Section 1. Economics of recreation and tourism

DIGITAL COOPERATION IN ONLINE COMMUNITIES

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Abstract

This paper investigates the mechanisms that sustain cooperation in online communities by examining how reciprocity, signalling, and decentralised enforcement function in the absence of formal governance. Drawing on microeconomic theory, particularly game theory and public goods analysis, the paper challenges the assumption that rationality or trust are prerequisites for sustained cooperation. Instead, it argues that durable interactions and reputational incentives foster self-policing behaviours, enabling users to share digital goods – such as knowledge and information – despite anonymity and the risk of free-riding. Through a case study of Stack Overflow, the paper demonstrates how gift-like exchanges, identity persistence, and gamified reputation systems encourage participation in environments where repeated interaction and indirect reciprocity prevail. The study also explores the structural and cultural limits of cooperation.

Keywords: *Indirect reciprocity, Gift economy, Repeated games, Generalised exchange, Reputation systems, Self-policing mechanisms, Signalling theory, Decentralised governance, Digital cooperation, Trust and trustworthiness*

Introduction

In digital platforms such as Reddit, Stack Exchange, and Discord, users voluntarily contribute information, answer questions, moderate content, and enforce community norms – often without direct compensation or formal authority. These cooperative behaviours occur within anonymous, decentralised environments, raising an important question: what sustains such cooperation in the absence of contracts or external enforcement? Game theoretic models – particularly repeated games – and behavioural concepts such as signalling and generalised exchange explain how communities self-police, motivate participation, and maintain digital public goods.

This paper investigates how cooperation is sustained in online communities by applying concepts from repeated games, signalling theory, and public goods theory. I argue that cooperation in digital spaces arises from strategic incentives structured by reputation systems, persistent identity, and generalised reciprocity. These mechanisms substitute for governance, reduce the risk of defection, and

make the supply of digital public goods sustainable. Using examples from major online platforms, I explore both the enabling conditions for cooperation and the structural limits that constrain it.

Results analysis

In a standard one-shot prisoner's dilemma, rational agents defect due to dominant strategy reasoning. However, in infinitely repeated games, players have incentives to cooperate in order to preserve future payoffs (Axelrod, 1984). Thus, for stable cooperation to emerge, players must value future benefits more than payoffs from immediate defection. Furthermore, they must expect interactions to continue indefinitely – there should be no known endpoint to the game. Hence, the cost of terminating a relationship will be higher and therefore more prominent in individual's decision-making process. Players must be able to observe other's actions and respond accordingly. Fast response times would prevent accumulation of defections to such an extent that the victim's provocability is no longer enough to prevent the challenger from having an incentive to defect. It was shown that immediate response to provocation ensures minimal losses for the victim, rendering Tit-for-Tat strategy the best way to foster cooperation (Axelrod, 1984).

Therefore, cooperation mainly depends on durability of relationship rather than trust, which makes anonymous exchanges in digital spaces possible (Axelrod, 1984). There is no definite end to online activity and future benefits may greatly exceed payoffs from exploiting the system – for example, by supplying a good of low quality, an individual risks negative reputation which will pose difficulties during future sales. In terms of provocability, online communities tend to have immediate response to defection because it is very easy to react by posting a negative review or banning the defector. Therefore, the required conditions are maintained in digital spaces which makes stable cooperation possible.

The concept of reciprocity provides a deeper insight into cooperation in online communities, particularly in the absence of formal enforcement mechanisms. In such environments, users often adopt informal strategies drawn from repeated games, rewarding cooperative behaviour while punishing non-cooperation through social sanctions such as downvotes, exclusion, or reputational loss. In this way, reciprocity acts as a decentralised substitute for governance, enabling self-regulation even in large, anonymous networks.

To better understand this mechanism, it is useful to distinguish between gift exchange and commodity exchange. In a gift exchange, a contribution is made with an implicit, delayed expectation of reciprocation, without explicit bargaining or fixed terms. These exchanges foster long-term social bonds and mutual trust, especially when the giver and recipient share a continuing relationship or group membership. By contrast, a commodity exchange is transactional: it involves a clear, immediate equivalence of value, based on the incidence of wants and governed by market logic.

In online communities, content shared voluntarily – such as tutorials, advice, or answers to questions – is a gift in a strict sense (Kollock and Smith, 1999). It is often offered without any guarantee of return, particularly in spaces where the recipient is anonymous or unknown. Yet such digital gift economies flourish because contributors anticipate indirect reciprocity: others may reward them later, or the group as a whole may sustain a culture of helpfulness. This structure allows for network diversification, where social capital and recognition extend beyond direct exchanges. In contrast, commodity exchanges would restrict cooperation only to clear, mutual benefit, undermining the openness that underpins many online platforms. Therefore, digital reciprocity transforms unilateral contributions into socially valuable signals, reinforcing cooperative norms without relying on central enforcement.

Many of the services provided in online communities – answers to questions, shared advice, user moderation – qualify as public goods: they are non-rivalrous and non-excludable. Information posted online is publicly accessible on many platforms, while an individual viewing the information does not diminish the access for other people. However, public goods are prone to underprovision due to the free rider problem: individuals may benefit from others' contributions without re-

ciprocating, reducing the incentive to contribute. Stack Overflow receives 7 million monthly visitors, but there are only 300,534 registered users, demonstrating the extent of contribution inequality (Mamykina et al., 2010).

Digital communities address this dilemma through indirect reciprocity and generalised exchange (Kollock and Smith, 1999). Users help others with the expectation that someone else in the community will eventually return the favour (not necessarily the same individual). Other non-monetary incentives that support this behaviour include:

- Strategic incentives: building a good reputation, increasing one's visibility, or improving access to future help;
- Social incentives: intrinsic satisfaction from helping, status within a group, or moral obligation;
- Psychological incentives: feelings of efficacy, identity alignment with community values, or personal attachment to the platform.

One of the key challenges in digital environments is asymmetric information – users cannot immediately observe others' intentions or trustworthiness. In economic terms, the risk of adverse selection and moral hazard is high: low-quality contributors may flood the community, and once accepted, users may shirk cooperative norms without penalty. To mitigate these risks, platforms implement signalling mechanisms: Reddit uses upvotes and karma scores; Stack Exchange ranks users by reputation points; Discord servers often assign roles based on activity or trust. These signals reduce information asymmetry by making users' past behaviour visible, allowing others to adapt their responses accordingly.

Identity persistence allows players to distinguish between people despite anonymity of online platforms, which makes retaliation strategies possible. Additionally, past interactions are available to players – such as server history or user reviews. Therefore, people who exploit the system and become free riders can be punished by community due to their public activity. Reputation, in this context, becomes a strategic asset. Users invest in cooperative behaviour to build a reputation that yields future benefits, such as access to information, faster help, or social status.

Reputation also functions as an enforcement mechanism on many platforms, punishing defectors by excluding them from future benefits. In comparison to contractual or relational enforcement which are used in real world markets, reputation enforcement mitigates the risks of asymmetric information in the market without hindering the individual's ability to differentiate between trustworthy players and defectors. According to empirical research, reputational enforcement is particularly effective at developing self-perception of trust and trustworthiness (Kuwabara, 2015). Furthermore, reputational knowledge tends to increase the level of cooperation within community highlighting its positive effects on perception of trust (Gallo and Yan, 2015).

Despite their strengths, online communities face structural and cultural limits that constrain cooperation. First, voluntary moderation, that allows platforms like Discord to function, depends on individuals' intrinsic motivation and available time. Without sufficient engagement, norm enforcement breaks down, and communities risk being overrun by spam, misinformation, or toxic behaviour. Stack Overflow has been operating on the basis of achieving minimum response time rather than increasing total number of registered users since it is more important to ensure frequent participation of users (Mamykina et al., 2010).

Second, the scalability of cooperation within small groups is questionable since more complex interactions will have higher implicit costs. Although digital space significantly reduces management and organisation costs for any public good, it may be hard to coordinate between anonymous participants (Kollock and Smith, 1999).

Finally, absence of explicit governance over the space allows for freedom and development of reputational and relational enforcement, but it inevitably leads to higher risk of defection for anyone involved (Kuwabara, 2015). Generalised exchange is riskier because there is no guarantee that fairness would be maintained within community. Contractual enforcement, which is based on contracts rather than reputation, ensures cooperation via rule of law, but makes trustworthiness seem forced. Hence, players fail

to learn effective strategies for cooperation, becoming less trusting of transactions that do not involve contracts.

Case study

To support my arguments I look at Stack Overflow as my case study. The platform hosts over 29 million registered users, with more than 24 million questions and 36 million answers as of 2025 (Stack Exchange Inc, 2025). Despite this scale, the platform sustains high rates of cooperation – 92.6% of questions received at least one answer as of 2010, with median first response time around 11 minutes (Mamykina et al., 2010). This demonstrates that large, decentralized communities can still act cooperatively and respond rapidly, aligning with public goods dynamics.

Stack Overflow's gamification system is well-documented: users earn reputation points and badges for contributions such as answering questions and receiving upvotes, which unlock moderation privileges and visible status within the community. Users with reputation over 20,000 are considered "trusted users", leading to real and material implications of high reputation (Osborne et al., 2023). Only 0.05% were considered "trusted" at the time of the study (Osborne et al., 2023). This reflects signalling theory in action: users build visible reputational capital via sustained cooperation.

Empirical work shows that 35.2% of developers answer two or more questions, and only 7.8% answer more than 5 questions (Wang, Lo and Jiang, 2013). This illustrates participation inequality and how reputation incentivises consistent cooperation. Moreover, users experience loss aversion – they react more strongly to downvotes than upvotes – indicating that reputational penalties effectively deter defection (Shankar, 2022). StackOverflow surveys reveal that 25.6% of respondents visit the website to "contribute to a library of information", and 12.4% of respondents say they contribute to open source at least monthly (Stack Overflow Inc, 2019). This suggests reputational rewards create positive feedback loops reinforcing cooperation.

Conclusion

Cooperation in online communities does not arise from altruism alone but is sustained by the strategic logic of repeated interaction, signalling, and reciprocal enforcement. Through identity persistence, reputation systems, and decentralised monitoring, platforms recreate the incentive structures necessary for cooperation to emerge in anonymous, large-scale environments. Game theory thus provides a framework for understanding digital cooperation, illuminating how public goods are provided and sustained without central governance. As online communities continue to shape our social and economic lives, understanding these dynamics is essential to designing more cooperative digital spaces.

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