Elements of Antirival Accounting with sNFT

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Abstract. Accounting with antirival tokens, i.e., accounting based on shareable units that gain value with increased use, enables efficient and effective collective action. However, most currencies are rival tokens which can naturally represent — and be exchanged to — rival goods, such as a cup of coffee. Antirival systems of account would be a natural fit for the economy of antirival goods because the logic of value creation and accounting would be compatible. It is challenging to find an allocatively efficient price for antirival goods, such as data, measured in rival units of account. We present an antirival accounting system based on Distributed Ledger Technology (DLT), where the fundamental operation is *sharing* instead of exchanging and study it with system dynamics models and simulations. We illustrate our arguments by presenting a system known as Streamr Awards that defines three tokens of a fundamentally novel type, shareable non-fungible token (sNFT). We present the functioning of one of these in the work allocation of a self-directed online community.

Keywords: sNFT, Antirival goods, System dynamics, Blockchain, DLT

1 Introduction

Accounting and accounting systems are a way to increase accountability and transparency. These map to information security properties for data, integrity, and availability, respectively [5]. Businesses use accounting methods and financial accounting systems to maintain checks and balances, reduce risk of fraud, and be regulatory compliant. These types of accounting systems are commonly seen as mechanisms to register financial transactions measured in currency values where the unit of an account is money [8,14]. Hence, to date, these systems have been predominantly designed for rival resources –most commonly understood as physical resources characterised by scarcity and expendability.

However, we enter into a novel territory with the economic system in which we wish to apply accounting, e.g., in information goods. Such systems and resources are not rival, as they do not deplete in use and can be multiplied practically indefinitely [6]. Consequently, they do not fit the traditional accounting system, and money is proving to be an unsuitable unit of account, as repeated shortcomings

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of the data markets indicate [10, 15]. This paper addresses this shortcoming by describing and exploring the concept of antirival accounting through tokenised efforts of a decentralised open-source community. We ask: how antirival accounting can impact the work of decentralised communities using antirival goods?

Building on previous work [6, 10, 16], we hypothesise that data markets, in particular, and society, in general, need an efficient socio-technical accounting system that supports the underlying antirival goods. Yet, such antirival accounting systems are far from being standardised arrangements, requiring institutional work [12]. We present a solution implemented by utilising open DLTs to create antirival accounting units that combine the efficiency and security of traditional rival units of account with fundamentally different economic implications.

The proposed solution defines an antirival system with rules and behavioural patterns. We develop a simple theory [4] for the conceptual virtual laboratory [7] of antirival [21] accounting and describe it with system dynamics [19], a complex adaptive systems modelling and simulation methodology. We further explore the arising dynamic feedbacks, and potential value dynamics, of antirival accounting with system dynamics modelling and simulations. Thus, the solution contributes to the development of "antirival institutions" toward a more inclusive digital economy [6].

2 On Open DLTs and Antirival Goods

Accounting can be defined as an information system that measures, processes, and communicates financial and non-financial information about an economic entity [14]. Accounting is a social science representing the economic reality of the enterprise, but it also has the power to create new social realities [8].

There are situations where the use of rival accounting units would be suboptimal. This dilemma exists, e.g., as part of data markets since the goods traded, data and information are of fundamentally different nature than physical items or services [10, 16]. For physical items a typical operation is *exchanging*; for data, the typical operation is *sharing*. A blockchain is a growing list of data items, blocks, that are securely linked together using cryptography [13]. An open DLT is public, and anyone can participate in the core activities of the blockchain network, such as reading and writing to the chain. These examples illustrate how data and information are shared, not exchanged.

Economic goods can be classified as rival, nonrival, and antirival based on their subtractability dimension (e.g., [15, 16]). *Rival goods* are defined as goods with positive subtractability, which means that their value is transferred and lost if the good is consumed. Meanwhile, nonrival and antirival goods are defined as having neutral and negative subtractability, respectively. Contrary to rivalry, antirivalry is the quality of those goods having negative subtractability. Antirivalry means that the goods having antirival nature *gain value* when given to and shared with others; that is, they have positive network externalities [6]. Furthermore, economic goods can be classified as excludable or non-excludable according to their excludability dimension, i.e., how excludable they are via hu-

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Table 1. Example goods of the extended classical economics taxonomy to information goods [16].

		Subtractability		
		Rival	**Nonrival**	**Antirival**
Excludability	Excludable	private key of a cryptosystem	*uncopyable* electronic book / PDF	access-controlled science journal
	Non-excludable	public key of a cryptosystem	electronic book / PDF	open science journal

man decision-making (typically by their owner). Examples of each category of information goods – rival, nonrival, antirival – are presented in Table 1.

An online science journal is antirival since the articles (in) increase value when shared. It is excludable because the journal may require money or some form of membership for access. When open sharing to all interested parties without exclusion is enabled, it is an example of a non-excludable good, an *open science journal*. Should the products be *uncopyable PDFs of scientific papers*, those would be an example of nonrival, excludable goods. Because the data of the book remains nonrival, the uncopyability would make it exclusive to the holder of the (only) copy. Finally, a private key of a public key cryptographic system may be rival because it is essential to use it only by one person or entity and not anyone else. Otherwise, the function of the key is lost; this is an example of a rival yet excludable good since we can keep a private key confidential. The corresponding public part of the same key pair is equally rival but is not excludable since everyone needs to have access to it.

In addition, we follow the argumentation by Olleros [6] that a good itself, in isolation, is not necessarily antirival without the more extensive (social) system, where the good is embedded. The system defines and decides if something is antirival or merely nonrival. For example, an informational component that complements a rival transaction has the potential of being a nonrival or antirival good [16].

3 Methodology

In this paper, we develop a system dynamics model to demonstrate how the work becomes more efficient when directed in a decentralised community utilising the antirival units of account in open DLTs. By applying it in pilot experiments, we have chosen to utilise DLTs to model and implement a representation of an antirival accounting unit as a shareable non-fungible token (sNFT). An sNFT is distinguished from a regular rival NFT via its novel fundamental operation, as they can be shared, not only exchanged, between parties.[4]

Recently, system dynamics has gained more recognition as a prime modelling methodology for a novel branch of economics [3]. System dynamics is commonly

[4] ERC-5023: https://eips.ethereum.org/EIPS/eip-5023

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utilised to model complex adaptive systems, such as taxation economics [18], and has shown applicability in institutional economics [17]. This paper presents a CLD model of our simulations, illustrating how sNFT tokens can improve the work efficacy in a decentralised community.

As our case, we introduce an active community which underlies and supports the Streamr project. The project is developing a decentralised peer-to-peer network for transmitting real-time data using a topic-based publish-subscribe system. Streamr community is worldwide, and it is built around a strong ethos. The Streamr community produces antirival information goods which form a body of knowledge for the open-source technology. Three types of sNFT tokens were designed to align and reward contributions from the community members to support the goal of a thriving decentralised open-source knowledge creation community. The Streamr Awards tokens, serve as units of account for finding relevant contributions and their producers.[5] The sNFTs form the basis for the CLD model (Fig. 1) and simulations. The model depicts the Streamr Awards system for member contributions in terms of causalities but may be applied to any open knowledge creation community.

4 Model description

In Fig. 1, starting from the first feedback loop *R1: efficient collaboration*, the more the community has engaged collaborations, the more foundational work rate is increased. *Foundational work* is the work the community was founded for as described by the constitution and inspired by the ethos [11]. The bigger the foundational work rate, the more completed foundational work is achieved and the more significant the amount of identified evaluation work, as all completed foundational work directly defines a work item to be evaluated. *Evaluation work* is the work community does to quality-check the foundational work. Evaluation work, together with endogenous variables *identified evaluation work* and *constitution of the catallaxy* [2], determine how both, the number of contribution sNFT tokens, and body of knowledge develop. The *body of knowledge* is all the vocabulary and processes that make up the knowledge of a particular professional field as defined by the knowledge creation community [9]. Increasing the number of contribution tokens increases the internal blockchain effects, which are assumed to decrease the internal search costs as the open blockchain is a fully openly searchable and reliable joint database describing all the critical internal elements to be searched. Decreasing the internal search costs will lead to a change in the opposite direction of the engaged collaborations, which will thus increase, closing the *R1*, which is named *efficient collaboration* because it is what makes collaboration in the community more efficient each round.

Concentrating on the leftmost part of the diagram, the constitution of the catallaxy also balances foundational work. It is precisely the function of the constitution to frame the work, i.e., the digital catallaxy's constitutional smart

[5] A more detailed description in the Streamr blog: `https://blog.streamr.network/streamr-awards-are-here-contribute-and-earn-unique-snfts/`

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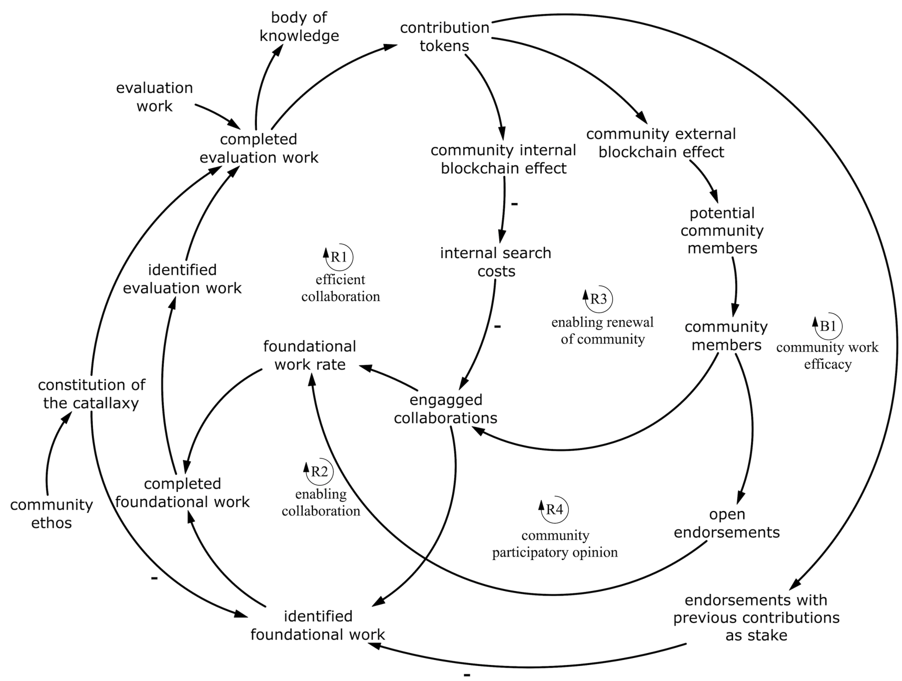

Fig. 1. CLD of the community managed via contribution sNFTs.

contracts, separate from all possible work, the foundational work to be performed. Focusing on the second reinforcing feedback, *R2: enabling collaboration*, the engaged collaborations also increase identified foundational work, as work gets identified synchronously with the collaboration formation. *Engaged collaborations* are collaborations of members working on a piece of foundational work. The more identified foundational work there is, the more manifests as completed foundational work, closing the *R2* feedback by joining it with the *R1*.

The word *effective* needs an outer framing and cannot be described by mere increasing numbers without knowing what such numbers mean. I.e., it needs a context, (ethical) values being attached to those numbers and attaching them to a meaning, an ethos. The constitution is the rules about what the founding fathers found valuable in itself, not quite intrinsically, but instead for some purpose under some value definition, and it describes the actionable purpose of the community. Turning to *R3: enabling renewal of community*, increasing the number of contribution tokens increases the community external blockchain effects. Blockchain effects consist of *transparency effect* and *integrity effect* [5]. Here the word *external* refers to the effects which reach outside the community. The nature of an open Nakamoto blockchain is that it is and remains world readable without the possibility of closure [13]. Thus, the potential community members outside the community will remain in the know about those aspects of

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the community which are enjoyed by the members. Such an external blockchain effect leads to an increasing number of potential community members. Moreover, the number of community members also increases as new members engage in collaborations which increases *engaged collaborations*.

In the dynamic reinforcing loop *R4: community participatory opinion*, increase in the community members, also increases open endorsements, as people give public encouragement (e.g., thumbs up) to each other. *Open endorsements* are a form of low-commitment participatory commitment work. Open endorsements help to reduce and prioritise the work leading to the effectiveness of the community, instead of mere increasing work rate (efficiency). The loop *R4* is affected by the community constitution, catallaxy. *R4* is a reinforcing loop increasing identified work since it will help speed up the work rate by prioritising what is widely considered most valuable. Finally, there is a goal-seeking loop *B1: community work efficacy*, starting from the contribution tokens. As the number of contribution tokens increases, endorsements with previous contributions as stake increase as community members engage in endorsements based on their and others' contributions. This type of endorsement is a form of high-commitment, high-stakes participatory work to the community. It is based on pre-existing, formally acknowledged deeply community-embodied previous contributions (staking) and others' contributions (basis). The goal-seeking loop *B1* is mediated by the constitution of the catallaxy. The constitution is connected to the identified foundational work with a minus sign because it reduces and selects which work is inside the community and which is outside. Behind it is the hard-to-formalise human interactions related to community ethos, i.e., off-chain governance. The mere compositional structure of the collaboration effort defines the newly identified foundational work in conjunction with the community constitutional catallaxy because these two are the direct reasons causing new work (efficacy).

5 Discussion

Our simulations describe the general dynamics of an sNFT representing contributions in a decentralised community. Via tokenisation, they form a basis for a different type of accounting. Any good can be excluded with the use of force, and even information goods can be excluded with cryptography and secrets. Confidentiality provided by cryptography is based on information asymmetry, with some knowing the key and some not. However, these instruments have not been successful in facilitating efficient markets to share or trade data [10, 15]. The *R2* loop of Fig. 1 has the mechanical efficiency to expand very fast. However, it shall remain under the framing of *R3*, *R4* reinforcing, and *B1* balancing loops, which are in turn mediated and controlled by the founding constitution of the catallaxy [2]. The value accumulation of such a system remains under the control of the founding ethos of the community, guiding the embodiment of practical, actionable rules into the constitution of the catallaxy.

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A decentralised institution secured with blockchain means sustainable distribution of power. Members of our antirival community contribute to the constitutional catallaxy [2] through exit, voice, or loyalty [1]. The process we define increases efficiency and efficacy within the confines of the pre-existing interpretation of the constitution [2]. So far, such a constitutional process has been known to take place mainly in the context of nation-states. However, later, via the constitutional catallaxy, it can also apply to smaller communities, such as platforms [9]. Streamr Awards allows the members to shape the constitutional catallaxy by contributing directly or by two types of community members endorsing contributions. Previous contributions do not back the first kind of endorsement. The second kind is backed by previous contributions wherein the community member endorsing is included. The second kind is more valuable than the first. In simple terms, the contributions backing the endorsements are part of the post-constitutional game, a process that increases work efficacy (work selection from all possible work) [2]. There are also indirect efficiency effects via *engaged collaborations.* This process is an incremental prioritisation and incorporation of contributions that is fully decentralised without a need for political or centralised negotiation.

Loop *B1* decreases work, i.e., the set of all possible work is larger than the work to be done under this community and in the particular selected collaboration. *Effectiveness* or *efficacy* is a qualitative change in what work is selected to be done, while the efficiency-producing loops merely increase the work rate. Together these components, efficacy, and efficiency, produce increased *allocative efficiency*, which is a better allocation of work and a more efficient execution The direction and selection of work happen in a decentralised manner [20].

We introduced and made progress in developing antirival accounting, a new form of accounting where the fundamental transaction is sharing instead of exchange. We presented an open blockchain-based antirival taxonomy and a further tokenisation example of an antirival token (sNFT). We illustrated our arguments by describing the system dynamics model for Streamr Awards. The sNFT formulation can efficiently and transparently represent values that are considered *externalities* in the rival accounting system. When antirival accounting is utilised in bottom-up digital communities, new egalitarian, decentralised, and heterodox modes of governance become possible. The resulting antirival accounting system seems particularly suitable for the areas of the economy which mainly produce valuable and reliable data, information, knowledge, or wisdom.

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