Perceived Social Norms, Token Rewards, and Cooperation in Decentralized Autonomous Organizations (DAOs)

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Abstract

Decentralized autonomous organizations (DAOs) offer a novel paradigm, fostering members' decentralized cooperation towards collective goals. Central to this are token rewards, aligning individuals' interests with DAO's collective goals to enhance cooperation. We introduce a theoretical model proposing that DAO members' perceived social norms impact the effectiveness of this token-based interest alignment mechanism by influencing members' tendencies to hold tokens, subsequently affecting their cooperative behaviors. By analyzing data collected from the prominent social DAO, Steem, our empirical findings validated this proposition. Our study stands at the forefront of elucidating the complex interplay between economic incentives and social motivations in DAOs, particularly the interest alignment mechanism. Moreover, based on the basic rationales of profit-sharing arrangements in traditional organizations, we transpose this understanding to the context of DAOs, offering a nuanced articulation of the interest alignment mechanism, which is absent in the current DAO literature.

Keywords: Decentralized Autonomous Organizations, Token Rewards, Perceived Social Norms, Interest Alignment

Introduction

Decentralized autonomous organizations (DAOs) have emerged as an innovative approach to managing various aspects of an organization, group, or community in a decentralized and autonomous manner. A DAO is an organization running autonomously on a blockchain, governed by rules encoded as smart contracts that are self-executing computer programs, aiming to facilitate decentralized cooperation among its members towards shared goals without reliance on a central authority. Our study draws upon the well-established definition of cooperation as delineated by Das and Teng (1998) and adapted it within the context

of DAOs. We conceptualize cooperation in DAOs as a process wherein distributed and often anonymous members cooperate together towards the DAO's collective objective while consciously avoiding opportunistic behaviors that might undermine this objective.

Unlike traditional organizations that typically rely on either economic factors, such as monetary rewards in firms, or social factors, like the establishment of social norms in online communities, to motivate cooperation, DAOs combine these two dimensions. More specifically, DAOs integrate social motivations with token rewards, instituting an economic mechanism to foster members' cooperation. While this hybrid approach broadens the spectrum of motivations for cooperation, it also introduces potential complexities, underscoring the need to understand the nuanced interplay between economic and social motivations in shaping cooperation within DAOs.

The absence of a central authority makes DAOs largely depend on members' shared understanding and mutual expectations regarding how individuals ought to behave, commonly referred to as social norms (Elster 1989). The decentralized nature of DAOs underscores the importance of these norms in shaping their members' behaviors. Bicchieri (2017) offers a more structured definition of social norms, characterizing them as behavioral rules that individuals tend to conform to, contingent upon two conditions: (a) these individuals believe that most people in their reference network conform to these rules (empirical expectation), and (b) most people in their reference network believe they ought to conform to such rules (normative expectation). Our study focuses on Bicchieri (2017)'s notion of empirical expectation at the individual level. Following Rimal and Real (2005) and Rimal and Real (2003), we define an individual's perception of the prevalence of certain norm behaviors as "perceived social norms". Given the inherent transparent and often geographically distributed nature of DAOs, a member is more inclined to derive insights from the behaviors of her peers recorded on the blockchain. This contrasts with conventional organizations, such as firms, where a member's understanding of others often emerges from close interpersonal interactions.

Drawing from the economics literature, social norms have long been indicated as a potential driving force behind cooperation (Camerer and Fehr 2004; Fehr and Fischbacher 2004; Fehr and Schurtenberger 2018). The emergence of DAOs introduces a novel perspective, adding layers of complexity to this foundational understanding. Our research posits that DAO members' perceived social norms concerning cooperation may intricately intertwine with the interest alignment mechanism of token rewards. We suggested that this interaction can give rise to complex and multifaceted consequences in shaping cooperation within DAOs, underscoring the imperative for rigorous research.

To elucidate this intricate interplay, firstly, our study delineates the interest alignment mechanism of DAO's token reward system. Previous research has defined organizational interest alignment as the extent to which a member of the organization is motivated to behave in line with the organizational goals (Gottschalg and Zollo 2007). The discourse on interest alignment in traditional organizations like firms is deeply rooted in the Principal-Agent theory (Alchian and Demsetz 1972; Fama and Jensen 1983; Jensen and Meckling 2019) and profit sharing literature (Berhold 1971; Fitzroy and Kraft 1987) which focuses on the potential conflicts of interest between principals (e.g., firm shareholders) and agents (e.g., company employees). A salient example of the profit-sharing arrangement is the Employee Stock Ownership Plan (ESOP) (Jones and Kato 1995), which offers employees (often top executives) an ownership stake in the firm. Thereby, ESOPs effectively align these employees' financial interests with the company's collective success. Consequently, these employees are predisposed to act in the best interest of their company, knowing that they too stand to benefit directly from its success.

Building on this basic rationale of profit-sharing arrangements in traditional centralized organizations, our study adapts this understanding into the context of DAOs, offering an articulation of the interest alignment mechanism inherent in token rewards as follows. DAOs often reward members' cooperation with tokens, a specialized class of fungible assets operating on blockchains. These token rewards are not just mere economic incentives but also represent the holding member's stake within the underlying DAO. This dual role of tokens engenders a mutually benefit dynamic: as a member actively engages in cooperative behaviors to achieve the DAO's objectives, she not only contributes to the collective success of the DAO but also enhances the inherent value of her token holdings, given that this value is often intrinsically anchored to the DAO's overarching success. Given its decentralized structure and often socially oriented objectives, the success of the DAO, in turn, largely depends on the collective cooperative efforts of its members. Therefore, widespread cooperation among a DAO's members tends to drive its long-term success, leading to an

appreciation in the value of its tokens, thereby benefiting all its token holders. This sophisticated mechanism of token rewards inherently aligns the economic interests of individual members with the collective objectives of the DAO. This mechanism, although reminiscent of the ESOPs principles employed in traditional firms, distinguishes itself when operating within the decentralized and socially oriented context of DAOs. The nuances that set it apart from profit-sharing arrangements in conventional centralized organizations are illustrated in the subsequent related literature section.

Secondly, we suggest that the efficacy of this interest alignment mechanism hinges on a critical factor: the cooperating member's tendency to hold the tokens as her stakes in the DAO's success rather than selling them. Given that most tokens can be converted to fiat currency through cryptocurrency exchanges, a member's choice to hold or sell is largely contingent upon her expectation about the token's future value. A key novelty of our study is the proposition that this expectation is substantially influenced by the token holder's perceived social norms regarding cooperation within the underlying DAO.

More specifically, our study posits that, when a member perceives a higher prevalence of cooperative behaviors among her peers, she is more likely to anticipate the long-term success of the underlying DAO. This heightened anticipation, in turn, elevates her expectations regarding the future value of the DAO's tokens. Consequently, she becomes more inclined to hold her tokens rather than liquidate them, thereby ensuring the seamless operation of the DAO's interest alignment mechanism. While previous research has extensively studied the relationship between social norms and cooperation in general, this nuanced interaction between DAO members' perceived social norms and their cooperation, mediated by the interest alignment mechanism of the token reward system, remains an uncharted area of study.

To address this research gap, we first propose a theoretical model based on Krupka et al. (2017)'s utility framework that combines individuals' concern for norm compliance and other relevant economic pay-off preferences. Our model extends this framework by adding the component of perceived social norms and the interest alignment mechanism of token rewards in DAOs, and modeling their nuanced interplay. We then empirically examine the interactions elucidated in our model using a large-scale data set collected from the Steem DAO. A significant challenge is to empirically measure the shifts in members' perceived social norms within DAOs. To tackle this challenge, we follow the approach used by Bursztyn et al. (2020), leveraging an exogenous event, the takeover of the company behind the Steem blockchain, that reduced members' perceived social norms regarding cooperation within Steem. This approach allows us to casually identify the impact of this event on Steem members' cooperative behaviors through its token system.

Our results show that the takeover event negatively affected cooperative behaviors among Steem members. We also examined the heterogeneous effects of this event on members with varying degrees of conditional social preferences (i.e., the extent to which an individual's social behavior changes in response to the perceived behaviors of others) and long-term vested interests. We discovered that the adverse impact of this event was more pronounced for those who had not previously engaged in any opportunistic behavior, suggesting that individuals with stronger conditional social preferences are more likely to comply with social norms. Interestingly, we also observed that these conditional cooperators started to engage in opportunistic behavior following the takeover event. Moreover, our results demonstrated that the cooperative behaviors of members with a greater amount of staked Steem Power tokens were more severely affected by the event. Holding more staked SP tokens indicates that these members perceived a higher prevalence of cooperative behaviors within Steem. This finding implies the takeover event adversely affected DAO members' cooperation by reducing their beliefs regarding the prevalence of others' cooperative behaviors.

Our contribution is threefold. First, the novel economic model we developed is among the first to delve into the complex theoretical mechanism wherein perceived social norms influence the interest alignment mechanism through DAO members' tendencies to hold tokens, thereby affecting these members' cooperative behaviors. This enriches the discussions on how economic motivations and social motivations, such as norms and preferences, can work synergistically to better facilitate decentralized cooperation in DAOs. Second, our empirical findings provide evidence that members' diminished perceived social norms regarding others' cooperation negatively affect their expectations on future token value, as well as their own cooperative behaviors, validating our key proposition. This highlights the importance of the intricate interplay between the perceived social norms and the interest alignment mechanism. Third, based on the principles of profit-sharing arrangements in traditional organizations, we transpose this understanding to

the context of DAOs, offering a nuanced articulation of the interest alignment mechanism inherent in token rewards, which is absent in the existing DAO literature.

Related Literature

Token Rewards as an Interest Alignment Mechanism

Monetary rewards have been widely used by internet platforms to incentivize users to engage in cooperative behaviors, such as creating online reviews (Khern-am-nuai et al. 2018; Sun et al. 2017). However, these monetary incentives often fall short of effectively aligning the interests of users with the platforms, mainly because these rewards do not confer upon users economic and governance rights inherent to the platforms. Therefore, they cannot offer users a stake in the platform's success. This is in stark contrast to the interest alignment mechanism of token rewards, as articulated in the introduction, where tokens not only serve as economic incentives but also symbolize a tangible stake within DAOs.

Recent research about tokens done by Cong et al. (2021) suggests that cryptocurrency platform users' opportunity costs for holding tokens are offset by the expected appreciation of these tokens. This is consistent with our articulation that DAO members' decisions to hold or sell tokens are contingent upon their expectations about the token's future value. Their rationale is that the prospective growth in the user base of a cryptocurrency platform, driven by productivity growth, can lead agents to expect more users and, thus, stronger token demand in the future, which implies an increase in token price. However, their study mainly focuses on developing a dynamic valuation model for platform tokens and does not delve into the interest alignment mechanism of DAOs.

A stream of literature relevant to the interest alignment mechanism is the research on profit-sharing arrangements among different stakeholders in traditional organizations, such as firms. For instance, performance-based bonuses can be awarded to individuals, groups, or entire organizations upon achieving specific performance targets (Florkowski 1987), with the aim to increase employee's productivity, shareholders' returns, and future growth of the organization (Florkowski 1987; Jones and Kato 1995; Kim and Ouimet 2014). Another widely adopted profit-sharing arrangement in firms is Employee Stock Ownership Plans (ESOPs), which grant employees company shares or stock options as ownership stakes. This approach incentivizes these employees to contribute to the success of the underlying firm, as their financial well-being is directly tied to the firm's market performance (Nyberg et al. 2010). Moreover, Fitzroy and Kraft (1987) conducted an empirical study on German firms, finding that profit-sharing has a positive and significant effect on the firms' productivity. This effect is more pronounced when firms combine profit sharing with cooperative work environments, highlighting the importance of considering both economic incentives and cooperation when designing profit-sharing schemes to improve organizational performance.

This stream of research differs from our study mainly from two perspectives. Firstly, profit sharing literature is primarily situated within the context of centralized organizations like firms. In these traditional settings, a firm's market performance is disproportionately shaped by the strategic decisions made by top-tier executives, rather than by the collective contributions of average employees. Therefore, this body of literature often studies the impacts of executive-centric issues on firm performance, such as their compensation levels (Bebchuk and Fried 2003) and risk-taking behaviors (Tosi et al. 2000). In contrast, our exploration into the interest alignment mechanism within decentralized autonomous organizations underscores the mutual benefit interplay between the cooperation of average DAO members and the overall success of the organization.

Secondly, the profit-sharing arrangements predominantly underscore the economic factors of organizations, such as enhanced productivity, elevated stock prices, and ultimately greater profits, all of which shape employees' perceptions regarding their firms' prospects for success. This focus is rooted in the reality that employees' ownership stakes from ESOPs (e.g., stock options) are often intrinsically linked to these economic indicators. However, for organizations where the primary objectives transcend mere profit, such as the socially-driven DAO of Steem, an individual's perception of long-term organizational success might be largely influenced by her perceived prevalence of cooperation among members within the organization (i.e., perceived social norms). The next section reviews research on the impact of social norms on cooperation and the interplay between social norms and economic incentives.

Social Norms and Economic Incentive, and Cooperation

A stream of literature relevant to our study is about the complex interaction effects between social norms and economic incentives (Benabou and Tirole 2011). Sliwka (2007) posits that implementing economic incentives within organizations might lead to unintended consequences if these incentives inadvertently undermine social norms. Fischer and Huddart (2008) contend that social norms can influence the design and efficacy of incentive structures (commonly in the form of contracts) within organizations. Their theoretical model shows that strong social norms can reduce the need for economic incentives. However, relying only on social norms may be less effective in situations where employees exhibit diverse conditional social preferences. More efficient mechanisms are needed to better align employees' interests with organizational goals. Similarly, Huck et al. (2001) studied the interplay between social norms and economic incentives when determining optimal incentive structures (contracts) within firms. They find that social norms and economic incentives can complement one another in influencing employee efforts. Moreover, they discovered that when employees perceive that their peers are working diligently, they are more likely to conform to such social norms and exert greater effort themselves. This empirical finding is consistent with Bicchieri (2017)'s definition of empirical expectation of social norms.

However, these studies were primarily conducted in the context of traditional organizations like firms, which mainly rely on centralized management and fixed monetary incentives to facilitate employees' cooperation. In contrast, DAOs operate in a distinct framework that emphasizes decentralized cooperation and interest alignment mechanisms through token systems. Consequently, the role of social norms in shaping members' expectations and cooperation within DAOs may differ significantly from their traditional counterparts. As such, there is a pressing need for research investigating the impact of social norms on DAO members' cooperation through the interest alignment mechanism inherent in token systems.

Moreover, this stream of research mainly focused on the interplay between economic incentives and social norms, with limited attention given to perceived social norms. As DAOs' token reward systems often implement specific rules to promote certain behaviors, such promotion may influence the attraction or attrition of members with particular preferences or behaviors. Consequently, the prevalent characteristics or behaviors of the DAO's membership may change over time, influencing each DAO members' perceived social norms. The impact of these shifts in perceived social norms, especially in their interaction with the economic incentives (e.g., token rewards), warrants further exploration.

As articulated earlier, the key rationale behind the proposed interest alignment mechanism is that when a DAO's token holders perceive stronger social norms regarding other members' cooperative behavior (i.e., believe there is a higher prevalence of cooperative behaviors among others), they are more likely to expect long-term success for the DAO.

This notion aligns with the findings in a highly relevant study conducted by Fischbacher and Gächter (2010), which examined the role of beliefs (expectations) and conditional social preferences in shaping individuals' cooperative behaviors. Through a set of public goods experiments, the researchers discovered a type of behavior called conditional cooperation in which a participant's willingness to cooperate is contingent upon her expectation about others' cooperative behavior in the group. Their agent-based simulations further demonstrate that initially cooperative participants became less willing to cooperate as opportunistic behaviors, such as free riding, became more prevalent in the group. This change in behavior occurred because participants' beliefs about other members' cooperative tendencies diminished when they observed others engaging in free riding. However, this study mainly relies on experimental methods, as defining and measuring social norms in the real world presents significant challenges. Empirical analyses are needed to validate the findings of this study. Moreover, incentive structures of those experiments were intentionally designed to be ineffective, enabling free riding without achieving the alignment of interests as observed in DAO's token systems.

Our Theoretical Framework

Based on the above discussions, our study posits that when a DAO member perceives stronger social norms concerning other members' cooperative behaviors (i.e., believes there is a higher prevalence of cooperative

behavior exists among others), she is likely to hold two beliefs: 1) her own cooperation is more likely to be reciprocated, and 2) DAO members are working collectively towards a shared goal. The first belief positively influences her own cooperation level. The second belief enhances her expectation regarding the likelihood of other DAO members cooperating together to achieve the shared goal, ultimately contributing to the DAO's long-term success. Such enhanced expectation of the DAO's success can influence a member's expectation of future token value, thereby increasing the likelihood that she will hold these tokens for extended periods.

Basic Model

To further study the complex interplay between social norms, interest alignment mechanisms of tokens, and members' cooperation within a DAO, we first develop a theoretical model based on based on Krupka's (2017) utility framework that combines individuals' concern for norm compliance and other economic pay-off relevant preferences in previous research (Benabou and Tirole 2011; Fehr and Schurtenberger 2018; Krupka et al. 2017; Krupka and Weber 2013). These theories assume individuals are motivated by (i) material self-interest represented by economic incentives, and (ii) an intrinsic desire to comply with social norms because of their tendency of conditional cooperation (a specific type of conditional social preference).

We let $A = \{a_1, \ldots, a_k\}$ represent a set of k actions available to a decision maker. Based on this framework, within a DAO, individual member i's general utility function for the action/behavior a_k is as follows:

(1) $u_i(\pi_i, a_k) = \gamma_i N_i(a_k) + \max\left(\pi_{i,0}\big(n_i(a_{i,k}), V_0\big), \pi_{i,t}\left(n_i(a_{i,k}), E_{a_i, a^{-i}}[V_t(\bar{a})]\right)\right)$

The first term $\gamma_i N_i(a_k)$ in the right side of formula (1) represents the influence of member i's perceived social norms. $N_i(.)$ is i's perceptions of the prevalence of an action within the DAO. γ_i represents the extent to which individual i values social norms. A higher γ_i indicates that i is more concerned with social norms and likely to comply with them. Moreover, there are mainly two types of behaviors in the action sets A, differentiated by the degree of cooperativeness. First, cooperative behavior in a DAO involves valuable contributions that help the DAO to achieve its common long-term goals. It is considered prosocial and receives greater social rewards, such as social approval and prestige. Thus, if a_k represents cooperative behavior, $N_i(a_k) > 0$. On the other hand, token-related incentive structures in many DAOs may inadvertently contain loopholes that can lead members to engage in opportunistic behaviors, rather than cooperative ones. Such behaviors prioritize individual interests over the collective interests of the DAO, echoing the potential opportunistic nature of human actors (Lumineau et al. 2021). Examples of opportunistic behaviors include collusive transactions, fraud, and hacks, which often aim to maximize the token rewards of the perpetrators at the expenses of other DAO members. These behaviors are often considered socially inappropriate and may receive punishment. If a_k represents opportunistic behavior, then $N_i(a_k) < 0$, due to social disapproval.

The latter term $\max\left(\pi_{i,0}\big(n_i(a_{i,k}), V_0\big), \pi_{i,t}\left(n_i(a_{i,k}), E_{a_i, a^{-i}}[V_t(\bar{a})]\right)\right)$ represents the economic utility (i.e., material payoffs) that member i can obtain from holding or selling her token rewards, which result from her chosen behavior a_k within a DAO. In DAOs, both cooperative and opportunistic behaviors can lead to the allocation of token rewards for individual i. The function $\pi_{i,t}(.)$ represents the economic utility that i can obtain from her chosen action at a specific time point t. It reflects the extent to which i values the monetary gains derived from her token rewards and involves two input functions. The first function, $n_i(a_{i,k})$, identifies the number of tokens allocated to i due to her chosen action $a_{i,k}$, and we assume this function is increasing. The value of $n_i(a_{i,k})$ is mainly determined by the DAO's incentive structures for token rewards. The second input concerns the monetary value that member i assesses or expects her token rewards to have at the current stage (V_0) or at a future time point t ($E_{a_i, a^{-i}}[V_t(\bar{a})]$). V_0 can be assessed by the current token price listed on exchanges or by utilizing the tokens to trade for services or products provided by the DAO.

On the other hand, the future token price V_t is not directly observable. Our model posits that member i's expectation of the future token value, $E_{a_i, a^{-i}}[V_t(\bar{a})]$, mainly depends on three factors: $\bar{a}$, a^{-i}, a_i. The first

factor, $\bar{a}$, represents the aggregate supply of values from each DAO member based on their chosen actions. Moreover, a^{-i} denotes the aggregate supply of values from all other members, excluding i herself, based on their chosen actions. As individual members often cannot directly observe all others' behaviors due to the decentralized structure of DAOs, one may infer $\bar{a}$ and a^{-i} from her perceived social norms. Following the mechanism we proposed above, our model demonstrates that if i perceives stronger social norms regarding the likelihood of other DAO members' cooperating together to achieve the shared goal, her expectation of the future token value $E_{a_i,a^{-i}}[V_t(\bar{a})]$ will be higher. Since i's decision to hold or sell her tokens is influenced by her current assessment and expectation of the future value of these tokens. If $E_{a_i,a^{-i}}[V_t(\bar{a})] > V_0$, then i may choose to hold onto her tokens to potentially obtain a higher value in the future. Additionally, the third factor—her own past action choices, a_i, will also influence $\bar{a}$. If most DAO members choose cooperative behavior, then $\bar{a}$ will increase. Conversely, if most members act opportunistically, then $\bar{a}$ will decrease.

Hypotheses

Based on our theoretical model, we hypothesize that, if the member i's perception of prevailing social norms regarding cooperative behavior a_k within a DAO decreases, such that $N_i'(a_k) < N_i(a_k)$, where $N_i'(a_k)$ denotes i's diminished perceived social norms, the consequence will be a decrease in i's general utility/tendency for choosing cooperative behavior a_k. Conversely, her tendency for choosing the opposite action will increase, as $N_i'(a_j)$ is positively affected, where a_j represents the opportunistic behavior.

H1a. When a DAO member's perceived social norms regarding other members' cooperative behavior decreases, her tendency to engage in cooperative behavior will decrease.

H1b. When a DAO member's perceived social norms regarding other members' cooperative behavior decreases, her tendency to engage in opportunistic behavior will increase.

We also examine the heterogeneous effects among different groups to understand the mechanism through which social norms influence cooperation in DAOs. Based on our theoretical model derived from previous literature (Fehr and Schurtenberger 2018), individuals are motivated by (i) material self-interest represented by economic incentives, and (ii) an intrinsic desire to comply with social norms because of their tendency of conditional cooperation. We select individuals with heterogeneous tendencies on each of those two incentives to investigate the heterogeneous effects.

Firstly, some individuals may have a stronger tendency for conditional cooperation and prefer to align their cooperation with their expectations about others' cooperation levels and are thus defined as conditional cooperators (Frey and Meier 2004; Rustagi et al. 2010). In contrast, others may consistently exhibit non-cooperative behaviors and are referred to as non-cooperators (Croson et al. 2005; Croson 2007; Fischbacher and Gächter 2010). The main distinction between these two groups can be attributed to their varying tendency of conditional cooperation, as reflected in the γ_i in our model. Conditional cooperators are expected to be more substantially influenced by the change of norms because perceived social norms encapsulate the expectations surrounding others' cooperation (Fehr and Schurtenberger 2018). Consequently, when they perceive others as cooperative from stronger perceived social norms, they tend to cooperate, in contrast to the case of non-cooperators who prioritize solely their own private benefits, irrespective of the behavior of others (Rustagi et al. 2010).

H2. A decline in a DAO member's perceived social norms regarding cooperation will more adversely impact the cooperative tendencies of conditional cooperators than those of non-cooperators.

Secondly, within the context of DAOs, token rewards serve as the primary economic incentive with interest alignment effects, and the efficacy of interest alignment effects depends on members' tendency to hold their tokens. Some DAOs utilize staked tokens that cannot be easily liquidated in a short time frame. Consequently, holding staked tokens reflects members' tendency to hold tokens over a longer period, and we defined those members as long-term driven members. The key distinction between these long-term driven members who have a stronger tendency to hold tokens over longer periods with others lies in their initial token valuation and the degree of interest alignment resulting from token ownership. Distinct from

pure monetary rewards frequently studied in previous literature, token value possesses appreciation potential in the future (Freni et al. 2022). Thus, long-term driven members are more likely to believe that future token value will appreciate, and thus those members are more likely to hold the prior belief that $E_{a_i,a^{-i}}[V_t(\bar{a})] > V_0$. As token value is derived from the performance of the underlying organization that is dependent on all members' collective action (Cong et al. 2021), when their perceived social norms are eroded, they may adjust their expectations of future token value $E_{a_i,a^{-i}}[V_t(\bar{a})]$ accordingly and become less likely to hold tokens. Therefore, we hypothesize the following:

H3a. When a long-term driven DAO member's perceived social norms regarding cooperation decrease, her tendency to hold staked tokens decreases.

When a member holds staked tokens, she is more likely to actively engage in cooperative behaviors to achieve the DAO's objectives, as she not only contributes to the collective success of the DAO but also enhances the inherent value of her token holdings. Conversely, as long-term driven members divest from token holdings, the interest alignment effect—originating from the convergence of private and collective interests—weakened, resulting in a more pronounced adverse impact on long-term driven members. This mechanism, where social norms interact with token rewards, constitutes a new mechanism through which social norms and economic incentives intertwine to influence cooperation dynamics within DAOs.

H3b. A decline in DAO members' perceived social norms regarding cooperation will more adversely impact the cooperative tendencies of long-term driven members than those of other members.

Methodology

Empirical Setting

Our empirical study collected data from the DAO of Steem blockchain that aims to create a decentralized social media platform and online community (Steem 2017). Steem DAO utilizes a token system consisting of three types of cryptocurrency tokens for different operational goals. Among these tokens, STEEM and Steem Dollars (SBD) are two types of liquid tokens that can be directly traded on exchanges, as well as transferred among members. While both tokens are currency-like assets, the main difference is that SBD is pegged to the U.S. dollar at a 1:1 ratio. Steem Power (SP) is a less liquid form of Steem token that requires a minimum holding period of 13 weeks before being converted back into Steem for sale. SP can be obtained by converting STEEM through a process known as power up and must be converted back to STEEM through a process called power down before it can be sold. We defined SP holders as long-term driven DAO members.

The primary method of earning rewards on Steem involves participating in content creation and curation. To calculate content rewards, the smart contract automatically calculates all votes received by a piece of content from other members and weighs them based on their SP holdings within a 7-day period from the content's creation. These token rewards are distributed to both content creators and curators. Content creators receive 50% of the total rewards, while the remaining 50% is distributed among curators who voted for the content based on their SP holdings. As a social DAO, the creation of high-quality content is crucial for the growth and success of the community. Thus, we define actions such as creating posts and comments as cooperative behaviors on Steem. On the other hand, opportunistic behavior in Steem can be defined as collusive transactions. As Steem relies on the collective evaluation of content quality to determine the appropriate rewards for content creators, in certain cases, content creators may purchase votes from others. Thus, regardless of the value of their contributions, they can still receive token rewards generated automatically by the blockchain. These actions could harm the other members of Steem platform by lowering the overall quality of content and creating negative externalities, representing opportunistic behaviors in Steem.

Shifts in Perceived Social Norms

An individual's perceived social norms are dynamic and evolve over time (Bicchieri 2017). Bicchieri et al. (2022) found that observing norm violations will diminish an individual's own norm compliance because of the change in norm-related beliefs (perceived social norms). Studies on social norm interventions also

confirmed that providing information on others' behavior can effectively alter individuals' perceived norms, and such interventions can also lead to changes in behaviors (Bursztyn et al. 2020b; Gimpel et al. 2021; Goldstein et al. 2008). Thus, for an event to effectively shift individuals' perceived social norms, it needs to contradict existing norms and thus alter individuals' norm-related beliefs regarding a particular action. (Bicchieri 2017). Simultaneously, the event should be salient enough to be observed by others. As demonstrated by Acemoglu and Jackson (2015), prominent individuals can use their visibility to affect prevailing social norms.

For these reasons, we study the impacts of a unique event that occurred in the Steem community in February 2020. We posit this event has shifted many Steem DAO members' perceived social norms regarding others' cooperation. On that day, Mr. Justin Sun, founder of a large blockchain network—TRON, declared the takeover of Steemit Inc., the company that launched the social media platform Steemit as the first application built upon Steem blockchain. As the major frontend application that exhibits the contents of the Steem blockchain, Steemit has great influence on the community. Mr. Sun also announced the intended migration of Steem with the TRON network.

The acquisition of Steemit Inc. by Justin Sun potentially shifted members' perceived social norms for the following reasons. First, this event contradicts existing norms as most community members perceive this event as a violation of the "decentralization principle," which serves as a core value for the Steem blockchain. This is because Steemit Inc. sold a huge amount of Steem tokens to a single entity without consulting the community. Additionally, these tokens purchased by Justin Sun, known as "ninja-mined" tokens, were obtained through opportunistic behaviors. Steemit Inc. secretly launched the Steem blockchain and mined a large number of STEEM tokens before announcing the launch to the Steem community. Later, Steemit Inc. reached an agreement with the Steem community not to use these "ninja-mined" tokens to participate in any governance and decision-making activities within the Steem DAO. However, on February 14, 2020, Steemit Inc. violated this agreement with the community by selling those tokens to TRON for monetary gains. Second, as this takeover event is widely publicized and intensively discussed within the community, it is widely known by community members. In sum, this event potentially conveys information on norm violations that signal the non-cooperative tendencies of several influential members within the community, like Justin Sun and the management team of Steemit, in a salient way.

Even though this takeover is not directly related to generally defined daily cooperative and opportunistic behaviors, social norm violations in one action can spill over to other actions. Thus, an event or intervention regarding social norms on one action can also impact the norm compliance on other actions, even for the ones not directly related to it (Benabou and Tirole 2011). For example, such a broken windows effect was found by Keizer et al. (2008) that witnessing a violation of a contextual norm can lead to an increased violation of target norms. This is because the observed norm violations may weaken individuals' senses of appropriateness, even when the norms being violated are not directly related to the targeted actions.

To further support our argument that this event contradicts existing norms, we use punishment as an indirect measure. In economic games, punishment can serve as evidence of the presence of norm violations, as individuals may initially perceive violations of these norms and subsequently impose negative sanctions to penalize such transgressions (Bicchieri 2017). Since downvotes are designed to function as a primary means in Steem for penalizing inappropriate blogs or comments, as this function enables community members to nullify any gains from inappropriate actions (Steem 2017), we interpret the heightened level of downvotes as an indirect indication that increased perceived norm violations. As shown in Figure 1, we observed a sudden surge in the total weighted downvote intensity in Steem after the takeover event (week 0), indicating that members' perception of others' cooperative behavior worsened after the takeover.

To exclude other potential explanations, it is worth noting that prior to the takeover, STEEM price had remained stable and gradually increased, indicating that there were no prior negative events in Steem that may have triggered this takeover and potentially shifting social norms. It is generally believed that the substantial user base and technology of Steem could create a synergy with Tron, and this acquisition was not an opportunistic acquisition, where the acquiring party takes advantage of a target company's weakened position to purchase it at a lower price. Meanwhile, before the announcement, other community members were not informed or consulted about this takeover. As this event cannot be foreseen or influenced by most

existing community members, we treat it as an exogenous shock that caused a negative impact on memebrs' perceived social norms within the Steem DAO. In contrast to other negative events, such as a hacker attack, there were no changes made to the incentive structures of token rewards, nor were large amounts of new tokens issued within Steem DAO after the announcement. This indicates that $n_i(a_{i,k})$ in formula (1) remained unchanged for all members.

Figure 1. Trend of Total Weighted Downvote Intensity in Steem Before and After the Announcement
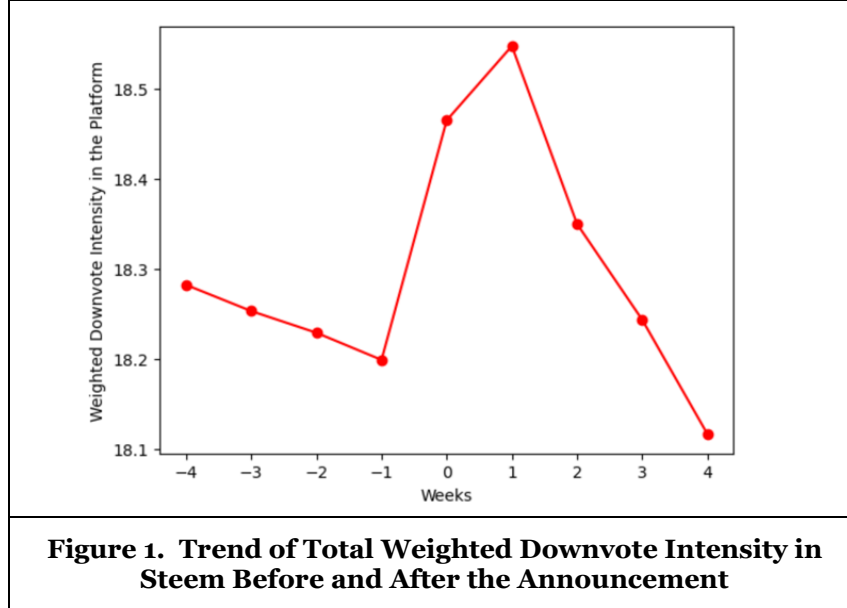
Data and Variables

We collected blockchain data from both the Steem API and the Hive SQL server to study the impact of the shifts in perceived social norms following the takeover event. To control for the short-term fluctuation of the current token value V_0, we also obtained historical STEEM price data from Marketcap.com. To measure cooperative behavior, we retrieved comment and post records containing the full text of all posts and comments, tags, author name, and posting time between January 1, 2020, and May 1, 2020. The complete dataset consisted of 586,540 posts and 2,237,788 comments.

For our main analysis, we focused on contributions four weeks before February 14, 2020, and four weeks after February 15, 2020. We chose a two-day event window to ensure that most members in Steem had enough time to notice and digest the meaning or consequence of the takeover event. We selected this four-week time window because, on March 20, 2020, the Steem community initiated a hard fork, which caused some users to stay in the existing platform while others moved to the new chain, Hive. Thus, including any period afterward may confound our results.

All users on Steem are uniquely identified by their account name, and only registered users can post blogs or comments on the site. To get account information, we downloaded the complete account information dataset, which contained 2,374,851 users registered since 2016. We selected our sample by considering only those who created their account before February 14, 2020, when the takeover was announced. We also excluded members who had not created any posts during the study period. Thus, our final sample included 18,114 members.

Identifying Collusive Transactions

Collusive transaction is a common form of opportunistic behavior in the context of DAOs. As previously mentioned, the system calculates the total reward shares (rshares) received by an article to determine the token rewards distributed to its author. The total rshares are calculated by summing up the voting power, which is weighted by curators' SP holdings. While this mechanism is intended to incentivize members to

contribute good content, it provides an opportunity for some members to purchase votes from others to earn more token rewards unfairly.

To identify such conduct, we adopted the approach of Li and Palanisamy (2019) by examining the temporal correlations between transactions and votes. Our analysis relied on two sources of information. Firstly, we collected all transfer transaction records since the launch of Steem until May 1, 2020. In particular, the "memo" area in each transaction contained textual data of messages, which were publicly available unless encrypted. Second, we download all curation history which contains the records of upvotes and downvotes since the launch of Steem. The curation dataset comprised the curator's account name, the identifier of posts or comments voted, the author of the posts or comments voted, the date of voting, and the voting weight calculated collectively by weighting a weight chosen by the curator to represent their preference for the content and a weight calculated based on the total SP holdings.

To detect collusive behavior, we began by identifying all transactions containing a web link and recording the pairs of sender and recipient. We then matched these transactions with voting history data, excluding downvote records since it is unlikely for a member to pay for downvotes. If a corresponding matching record within seven days was found in the voting history data, indicating that the recipient of the transaction voted for an article posted by the sender, we marked this transfer transaction as collusive. The seven-day time window is selected based on the platform rules, which only consider votes received within seven days since the creation date to calculate total rshares. To quantify the frequency of collusive transactions and measure opportunistic behavior, we calculated the total number of collusive transactions.

Variables and Summary Statistics

Table 1 presents summary statistics for the selected sample. We use content creation data to measure cooperative behavior. We define four variables: Post Length (total word count of all articles posted by an individual member per week), Post Count (total number of articles posted by an individual member per week), Comment Length (total word count of all comments made by an individual member per week), and Comment Count (total number of comments made by an individual member per week). To measure members' incentive to engage in opportunistic behavior, we count the total number of collusive transactions made by an individual member per week and define it as Collusive Count.

To distinguish between conditional cooperators and non-cooperators, we focused on members who engaged in at least one collusive transaction before February 14, 2020, and labeled them as non-cooperators. The remaining members were labeled as conditional cooperators. Prior research frequently employs experimental methodologies to discern conditional cooperators as those who adjust their cooperation degree in response to hypothetical scenarios involving varying levels of cooperation from others, while non-cooperators as those who maintain their uncooperative stance regardless of external behavior (Fischbacher and Gächter 2010). However, the feasibility of conducting experiments might be limited. Nevertheless, grounded in prior research, we can reasonably deduce that non-cooperators are more predisposed to engaging in opportunistic behaviors even in the presence of robust social norms. Thus, if a member engaged in opportunistic behavior prior to the takeover event, we can reasonably infer that these individuals, on average, place lesser emphasis on social norms and demonstrate a weaker tendency for conditional cooperation, compared with those who do not engage in any opportunistic behaviors before the event.

To assess if a member is committed to the Steem platform in the long term, we calculate their Steem Power (SP) holdings. As mentioned earlier, SP is required to be locked into the platform for at least 13 weeks, indicating a long-term dedication to the platform. However, as historical account balance data is not available, we manually calculated the SP account balance of each member on February 14, 2020, using the calculation rules. We also cross-check our calculated SP balance with members' current SP balance to ensure accuracy. Lastly, to verify whether the hold-or-sell decisions made by members have an impact on their behaviors, we also calculate the number of power-down transactions and the total amount of SP powered down.

	Obs.	Mean	Std.Dev.	Min	Max
Post Length	144,912	4791.29	42025	0	1.42e+07

Post Count	144,912	2.18	6.08	0	471
Comment Length	144,912	2713.05	164483.60	0	2.95e+07
Comment Count	144,912	7.21	179.16	0	32394
Collusive Count	144,912	.25	14.59	0	1915
Conditional Cooperator	144,912	.32	.47	0	1
SP Balance	144,912	3867794	4.14e+07	0	2.33e+09
Power Down Count	144,912	.03	.23	0	11
Power Down Amount	144,912	272925.90	1.03e+07	0	1.62e+09
Table 1. Summary Statistics by Individual Members					

Regression Analysis

Main Analysis

To empirically identify the relationship, we use the following regression framework to examine the change in cooperative behaviors and opportunistic behaviors of each individual contributor:

$$(2)\ Cooperative\ Behavior_{it} = \beta_0 + \beta_1 After_t + ControlVars_{it} + \epsilon_{it},$$

$$(3)\ Opportunistic\ Behavior_{it} = \beta_0 + \beta_1 After_t + ControlVars_{it} + \epsilon_{it},$$

where i indexes the members and t indexes the weeks. For all dependent variables, we take the logarithms transformation. $After_t$ is a dummy variable equals one if the time period is after the event and zero otherwise. We control for the individual fixed effects to control individual time-invariant confounding factors. We also control age, measured as the number of weeks since the members create their account, and the square of age. As the STEEM price also fluctuates during the sample period, we also control for the lagged STEEM close price to control for any change in members' short-term incentives.

Table 2 reports our regression results. All results show the same pattern: this takeover event significantly reduces contribution level. Thus, H1a is confirmed. Meanwhile, when examining its impact on members' frequency of collusive transactions, we did not find any significant change, and H1b is not confirmed. The insignificant result of opportunistic behaviors has two potential reasons. Opportunistic behaviors are driven by two competing forces. On one hand, there are diminished social costs associated with acting opportunistically. On the other hand, the reduced appeal of token rewards leads to lower economic incentives after the event. Therefore, the direction of change depends on which force predominates after the event. Another factor contributing to the absence of significant changes in collusive transactions is the presence of learning costs associated with participating in such behavior. Some individuals, even if their perceived social norms diminish, may not readily identify opportunities to engage in opportunistic actions aimed at maximizing rewards within a short time window.

	Post Length	Post Count	Comment Length	Comment Count	Collusive Count
After	-0.252*** (0.042)	-0.037*** (0.007)	-0.043* (0.022)	-0.020*** (0.007)	-0.003 (0.002)
Age	-0.092*** (0.010)	-0.016*** (0.002)	-0.054*** (0.005)	-0.018*** (0.002)	-0.001** (0.000)
Age²	0.000***	0.000***	0.000***	0.000***	0.000

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ClosePrice (Lag1)	4.149*** (0.400)	0.825*** (0.067)	2.575*** (0.209)	0.957*** (0.067)	0.060*** (0.017)
Individual FE	Y	Y	Y	Y	Y
Table 2. Detecting the Change in Members' Cooperative and Opportunistic Behaviors After the Event					

Heterogeneous Effects on Conditional Cooperators

We now examine the heterogeneous effects of this event on conditional cooperators and non-cooperators, respectively. If the diminished perceived social norms are the main driver for our observed results, in that case, we anticipated that conditional cooperators exhibiting more conditional social preferences would be more impacted by the event. Table 3 summarizes our findings, with around two-thirds of our sample consisting of conditional cooperators. This proportion aligns with previous field studies, indicating that conditional cooperators make up a substantial portion of the population compared to non-cooperators (Rustagi et al. 2010). As anticipated, the event had a stronger impact on conditional cooperators, leading to a significant decrease in their contribution level. Interestingly, despite the overall trend of decreasing collusive count, being conditional cooperators positively moderate the effect of the event, indicating that those conditional cooperators who had not participated in any collusive transactions before the event, started to engage in collusive transactions after the event. Thus, H2 is confirmed by this result, demonstrating that the event had differential effects on conditional cooperators and non-cooperators. These findings support our proposition that social norms play a critical role in shaping behavior, particularly for those with stronger conditional social preferences.

	Post Length	Post Count	Comment Length	Comment Count	Collusive Count
After	-0.121** (0.052)	-0.019** (0.009)	0.021 (0.030)	-0.007 (0.010)	-0.013*** (0.004)
Conditional Cooperator * After	-0.192*** (0.046)	-0.026*** (0.009)	-0.094*** (0.028)	-0.020** (0.010)	0.015*** (0.000)
Age	-0.080*** (0.010)	-0.014*** (0.002)	-0.049*** (0.005)	-0.017*** (0.002)	-0.002*** (0.000)
Age^2	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
ClosePrice (Lag1)	4.135*** (0.400)	0.823*** (0.068)	2.568*** (0.209)	0.955*** (0.067)	0.062*** (0.017)
Individual FE	Y	Y	Y	Y	Y
Table 3. The Impact of the Event on Cooperative and Opportunistic Behaviors with Different Levels of Conditional Social Preferences					

Heterogeneous Effects on Long-term Driven Members

We then examined if this event leading to DAO members' diminished perceived social norms can decrease their tendencies to hold tokens. Based on our theoretical framework, when individuals perceive others as less cooperative, they may adjust their expectations about the future token value, leading to a weakened incentive to keep holding their tokens. As results, the number of power down transactions that transfer SP (a long-term asset) to STEEM (a liquid asset) should increase. As summarized in Table 4, both the number

of power down transactions and the amount of SP being powered down increased significantly. Consequently, we confirm H3a, demonstrating that long-term driven members' motivation to hold tokens decreased after the event.

	Power Down Count	Power Down Amount
After	0.010*** (0.002)	0.114*** (0.022)
Age	-0.002*** (0.000)	-0.021*** (0.004)
Age²	0.000*** (0.000)	0.000*** (0.000)
ClosePrice (Lag1)	-0.033** (0.015)	-0.516** (0.227)
Individual FE	Y	Y
Table 4. Detecting the Change in Members' Hold-or-sell Decisions After the Event		

We then examined the heterogeneous effects of this event on long-term driven members, indicated by their holdings of SP. The shifts in perceived social norms will negatively impact the expectation of future token values and thus may weaken the interest alignment effect created by holding tokens as a profit-sharing scheme. Thus, long-term driven members may be impacted more adversely compared with short-term driven members. Table 5 confirms our hypotheses that the negative impact of this event on hindering cooperative behavior is further elevated if members have more SP holdings, indicating that long-term-driven members' incentive to contribute reduced more adversely in their cooperative incentive compared with short-term-driven members. Thus, H3b is confirmed.

	Post Length	Post Count	Comment Length	Comment Count	Collusive Count
After	-0.099** (0.051)	-0.003 (0.009)	0.053** (0.025)	0.018** (0.008)	0.002 (0.002)
SP Holdings * After	-0.192*** (0.046)	-0.026*** (0.009)	-0.094*** (0.028)	-0.020** (0.010)	0.015*** (0.000)
Age	-0.080*** (0.010)	-0.014*** (0.002)	-0.049*** (0.005)	-0.017*** (0.002)	-0.002*** (0.000)
Age²	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
ClosePrice (Lag1)	4.135*** (0.400)	0.823*** (0.068)	2.568*** (0.209)	0.955*** (0.067)	0.062*** (0.017)
Individual FE	Y	Y	Y	Y	Y
Table 5. The Impact of the Event on Cooperative and Opportunistic Behaviors with Different Levels of Long-term Token Holdings					

Robustness Check

To ensure the robustness of our findings, we have modified the event time window. We conducted the same analysis on various event windows, including 1-day, 3-day, 9-day, and 14-day windows. Our results and conclusions remain consistent across all these different event windows. In addition, we also conducted a falsification test by moving the event start date two weeks earlier to Jan. 31 and still found no significant decrease in contributions. We also incorporated more control variables into our empirical model. These variables account for the lagged token rewards received by members for both content creation and content curation. After adding these control variables, the results remain consistent, with only slight numerical variations observed.

Discussion

Our contribution is threefold. Firstly, we developed a novel theoretical model that contextualized Krupka et al. (2017)'s utility framework within the realm of DAOs, adding new components such as perceived social norms and the interest alignment mechanism of token rewards. Central to this model is the proposition that a DAO member's perceived social norms influence the efficacy of the interest alignment mechanism through her tendency to hold tokens, which in turn affects her cooperative behaviors. Secondly, our empirical study affirmed this proposition, as evidenced by the support for hypothesis H3a. This highlights the expectation-governing role of perceived social norms and the importance of the interest alignment mechanism by token rewards. Secondly, our empirical findings demonstrate that DAO members' diminished perceived social norms adversely affect members' expectations of future token value, their tendencies to hold staked tokens and cooperate. Our model and empirical analyses represent pioneering efforts to explore the intricate interplay between economic incentives and social motivations within DAOs, with an emphasis on the interest alignment mechanism of token rewards. Our proposition bridges these two motivational realms, demonstrating their synergistic potential in facilitating decentralized cooperation in DAOs. Thirdly, based on the basic rationales of profit-sharing arrangements like ESOPs, we adapt this understanding to the context of DAOs, providing a sophisticated articulation of the interest alignment mechanism inherent in token rewards, which is absent in the existing literature of DAOs. This paves the way for further theoretical and empirical inquiries into their interactions in broader blockchain-enabled decentralized ecosystems.

Our study also carries significant practical implications. Our findings underscore the vital importance of preserving and fostering social norms of cooperation within DAOs. Events that shift these norms can lead to a significant decrease in cooperation and even initiate a rush to liquidate tokens. This could spiral into a negative feedback loop and potentially lead to more severe consequences. Thus, DAO practitioners must remain alert to external occurrences that might destabilize members' perceived social norms. They can draw inspiration from tools used in traditional organizations to maintain norms and values, such as organizational-wide events (Gottschalg and Zollo 2007). Furthermore, practitioners should, therefore, clearly state the actions that are encouraged and discouraged in the whitepaper to ensure that members reach a consensus in understanding these norms, as ambiguity and misinterpretation of certain actions can significantly undermine compliance with social norms (Bicchieri 2017). Additionally, given the influence of perceived social norms on the efficacy of token incentives, it becomes crucial to consider these social aspects when designing token systems. This ensures that the incentive structures within a DAO remain effective.

Our future research aims to design token-based mechanisms that can more effectively incentivize members and better align their interests with the DAO. Moreover, with the proliferation of rich textual data for DAOs available online, new and more precise methods may arise to capture and measure perceived social norms. Our future research can leverage machine learning methods to analyze such data, creating novel measures that more accurately represent perceived social norms and capture their evolution over time.

Conclusion

DAOs represent a novel paradigm for digital cooperation, using tokens to foster cooperation within a decentralized and self-organized community, ultimately aiming to achieve shared goals. The token rewards can align individual members' interests with the collective interests of the DAO, promoting cooperative behaviors. However, in practice, the designated purposes of tokens are often invalidated. We posit that

perceived social norms may interact with the interest alignment mechanism of token rewards, influencing its effectiveness in promoting cooperation within DAOs. We developed a theoretical model based on previous economic theories to model the intricate interplay among perceived social norms, token rewards, and DAO members' cooperative behaviors. Our empirical study validated that the diminished perceived social norms not only influence DAO members' tendencies to cooperate but also affect the efficacy of token rewards in aligning interests. Leveraging an exogenous takeover event, we find that when norms of cooperation are violated, members' perceived social norms and tendency to engage in cooperative behaviors both diminish. Meanwhile, individuals with stronger conditional social preferences begin to behave more opportunistically. Our analysis further shows that long-term driven DAO members (i.e., members that staked their tokens) were more adversely influenced by the diminished perceived social norms. These findings highlight the importance of incorporating social factors, particularly perceived social norms, into incentive structure designs to foster cooperation within DAOs.

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