > 0$. These effects account for how economic incentives interact with social motivation to regulate opportunistic behaviors. We assume that $\chi(o_i, b) > 0$, acknowledging that there are no psychological rewards for engaging in opportunistic actions.

Based on Equation (2), the total utility flow for a member i to continue engaging in DAOs at period t is determined as:

$$(3) M_t = b(e_{it} + o_{it})v_t - e_{it} - \chi(o_{it}, b) + s_{it}v_t$$

where v_t represents the per-unit value that can be provided to DAO members at time t with a unit of token holding. In other words, it reflects the value that each token holds in terms of the overall value of the DAO at a specific time. Holding tokens entitles members to utilize services and products provided by the DAO in proportion to their token holdings (Sockin & Xiong, 2023b) We assume that this value is positively correlated with V_t and negatively correlated with the total tokens outstanding, S_t . $\tau \in [0,1]$ represents the extent of correlation between the token value and the DAO's value. Specifically, we define v_t as $v_t = \frac{V_t}{S_t}$. Therefore, the value of $b(e_{it} + o_{it})v_t$ represents the converted value of token rewards received by members for both opportunistic and cooperative behaviors. Even though DAOs do not intend to reward opportunistic behaviors, the difficulty in detecting such behaviors means that undetected

cheaters may still receive token rewards. s_{it} represents the total amount of token holdings accumulated by member i from the previous period until time t . $s_{it}v_t$ represents the converted value of these accumulated token holdings.

At first glance, Equation (3) suggests that when the disutility from opportunistic behavior reaches a sufficiently high level, such behaviors will cease to occur. The direct disutility from acting opportunistically, denoted as $\chi'(o_i, b)$, represents the psychological cost arising from members' social motivation. This disutility acts as a direct deterrent to opportunism. However, when $\chi'(o_i, b)$ is insufficient to effectively constrain opportunistic behaviors, the "rational cheater" perspective becomes relevant. This perspective applies to scenarios where members strategically choose their levels of opportunistic behavior (o_i) and cooperative behavior (e_i) to maximize their utility as outlined in Equation (3).

In this case, the first-order conditions for a worker's choice of optimal efforts for cooperative behaviors (e^*) and opportunistic behaviors (o^*) are as follows, respectively:

$$(4a) [b(e_{it}^* + o_{it}) + s_{it}] \frac{\partial v_t}{\partial s_{it}} - 1 + bv_t = 0$$

$$(4b) [b(e_{it} + o_{it}^*) + s_{it}] \frac{dv_t}{do_{it}} - \chi'(o_{it}, b) \leq 0$$

In this case, as observed from inequality (4b), the marginal psychological cost $\chi'(o_{it}, b) = \kappa_i + \rho\bar{m} - \lambda_i b$ is not the only constraint for opportunistic behaviors.

Since $\frac{\partial v}{\partial o} < 0$, we define $[b(e_{it} + o_{it}^*) + s_{it}] \frac{dv_t}{do_{it}}$ as the interest alignment costs, signifying the individual loss stemming from the diminished value of the community. These costs actively play a role in restricting opportunism.

To be more specific, we rewrite inequality (4b) as:

$$(5) bv_t \leq$$

$$\kappa_i + \rho\bar{m} - \lambda_i b - [b(e_{it} + o_{it}^*) + s_{it}] \frac{dv_t}{do_{it}}$$

Inequality (5) clearly reveals that the left-hand side of the inequality represents the marginal benefit of opportunistic behaviors, while the right-hand side represents the marginal cost of opportunistic behaviors, consisting of two components: marginal psychological costs $\kappa_i + \rho\bar{m} - \lambda_i b$ and interest alignment costs $- [b(e_{it} + o_{it}^*) + s_{it}] \frac{dv_t}{do_{it}}$. This suggests that when members lack strong social motivation to deter them from acting opportunistically, the interest alignment effect becomes crucial. Such effects are especially salient for members with higher accumulated token holdings within the DAO (higher s_{it}). Simultaneously, increasing token rewards introduces a tradeoff. On one hand, it can elevate the marginal benefits of

opportunistic behavior. On the other hand, it can also reinforce the interest alignment effects created by holding tokens, as acting opportunistically negatively impacts the value of the community, thereby diminishing the value of tokens held by members.

If we further rearrange the equation as:

$$(6) b \left(v_t + (e_{it} + o_{it}^*) \frac{dv_t}{do_{it}} + \lambda_i \right) \leq \kappa_i + \rho\bar{m} - s_{it} \frac{dv_t}{do_{it}}$$

This suggests that in the absence of crowding out effects ($\lambda = 0$), the impact of increasing token rewards, denoted as b , on opportunism depends on the relative relationship between v_t and $(e_{it} + o_{it}^*) \frac{dv_t}{do_{it}}$.

Holding all else constant, if opportunistic behavior significantly affects the community value ($v_t + (e_{it} + o_{it}^*) \frac{dv_t}{do_{it}} < 0$), then increasing token rewards will not result in an increase in opportunism. Conversely, for actions with minimal or gradual impact on community value, increasing token rewards may lead to an increase in opportunistic behaviors within the community. This aligns with the practical observation of more frequent opportunistic behaviors with small overall impact observed in DAOs, such as collusive transactions. Also, opportunistic behaviors are more prevalent in larger DAOs with a relatively higher token value (v_t).

On the other hand, when considering the influence of token rewards on social motivation, if token rewards exhibit a crowding-out effect ($\lambda > 0$) similar to monetary rewards, for example, if it alters the individual members' perception of the organization's purpose to solely facilitate members in earning money and thus shifts the social perception of opportunistic actions as less immoral, providing token rewards may lead to increased opportunistic behaviors within DAOs.

4. Conclusion

This paper proposes a model of opportunism to analyze the effects of tokens on opportunistic behavior in DAOs. We integrate elements from the rational cheater model, perspectives on social motivation, and the interest alignment effects of tokens into our framework. Additionally, we explore the interaction between social motivation and token rewards. Our model yields several key findings. Firstly, we discover that both the marginal psychological costs arising from members' social motivation and the interest alignment costs from token holdings are primary constraints on opportunism within DAOs. These two effects can complement each other in mitigating opportunism.

Secondly, offering token rewards may incentivize opportunistic behaviors by increasing the marginal benefits of those behaviors. However, in cases where opportunistic behavior significantly diminishes community value, thereby leading to a personal loss in the value of token holdings, increasing token rewards will not result in a rise in opportunism. Thirdly, if token rewards crowd out social motivation, such as altering the social perception of opportunistic behavior to be less immoral, token rewards may lead to increased opportunism within DAOs.

Our study contributes to the literature on the emerging area of research on blockchain-based platforms and DAOs. Firstly, while previous studies have mainly focused on conflicts of interest among various parties, we examine the collective action problem in DAOs that arises from conflicts of interest between individuals and the collective. Specifically, we explore opportunistic behaviors in DAOs that may have severe negative consequences on their overall development, a topic rarely documented in previous studies. Secondly, we focus on the interest alignment effects of tokens and examine how this unique feature affects individuals' motivations for opportunistic behavior within DAOs — a question previously unexamined. Lastly, we incorporate social motivation into our model and examine how they interplay with tokens.

Our study also offers practical implications. Firstly, our model suggests that while interest alignment effects embedded in tokens may mitigate opportunistic behaviors with significant negative consequences on the community, they may not be sufficient to deter opportunistic behaviors with minor and gradual impacts. Secondly, we highlight the significance of implementing a lock-up period, thereby reinforcing the tokens' role in aligning interests. On one hand, this approach can prevent members from rapidly liquidating their token holdings earning from opportunistic behaviors before any potential decrease in the organization's value is mirrored in the token's value. On the other hand, increased token holdings can lead to stronger alignment of interests, thereby fostering enhanced collaboration within DAOs.

5. Limitations and future studies

In this paper, we distinguish different types of opportunistic behaviors by their extent of consequences on DAOs. However, DAO members may exhibit varying levels of ability and propensity to engage in different types of opportunistic behaviors. In future studies, we will take members' abilities into consideration. Additionally, we plan to use an agent-

based model to examine individual decisions to engage in different behaviors, whether cooperative or opportunistic, within a diverse group of members with varying levels of social motivation and token holdings. This model will simulate the collective consequences of members' behaviors and the long-term dynamics of DAOs' value.

6. References

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