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Commoning with blockchain. The Ğ1 libre currency / Duniter case.

Maxime MALAFOSSE, Amandine PASCAL**
& Serge AMABILE****

*Aix Marseille Univ, CNRS, LEST, CERGAM, Aix-en-Provence, France

**Aix Marseille Univ, CNRS, LEST, Aix-en-Provence, France

*** Aix Marseille Univ, Université de Toulon, CERGAM, Aix-en-Provence, France

Abstract

The rise of the internet and peer-to-peer networks have fostered the formation of communities around new collective projects that bring Ostrom's (1990) work on the commons back to the forefront. From this perspective, a new field of specific research suggests that blockchain technology can support commons governance. Studies are still rare and remain very theoretical. The objective of this article is to study the actual use of this technology in the process of commoning. To do so, this paper relies on the case study of the Ğ1, a French free/libre cryptocurrency. Our results detail the governance arrangements of a new type of commons developed by members of the Ğ1 libre currency; the socio-technical system of money creation. In doing so, this case highlights the attributes of the Duniter blockchain specifically developed for the needs of the Ğ1 ecosystem. It also outlines the role of the blockchain in supporting self-organization and the bundles of rights that members have put in place to allocate the universal dividend.

Keywords

commons, Ostrom, commons-based peer production (CBPP), blockchain, Ğ1 libre currency

Cite

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La technologie blockchain au service du “faire commun”. Le cas de la monnaie libre Ğ1 / Dunitier.

Maxime MALAFOSSE, Amandine PASCAL**
& Serge AMABILE****

*Aix Marseille Univ, CNRS, LEST, CERGAM, Aix-en-Provence, France

**Aix Marseille Univ, CNRS, LEST, Aix-en-Provence, France

*** Aix Marseille Univ, Université de Toulon, CERGAM, Aix-en-Provence, France

Résumé

L’essor d’internet et des réseaux pair-à-pair ont favorisé la constitution de communautés autour de nouveaux projets collectifs qui remettent au premier plan les travaux sur les communs d’Ostrom (1990). Dans cette perspective, un nouveau champ de recherches s’intéresse au rôle de la technologie blockchain comme support de la gouvernance des communs. Ces recherches, encore peu nombreuses, sont essentiellement théoriques. Cet article se fixe ainsi comme objectif d’étudier l’utilisation concrète de cette technologie dans le processus de faire commun. Pour ce faire, cet article s’appuie sur l’étude du cas de la monnaie libre Ğ1. Nos résultats présentent en détail les modalités de gouvernance d’un nouveau type de commun développé par les membres de la monnaie libre Ğ1 : le dispositif socio-technique de création monétaire. Ce cas est intéressant car il permet de mettre en exergue les attributs de la blockchain Dunitier spécifiquement développée pour les besoins de l’écosystème Ğ1. Il souligne également le rôle de cette blockchain pour soutenir l’auto-organisation du projet et, notamment, les faisceaux de droits que les membres ont mis en place afin d’allouer le dividende universel et le processus de faire commun.

Mots clés

Commun, Ostrom, production par les pairs sur la base des communs / Commons-Based Peer Production (CBPP), blockchain, monnaie libre Ğ1.

Citer cet article

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Introduction

The increasing use of the internet in the 1990s led to the development of new virtual forms of collective organization. These have allowed many digital projects to come into being and become very successful: Creative Commons licences, Wikipedia, Linux, Wordpress, Firefox, Arduino, etc. These projects, characterized by decentralized and collective governance, have led researchers to revive the theoretical basis of the commons (Hess & Ostrom, 2003). The interest in the commons stems from the fact that it allows us to grasp various problems related to the efficiency and sustainability of social groups that have institutionalized collective action over time and are thus able to preserve their common resources (Ostrom, 1990).

Ostrom's (1990) research first outlined the conditions necessary for the sustainability of scarce physical natural resources such as forests, irrigation systems, grazing lands, or fisheries. Commons were thus defined as a shared resource that is collectively managed and maintained by a community. Today, the term "commons" is used in a broader sense to refer to both: (1) a shared resource, (2) a group of actors who have formal or informal rights and obligations related to the use or exploitation of that resource (also referred to as a bundle of rights), and (3) their own governance structure (Coriat, 2015). While research on the commons is always related to questions about the collective management of scarce resources, or at least those that might be undermined by free-riders or over-exploitation, it addresses different types of commons (Hess & Ostrom, 2003; 2007). Thus, the analysis of intangible resources, such as patents (Lessig, 2000), knowledge (Hess & Ostrom, 2003), free/libre open-source software (FLOSS) (Stallman, 1999, 2002), or even cryptocurrencies (Meyer & Hudon, 2019), has an important place in the recent literature. The particularities of these resources, especially their nature, have led researchers to revisit the theoretical framework of the commons originally developed by the work of Ostrom (1990).

Studies have therefore focused on defining these new information commons (Broca & Coriat, 2015; Coriat, 2015; Hess & Ostrom, 2007; Zimmermann, 2020), better locating where the scarcity in these digital commons lies in order to help understand the conditions of their existence (Jullien & Roudaut, 2020), and questioning their sustainability (Greco & Floridi, 2004; Potts, 2018). To an extent, some of the analyses suggest that the production of intangible commons may be associated with a new model of socio-economic production, that of commons-based peer production (CBPP) (Arvidsson et al., 2017; Benkler, 2006; Hippel & Krogh, 2003). More specifically, work suggests that blockchain technologies can be considered relevant solutions for supporting this mode of production and thus also for commoning (Bollier & Helfrich, 2019; Cila et al., 2020; Davidson et al., 2016; Rozas et al., 2021).

Research in this field is still scarce and mainly theoretical. This lack of empirical research is likely due to the fact that, to the best of our knowledge, there are few accessible field that use blockchain to support commoning. Moreover, while there are empirical studies on blockchain that could fit within the commons framework (Bass & Old, 2020; Mengelkamp et al., 2018; Pazaitis et al., 2017), these have not directly addressed the peer governance of the commons or explored in detail the contribution of blockchain to managing the commons.

From this perspective, the main objective of this article is to understand how the integration of blockchain and distributed ledgers is involved in commoning. To this end, in the first section, we present the theoretical framework of the commons, in particular the research on peer governance, and then we propose a definition of blockchain in order to establish the principles according to

which these technologies can support the peer governance of the commons. In the second part, we present the case of the Ğ1 libre currency, in which commoners use blockchain to facilitate their collective action, and our methodology. Our results, which are the subject of the third part, will shed light on both the organisation of the community and the Duniter blockchain. They thus put into perspective how the development and use of the Duniter blockchain allow the members of the Ğ1 libre currency to manage the commons, that is, the socio-technical device for money creation. They also show how blockchain technology enables the boundaries of the commons to be established and, more broadly, support collective action.

1 Literature review

After introducing the issue of governance of the commons, we present blockchain technology and its technical characteristics. Finally, we show how this technology can be useful for commoning.

1.1 The sustainability of the commons and the importance of peer governance

According to Ostrom and Ostrom (1977), common-pool resources differ from other types of goods in two characteristics: subtractability, also called rivalry, according to which the consumption of part of the resource by one individual reduces the availability of that resource for others; the difficulty of excluding a potential beneficiary from using that resource. Common-pool resources are thus a type of resource that is neither publicly nor privately owned (such as the air, forests, etc.) and that, in this sense, constitute a problem of collective action that can lead to over-exploitation of the resource.

The pioneering studies of Ostrom (1990) have shown that communities that self-organize are likely to be able to manage these common resources satisfactorily so that they can be used by as many actors as possible without depleting them. Under certain conditions, these communities are more effective than government or market regulation. Here, the concept of community is central (Ostrom, 1992). It is understood as a group of people (i) who share certain beliefs, including normative beliefs, and preferences, beyond those that constitute their collective action problem, (ii) with a more or less stable group of members, (iii) who expect to continue interacting with each other over a period of time, and (iv) whose relationships are direct (not mediated by third parties) and multiplex (Singleton & Taylor, 1992, p. 315).

Ostrom (1990) has also defined the conditions necessary for the survival of common resources. By observing numerous communities, she identified the social norms and the collective rules governing them. In particular, her work has highlighted constitutional principles that, when present, promote the collective and sustainable management of common resources. The eight principles include rules for accessing the resource, rules for regulating behaviour, mechanisms for managing conflict, and, finally, integration into the local environment, which requires relationships with other institutions. These principles are as follows (Ostrom, 1990, p. 90):

1. Clearly defined boundaries: Individuals or households who have the rights to withdraw resource units from the Common-Pool Resource (CPR) must be clearly defined, as must the boundaries of the CPR itself. (O1)

2. Congruence: The operational rules of appropriation/provision must match the local conditions. Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to the local conditions and to the rules of provision requiring labour, material, and/or money. (O2)
3. Collective-choice arrangements: Most individuals affected by the operational rules can participate in modifying them. (O3)
4. Monitoring: Observers (including the members of the commons) who audit the resource use are collectively accountable to the appropriators. (O4)
5. Graduated sanctions: Appropriators who violate the operational rules face graduated sanctions by other appropriators or by officers of the commons. (O5)
6. Conflict-resolution mechanisms: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts. (O6)
7. Minimal recognition of rights to organize: The rights of the appropriators to devise their own institutions are not challenged by external governmental authorities. (O7)
8. Nested enterprises: All the activities above are organized in multiple layers of nested enterprises. (O8)

These principles highlight how a group of interdependent actors can self-organize to preserve the use of common resources, while some may be tempted to take advantage, evade or act opportunistically (Ostrom, 1990). Ostrom's principles make it possible to avoid free-riding behaviour, that is, cases in which some participants take advantage of the efforts of others and do not contribute, or not sufficiently, to the management of common resources.

The creation of boundaries to restrict access to a rival resource (or at least a resource that is subject to degradation, pollution, and inequality) and the management of these boundaries are also central to the definition of a commons and its governance system. Thus, the definition of this type of collective arrangement, the bundles of rights according to Schlager and Ostrom (1992), regulate the access and management of the rival resource. Several types of rights are associated with positions. Therefore, the constitution of the bundles of rights makes it possible to distinguish the different possible actions with respect to the use of the common resource, as shown in Table 1.

		Type of position				
		Owner	Proprietor	Claimant	Authorized user	Authorized entrant
Type of rights	Access	x	x	x	x	x
	Withdrawal	x	x	x	x	
	Management	x	x	x		
	Exclusion	x	x			

	Alienation	x				
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Table 1 – The bundles of rights associated with positions, after Ostrom and Schlager (1996)

More recently, the commons theoretical framework has been applied to types of common resources other than scarce physical resources. Based on the research of Hess and Ostrom (2007), several papers have shown that the scope of the commons theoretical framework can be applied to intangible resources. There is research which presents the specific cases of patents (Lessig, 2000), knowledge (Amabile et al., 2018; Cardon & Levrel, 2009; Forte et al., 2009; Hess & Ostrom, 2003), free/libre open-source software – FLOSS¹ (Stallman, 1999, 2002; Jullien, 2003), money (Peltokoski et al., 2015; Ruddick et al., 2015) or cryptocurrency (Meyer & Hudon, 2019).

However, recent work by Jullien and Roudaut (2020) challenges the often too quickly accepted meaning of the information commons. Indeed, managed resources in the information commons are non-exclusive and non-rivalrous, making these resources akin to a public good rather than a common resource. Their work thus emphasizes the importance of analysing the rights and obligations of participants and, more specifically, the bundles of rights, in the spirit of Ostrom and Schlager (1996), in order to avoid the risk that “any decentralized online platform where participants share a common goal” qualifies as an information commons (Jullien & Roudaut, 2020, p. 71). These authors show, therefore, that, in knowledge commons such as Wikipedia, it is the contribution that is highly regulated on several levels, despite its apparent openness to all (Jullien & Roudaut, 2020; Jullien & Zimmermann, 2006). Specifically, access to administrative infrastructures and certain privileges acquired by the individuals involved are rivalrous, with the rivalry being acted out by peers a posteriori during the evaluation and regulation process (Jullien & Roudaut, 2020). The rival resource shared in the knowledge commons that they specifically study is therefore not knowledge, but the socio-technical system of producing new knowledge (Jullien & Roudaut, 2020).

Analyses have also pointed out that the production of intangible commons can be accompanied by a new production model, that of Commons-Based Peer Production (CBPP) (Arvidsson et al., 2017; Benkler, 2006; Hippel & Krogh, 2003). CBPP refers to a socio-economic production model in which many people work cooperatively, usually via the internet. CBPP communities are thus characterized by (Rozas et al., 2021): decentralization, as authority rests with individual actors rather than a central organizer; reliance on common goods, as CBPP communities often share common resources; and the non-monetary motivations of individuals.

Research also shows the importance of considering the process of collective action in its entirety (Jullien & Roudaut, 2020), which Bollier and Helfrich (2019) refer to as commoning. Here, the commons and their peer governance are viewed as dynamic, iterative, and flexible processes. Instead of principles, Bollier and Helfrich (2019) prefer to speak of patterns, that does not refer to prescriptive ideals or a universal and unchanging truth and that can produce different responses. These patterns partly echo Ostrom’s principles, emphasizing the importance of the common goal and of finding ways to protect the commons. These studies also raise the question of the technologies that are suitable for commoning. Indeed, the collective design of tools can help to convey the collective goal, make shared values apparent, or provide coherence with the context

¹ FLOSS: Free/Libre Open Source Software

and personal expectations of participants. More generally, the interest of communities is to equip themselves with coherent tools adapted to the peer governance process, allowing them to manage technologies, infrastructures and procurement processes (Bollier & Helfrich, 2019).

From this perspective, a new field of research, named blockchain-based governance, is emerging (Beck et al., 2018; Lumineau et al., 2021). This research evokes the potential of blockchain-based distributed ledger technologies to provide a software architecture for peer-to-peer exchange that goes far beyond the limited forms of collaboration and security currently possible on the internet (Bollier & Helfrich, 2019; Risius & Spohrer, 2017). According to Rozas et al. (2021), these technologies have the potential to participate in the abolition of trusted third parties, improving peer-to-peer coordination and control. More specifically, researchers have explored the potential of blockchain to support CBPP communities and promote commons governance (Pazaitis et al., 2017; Rozas et al., 2021).

1.2 Blockchain to support commons and their peer governance

Distributed Ledger Technology (DLT) refers to multi-party systems that operate in an environment without a central operator or authority (Rauchs et al., 2018). Blockchain technologies are a subset of these systems. They use a data structure consisting of a chain of data blocks secured by cryptography, such as hashing (Shostak et al., 1982). Specifically, nodes validate the information that is added to the blockchain, and an algorithmic consensus protocol ensures the unique order in which the information is added. The consensus mechanisms can differ from blockchain to blockchain and require different computational power to validate the information (Bach et al., 2018; Cachin & Vukolic, 2017).

The cryptocurrency Bitcoin was the first application of a blockchain-like DLT (Nakamoto, 2008). In this case, the blockchain enables the peer-to-peer creation and transfer of unique digital assets (tokens) in a secure manner (Beck et al., 2017; Rauchs et al., 2018). In 2014, a second wave of innovation incorporated an automatization function into the blockchain through the use of smart contracts. These enable transactions, previously scheduled, between actors without an initial trust relationship and without additional precautionary measures (Tschorsch & Scheuermann, 2016). These smart contracts can thus facilitate the negotiation and execution of a contract, by verifying it or executing it, or even by making a contract clause useless. Smart contracts allow rules to be applied in an autonomous and traceable way (transactions are recorded in the blockchain with identification of the interactions) without human intervention, providing more security and lower transaction costs (Anceaume et al., 2016). More recently, new generations of blockchain allow the aggregation of a complex sets of smart contracts. These Decentralized Autonomous Organizations (DAOs) thus form new models of distributed organization (Calcaterra, 2018).

Recent studies have shown that blockchains can support more cooperative and generative forms of peer governance through commoning (Bollier & Helfrich, 2019; Rozas et al., 2021). More specifically, Rozas et al. (2021) show that blockchain functionalities can support the operation of CBPP. These technologies, like CBPP, are based on decentralization. They rely on distributed ledgers, support the sharing of open, collectively held data and enable the execution of transparent operational rules (Rozas et al., 2021). Finally, CBPP relies on multidimensional forms of value and incentives, often non-monetary, that could be supported by blockchain technologies such as sharing, voting or even reputation (Pazaitis et al., 2017).

The work of Rozas et al. (2021) clarifies how the functionalities of blockchain technologies can facilitate the governance of the commons and, more specifically, support Ostrom's (1990) principles. Six functionalities of blockchain (named F1 to F6 in the remainder of this article) are thus likely to support community coordination efforts, help define the governance of the commons, and serve to make decisions. The first functionality, tokenization (F1), allows the sending of data or rights that can be activated and constituted in the form of transferable and unique digital tokens (tokens). Tokenization facilitates the distribution of value and incentives in communities without the need to involve another trusted third party. This feature seems particularly interesting for delineating the boundaries of communities (O1). It can also be used to initiate discussions about defining the rules of rights and access inherent to the common resource (O2) or the collective choice devices concerning the community governance (O3). Self-enforcement and formalization of rules (F2) refers to the process of integrating collectives' rules within smart contracts that will then be executed in a decentralized manner when certain predefined conditions (encoded in the blockchain) are met. This functionality opens up interesting perspectives, especially for strengthening the monitoring and control of the resource (O4) and for the implementation of graduated sanctions (O5). Autonomous automatization (F3), through the principle of a DAO, promotes the emergence of new forms of collective intelligence, strengthening principles O4, O5 and O6, and facilitating exchanges between different institutions and thus the interactions at local and global scales that sometimes exist within the commons (O8). The decentralization of power in infrastructures (F4) takes place through the process of mutualization of the ownership and control of technological artifacts used by the members of a commons. This process helps to counterbalance excessive concentrations of power and engage actors in negotiations that would benefit principles O2, O3, O4 and O7. Transparency (F5), which is derived from the functionalities of the open and identical registers held by all members, supports the monitoring of the commons by the members of the community (O4) and facilitates conflict resolution mechanisms (O6). Finally, the codification of trust (F6) allows reliance on secure decentralized systems to establish the necessary trust between agents without the need for a third party, facilitating interoperability and interactions between different levels of the commons (O7, O8).

The proposals of Rozas et al. (2021) identify what can be generated by blockchain technologies to facilitate the governance of CBPP communities and contribute to the emerging debate on blockchain-based governance in commons management communities. Their proposals are based on interviews conducted with actors managing the commons, but who, in fact, do not mobilize the blockchain. Their analysis is therefore theoretical and speculative since it does not draw on real situations where blockchain is used by CBPP communities. Other authors have also proposed analysis of the contribution of blockchain technologies in the governance of the commons. Some studies propose tool designs (Cila et al., 2020) or the affordances of blockchain in an urban context (Gloerich et al., 2020). Other research highlights the potential of blockchain to create new modes of accounting that would reward generative rather than extractive practices (Bauwens & Niaros, 2017; Bauwens & Pazaitis, 2019) or anticipate new generations of DLT whose affordances seem to be even better suited to managing the commons (Bollier & Helfrich, 2019). Again, no real-world analysis is offered on how blockchain technology can be an integrated tool in commoning.

Following this perspective, our article responds to Rozas et al.'s (2021) call to conduct empirical work to improve the understanding of the role of blockchain technologies in the governance of communities managing the commons. Thus, the objective of this paper is to understand how blockchain can participate in commoning. Specifically, we present the case of the *Œ1 libre*

currency community, which enables empirical testing of the models previously discussed in order to better understand how blockchain technology can support the governance of a commons, here, a monetary one. In the context of the debate on blockchain-based governance of the commons, our work seeks to go beyond the model of Rozas et al. (2021) to incorporate more flexible and dynamic dimensions of commons management (notably those of Bollier and Helfrich, 2019).

2 Case study and methodology

2.1 The Ğ1 libre currency/Duniter case

The Ğ1 free/libre open-source currency was launched in 2017. This experiment of a peer-to-peer cryptocurrency with a universal dividend was developed according to open-source principles. The self-governing Ğ1 libre currency community consists of about 5,000 independent citizens, mainly from France. The members share a desire to experiment with an alternative monetary solution, relying on the implementation of the Relative Theory of Money (RTM) (Laborde, 2011). The RTM is an economic theory created by mathematician Laborde (2011) to describe the process of creating free/libre money. According to the RTM, a currency is free if it respects four fundamental economic freedoms: freedom of democratic modification; freedom of access to resources; freedom of value production; and freedom of exchange “in the currency”. These four freedoms are directly inspired by those of free software (Stallman, 1999), and freedom is understood in the sense of non-harmfulness of others to oneself but also the non-harmfulness of oneself to others. Applied to the Ğ1 libre currency money, these freedoms take shape in the spatial symmetry that allows an individual to avoid harming their contemporaries and in the temporal symmetry that allows one generation to avoid harming the next (Laborde, 2011). The Ğ1 community uses the word libre rather than free in order to avoid ambiguity about the meaning of free. In this way, they follow the recommendations of Stallman (2002) who advised thinking of “free as in free speech, not free as in free beer”.

The Ğ1 differs from other cryptocurrencies and in particular Bitcoin, where the scarcity of money creation is artificially programmed (Arjaliès, 2019), leading to a concentration of wealth (Kondor et al., 2014). In contrast, the Ğ1’s money creation mechanism involves a daily increase in the money supply through the egalitarian injection of new units (universal dividend), so that each member receives exactly the same share of the money growth (see Appendix A, the Ğ1’s monetary parameters). Monetary creation thus depends on the money supply at an instant T , the number of members – the spatial dimension – and the results from inflation that guarantees a relative value based on a life expectancy of 80 years – the temporal dimension (Arjaliès, 2019; Auber, 2019; Gensollen & Latapy, 2020; Lung et al., 2019; Tichit et al., 2018).

Currency creation, which is the focus of this project, is supported by the deployment of Duniter blockchain technology. Duniter open-source software is based on blockchain and was specially developed by a team of volunteer developers who do not work full-time on the Ğ1 open-source currency project. Duniter enables the drive and management of universal dividend currencies. The Ğ1 is the only experiment so far that relies on the Duniter blockchain.

Anyone who wants to can use the Ğ1 by creating a free account and starting to make transactions. However, to become a member of the Ğ1 libre currency and benefit from the universal dividend, one must go through a co-optation process. Indeed, five members of the Ğ1 libre currency must give their approval, here called certification, for a new entrant to become, in turn, a member of the

€1 libre currency. This certification process is carried out through a tool developed by the members of the €1 libre currency, which is based on a special case of a reputation system: a web of trust.

In the case of the €1, the combination of the web of trust with the Dunitier blockchain facilitates the management of members' identities and certifications. The 5,200 members are connected with each other by about 50,000 certifications. Official Dunitier €1 client software, such as Cesium² or Silkaj,³ facilitates account management (creation, certification) and the €1 currency operations (consultation, transactions). To date, the network includes about 60 member nodes that validate and store information on the blockchain. Since its inception in 2017, a total of 240 member nodes have calculated and stored more than 527,000 blocks on the Dunitier blockchain.

Building of the €1 ecosystem has required a significant amount of computer development work over several years, facilitated by the FLOSS forge software Gitlab,⁴ and continues to mobilize several dozen active members. Several exchange forums, such as the Dunitier technical forum⁵ (mostly used by computer developers) or the libre currency forum⁶ (mostly used by non-developers) allow members to communicate, share information or coordinate their actions. Physical meetings take place regularly (e.g., every six months during the Rencontres des Monnaies Libres) or periodically on the initiative of one of more than one hundred local groups.⁷ Even though there is no legal structure or official association supported by the €1, some members have created an association to carry out certain projects or seek funding, such as Axiom Team.⁸

To anchor the €1 in the real economy, marketplace platforms, such as gchange⁹ or gannonce¹⁰ allow users to place classified ads in the €1 libre currency to exchange second-hand goods, find helping hands, professional services, buy new goods or to apply for participatory financing. Some small merchants or actors from the world of social and solidarity economy support this initiative and allow the possibility of paying in the €1 currency.

2.2 Methodology

We conducted an intrinsic case study (Stake, 1995) with the €1 libre currency community. This case is interesting because the €1 is one of the first concrete experiments of a self-organised community relying on a blockchain for managing commons in France.

Data collection followed the multi-angulation principle specific for inductive qualitative analyses (Hlady-Rispal, 2015). First, we conducted an in-depth content analysis of websites and forums that talked about the €1 currency in order to familiarise ourselves with the case and to have the most comprehensive understanding of the €1 ecosystem. To better understand the functioning of blockchain technology and the dynamics between the libre currency actors, we then conducted a

² Cesium website <https://github.com/dunitier/cesium> (accessed 1 June 2022)

³ Silkaj website <https://silkaj.dunitier.org/> (accessed 1 June 2022)

⁴ Gitlab €1 website <https://git.dunitier.org/public> (accessed 1 June, 2022)

⁵ Dunitier website forum <https://forum.dunitier.org/> (accessed 1 June 2022)

⁶ La Monnaie Libre website forum <https://forum.monnaie-libre.fr/> (accessed 1 June 2022)

⁷ Website map of local groups <https://carte.monnaie-libre.fr/> (accessed 1 June 2022)

⁸ Axiom Team website <https://axiom-team.fr/> (accessed 1 June 2022)

⁹ gchange website <https://www.gchange.fr/> (accessed 1 June 2022)

¹⁰ gannonce website <https://gannonce.dunitier.org/#/> (accessed 1 June 2022)

participant observation (Lapassade, 2001), which can be described as external and peripheral (Adler & Adler, 1987). In order to become a member of the libre currency, it was necessary to physically meet the members in order to be co-opted. One of the authors thus attended the 12th Rencontres de la Monnaie Libre in Bordeaux from 17 to 25 November 2018. He was subsequently able to obtain a membership account, experiment with the Ğ1 technology tools, and take part in the formation of a small local group of insiders. Participating in this local group provided an opportunity to meet libre currency stakeholders who are not part of the development team and to experience the issues faced by ordinary users.

We returned to the “14th Rencontres de la Monnaie Libre” in Toulouse from 28 November to 1 December 2019. Nine interviews, lasting between 30 and 55 minutes, were conducted with founding members of the Ğ1 libre currency and some of the most active actors in the community. These members tend to have engineering profiles, strong skills in computer development and a pedagogical sensibility (see Appendix C, Table Interviewees). We pursued two goals with these interviews: to better understand the motivations of the community’s key players; and to delve into the functioning of the blockchain, especially its functions and role in monetary creation. As the community is small, we guaranteed anonymity to the respondents. We stopped the survey when the additional data collected did not provide any further information.

The data collected from the interviews was coded using a deductive coding process to highlight the empirical evidence that best exemplifies the concepts identified in the literature review (Point, 2018). Specifically, two main themes were identified: commons, bundles of rights, and shared resources; the definition of blockchain functionalities and its contribution to the process of commoning. A specific matrix was designed to compare respondents’ answers on the links between blockchain and the process of commoning (Miles & Huberman, 1994). We also specifically analysed the actors’ motivations for participating in this project.

3 Results

The interviews conducted, the analysis of documents and our meetings during the libre currency meeting allow us to put two complementary results into perspective. The first one sheds light on the functioning of the Ğ1 community, highlights the principles of self-organization of the members towards a shared resource, typical of commons, and explains the functioning of the web of trust associated with the Duniter blockchain. The latter illustrates the role of blockchain technologies in the process of commoning and thus in the governance of the Ğ1 community.

3.1 Self-organization of the Ğ1 community

The results here focus on the three characteristic elements of commons, namely the community, the shared resource, and the collective rulemaking. These results also describe the functioning of the web of trust, which is a central tool in this specific case to delineate the boundaries of the commons.

3.1.1 The Ğ1: A community built on shared values and organized through virtual forums and physical meetings

The actors interviewed underline the problems raised by the current money mechanism:

I have been an activist on the ecological aspect for a very long time. And I realize that the main problem we have is money.

Debt money, in place for 5,000 years, is an asymmetric currency. It allows us to do many things, it is essential for social life, but, by its mode of creation, by the debt, it mechanically leads to a monetary concentration, of power, of goods, of capital accumulation, to the detriment of other monetary deserts.

The members question the sovereignty of the Euro currency. They share the will to look for alternative solutions:

I hope that we can graft a true democracy in which no one will be held back by the problems of lack of money.

Very often, they put people and the perspectives for future generations at the centre of their concerns:

I have been trying to change the world for a very long time, and libre money is probably one of those tools. And in my opinion the most accomplished, the most intelligently thought out, to be able to build a society that is truly human based.

The fact that the Ĝ1 experiments are concrete and not just theoretical is seen as a necessity, “experimenting because only experience can validate a theory” and a strong point, “I feel like I can be at the heart of efficiency, contributing.”

Discussions between members take place throughout the year on web forums – the Duniter forum and the libre currency forum:

There are forums that are effectively a space where one can raise an issue and discuss it.

When the project was launched, these forums proved useful for the collective discussions necessary to establish the rules and governance of the commons:

Initially, the forums were trench warfare, even among the historical developers, both about the direction and the way to organise them, events or the like.

Twice-yearly physical meetings, called libre currency meetings, also allow the community to maintain good collective dynamics and “to bring together all those involved who are interested”. The Ĝ1 libre currency core group, which consists of a few dozen people, also makes strategic decisions. This collective time allows for discussion and further development of the collective rules that were originally set by the few members who initiated the project.

The dynamics of contributions are characteristic of the logic of FLOSS software:

The more it progresses, the more people who get involved understand what free software is. You make your contribution voluntarily because it brings something a priori and you do not need be rewarded for it.

These results show that both the actors carrying out the Ĝ1 experiment and the members share common motivations and that their interactions are frequent, which both stabilizes the members and maintains close ties, qualities that are characteristic of Ostrom’s (1992) communities.

3.1.2 *The Ğ1: A shared resource and collective rules*

Anyone who wants to can create a virtual identity with a few clicks and get a user wallet of the Ğ1 libre currency. So, there is no exclusion from using the currency, which by its nature, is a rival resource. The boundaries of the community and the collective rules are drawn up to give access to the socio-technical device of money creation, which turns out to be the shared resource:

The people who choose the free currency are part of this community because there are specific rules of governance, the protocol of money creation, which is really the fact of the community and which is not influenced or manipulated by anyone except the members of the community.

Thus, the members of the community do not consider the currency itself but rather the creation of money by the universal dividend as the commons:

It is not the currency itself that is a commons but the monetary protocol.

Ğ1 libre money is a currency created by the universal dividend in equal parts of space and time.

For the Ğ1 members, the web of trust helps to define the boundaries of the community:

We can define a community based on the web of trust by saying that the members of the community are the members of the web of trust.

The web of trust is a cryptographic system that verifies the relationship between a public key and a digital identity in a decentralized manner to form a web of trust (see Appendix B, Ğ1 web of trust parameters). The web of trust seeks to meet two objectives: (1) to ensure that each Ğ1 member is indeed human and unique, generating the same number of universal dividends per creation interval (to avoid attacks that could compromise the proper functioning of the currency and/or the computer network that carries it); (2) to identify block calculators to assign them a personalized difficulty in order to prevent the proof-of-work mechanism from generating a centralization of the currency support. The web of trust thus makes it possible to protect against free-riders whose objective is personal enrichment.

It is the certification system that differentiates between members, who will co-create a universal dividend, and non-members: “The basic rule for entering the community is to be certified by five other members of the community.” Anonymous accounts of non-members do not co-create a universal dividend but can still make transactions in the Ğ1 currency. In addition to the rules that govern the web of trust, a licence specifies the set of rules that the user agrees to abide by. In particular, the licence specifies the rules to be followed in order to certify new members:

Any operation to certify a new member of the Ğ1 must first be accompanied by the transmission of this licence of the Ğ1 currency, which the certifier must ensure has been studied, understood and accepted by the person who will be certified.

This is the equivalent of a charter and states that before certifying a new member it is necessary to “know the person well enough” and recommends that certain verifications be made, such as a face-to-face physical meeting.

The distribution model for the universal dividend is determined by a calculation that is intended to be as egalitarian as possible, since it is based on the approximate life expectancy of a human being in France. The principles of the RTM are thus perceived as a strength by the interviewees because they allow for the definition of collective rules for the management of the shared resource: “We cannot set what we want. It is almost imposed by the nature of things. The fact that man lives for 80 years.”; “The fact that we have a rigorous basis like the RTM means that we no longer have theoretical debates.”

While understanding and respecting the licence is crucial to maintaining cohesion in the community, some members regret that it is not more modifiable:

What I have felt for the three years that I have been very involved in the Ğ1 is a lack of governance in who can legitimately modify the Ğ1 licence, when it is supposed to be our common contract, the set of rules that the user commits to respect.

Thus, the previous results indicate that the boundaries of the community are constituted around monetary creation, which is the core of the commons. The originality of the case lies in the fact that the boundaries relative to the shared resource are reinforced by a web of trust that facilitates the process.

3.2 Blockchain for the governance of the commons

These results clarify the role of the features of the Duniter blockchain in the peer governance of the commons from three perspectives: fit with CBPP features; support for bundles of rights; activation of Ostrom’s (1990) principles and influence of these features on the patterns of commoning proposed by Bollier and Helfrich (2019).

3.2.1 The functionalities of the Duniter blockchain

A central tool in the Ğ1, Duniter blockchain technology is based on a public blockchain which increases its transparency (F5 – transparency). Duniter allows the accounting of exchanges between community members (F1 – tokenization) and certification registers in a distributed manner (F4 – decentralization) and, thanks to its technical protocol, it automates the parameters of the web of trust and those of the production of the universal dividend (F2 – self-enforcement and formalization of rules). The Duniter software specially developed for this project operates as a peer-to-peer network, that is, without a central server (F4 – decentralization). Developed in FLOSS, the detailed operation of this network, its server nodes and client nodes, is explained on the Duniter website forum:

There are two layers in the Duniter network: the servers, which synchronize with each other via the blockchain, and the clients, who are located on the periphery and connect to the server nodes. The execution of server nodes is anonymous. However, without associating the node with an identity, it cannot calculate a block; it behaves as a simple mirror of the blockchain. Once associated with a member’s identity, it can participate in the calculation of blocks on the chain.

The blockchain records four elements in a distributed manner: identity, transaction, certification and membership. The Duniter blockchain mechanism allows for the synchronization and security of transactions via distributed wallets with a pair of cryptographic keys and requires no additional central authority (F1, F4, F6 – trust coding). The choice made by the developers to associate a web

of trust with the Duniter blockchain meets practical community management needs, consistent with certain values and ethical principles of its members that are in line with the philosophy of the commons. Thus, in the consensus mechanism used by the Duniter blockchain (F4, F6), there is no particular reward for calculating a block and there is therefore no race for power:

Associating the blockchain with a web of trust means that there is no competition, in the validation of blocks, etc. This is what makes the operation of the blockchain extremely light and energy efficient.

This complementarity between the web of trust and the blockchain also makes it possible to provide solutions that combine transparency (F5) and security (F6), particularly in terms of the uniqueness of identity and the preservation of the true identity of the members:

The purpose of this certification process is to ensure that the person wishing to enter the monetary community is indeed (1) alive and (2) does not have a double account elsewhere and that he or she can be truly identified in an unambiguous manner. This is a way to ensure the true existence of a person without resorting to biometric means or trusted third parties.

The interviews reveal that the autonomous automatization functionality (F3) is not present in the Duniter blockchain, as it is not technologically advanced enough:

No, the language is too low level. There is no real CAD, there is no real autonomous automation. Although there are crowdfunding drivers that could be considered a bit. So, those are more like third-party services on top of the blockchain.

The characteristics of the Duniter blockchain thus appear to be in line with the functioning of CBPP:

(1) Blockchain, like CBPP, offers “the possibility of having a totally decentralized distributed database. The blockchain technology perfectly matches the needs of the spatial and temporal symmetry that we had defined for the currency.” It makes it possible to manage a complex phenomenon in a simple way: “We are much more likely to be able to create it [G1 monetary creation] and see it develop thanks to the blockchain.”

(2) Thanks to its distributed ledger functionality, the Duniter blockchain is suitable for CBPP, with open, collectively owned data and transparent operating rules. Here, production is based on intangible common resources, open-source software, which is used, shared, freely accessible and collectively owned. Specifically, many of the actors interviewed emphasize that the blockchain is secure and thus makes it possible to establish trust in a decentralized manner: “It [the blockchain] provides security in the persistence of the transactions [...] when something is written, it will be set in stone, it will not move.”

(3) The Duniter blockchain, specifically designed to generate libre currencies, allows the G1 members to explore other dimensions of value and supports its operation according to CBPP principles: “Yes, it’s a good way to start to make what is valuable to oneself heard in this world, not just heard but made concrete [...] it is not the same value according to the currency that we use.”; “Blockchain technology is completely compatible with the logic of libre and non-market. Because today, the G1 exists mostly by doing, almost solely by volunteers and volunteers who are not paid in debt currency. This is logical.”

Our results show that the Duniter blockchain supports the socio-technical device of money

creation. Central for the Ĝ1 members, it has functionalities that are mobilized to manage the resource and govern the community. Decentralization, distributed ledger functions, and the exploration of new forms of value allow the Duniter blockchain to support the CBPP of the Ĝ1 libre currency.

3.2.2 Blockchain in support of the bundles of rights

Our results also highlight the importance of the web of trust and its complementarity with the Duniter blockchain in supporting the bundles of rights related to the governance of monetary creation. While it is generally possible to identify individuals in the commons who may have rights to access, withdraw, manage, exclude, and/or even alienate, some of these rights are not as clearly identified in the Ĝ1 project.

Basically, anyone who wants to can become a simple user of the libre currency, have access to a wallet and exchange cryptocurrency through official Duniter Ĝ1 client software like Cesium or Silkaj (access rights). Only certified members in the web of trust will then have access to the money creation production device, generate their share of the universal dividend and be able to consume it as they wish (withdrawal rights). All certified members are participants in the commons and have regulatory power over the shared resource since they can certify other members (management rights). Certifications and transactions are recorded in the different nodes of the Duniter blockchain that forge their blocks through the consensus mechanism.¹¹ Thus, member management and monitoring are collaborative and aided by the transparency of the blockchain.

In libre currency, there is no proprietor or person in charge who would have the ability to exclude members who do not respect the rules (exclusion rights). However, there is a willingness to share this power at the collective level through the blockchain:

The blockchain allows the rules of the community to be decentralized. There is no centre that decides who gets in [to the community,] it's the rules that say such and such a person is going to be removed because their certifications have expired and they didn't do the right thing to renew them.

Some Ĝ1 members, however, enjoy a certain recognition that is legitimized by their historical or current involvement in the project. For example, members who are involved in the IT development of libre currency tools are responsible for/administrators of the software they are involved with. They also initially defined and implemented the rules of these digital tools and now have the natural legitimacy to make the rules and tools evolve. Similarly, at the territorial level, the constitution of local groups leaves the field open to certain forms of self-organization dynamics, such as the creation of independent associations or collectives.

Finally, there is co-ownership of the blockchain between the different hosts of the blockchain nodes, which reinforces the robustness of the commons and makes the alienation of the resource almost impossible (alienation rights):

¹¹ Specificity of the Duniter consensus mechanism <https://duniter.org/fr/miner-des-blocs/> (accessed 1 June 2022)

The blockchain brings to any computer system the possibility of having a totally decentralized distributed database, where no party, a participant or not, to the database can destroy it. It is replicated, and the nodes communicate with each other without there being any privileged nodes in this respect. The blockchain technology perfectly matches the spatial and temporal symmetry requirements that we had defined for money.

It should be noted, however, that co-ownership is relative insofar as the developers have a certain amount of power linked to the technical knowledge essential for the development and maintenance of digital tools. Even if they cannot destroy the blockchain, the developers seem to be the ones who ultimately control the commons and direct its strategy.

3.2.3 Dunitier blockchain features to support the commons

Our interviews provide an understanding of how the features of the Dunitier blockchain enable the implementation of Ostrom's (1990) key principles of governance of the commons. These findings also incorporate the refreshment of Ostrom's principles by Bollier and Helfrich's (2019) peer governance patterns.

(O1) The precise definition of the community's purpose and its members

Our interviews indicate that tokenization (F1) reinforces O1 since the boundaries of the community are delimited thanks to the Dunitier blockchain which records the identities and certifications of the members (see 3.1.2 and 3.1.3). It is important to emphasize here the importance of the complementarity between the blockchain and the web of trust in defining the boundaries of the community: "It is less and less dissociable [...] Dunitier, it is a whole that works: the web of trust, monetary issuance and shared book management."

The association of the Dunitier blockchain with a web of trust also reveals a link between O1 and the self-enforcement and formalization of the rules (F2):

The rules implemented in the blockchain, which are technical, help to move in this direction, this possibility of protecting the integrity of the members of the libre currency by the fact that they are not eternal members and that the human condition to remain in it is to respect the rules.

Some self-enforcement features by using smart contracts (F2) are useful for managing the certification of members:

Yes, they [smart contracts] are very limited. Four basic operations that can be combined, but still, yes, they are constraints. The first is signature [certification], the second operation is secrecy: we can provide a secret to unlock the data sources. We can use time: to say that a source of currency, for example, can be unlocked if a certain amount of time has passed since the transaction was registered in the blockchain, there is another one, it is still a matter of time...

(O2) Consistency between the rules for the common resource and the nature of the resource

The rules for allocating the universal dividend as well as additional collective rules defined by the community have been refined for encoding and integration into the blockchain (F1), strengthening O2. The functionalities of self-enforcement and formalization of the rules (F2), and of decentralization of power in the infrastructures (F4) also participate in O2. Indeed, the universal dividend, a central resource in the G1, is, in the long run, protected against potential free-riders

(here the beneficiaries of an account that creates money but is linked to a false identity, a person not involved in the project or who is acting in a malicious way) by the renewal or not of the certifications through the previously mentioned automation mechanisms (F2) and the distribution of the certification power to all the community members (F4):

Thanks to the blockchain, we can automate the common rules that are in the technical protocol that allow us to no longer need a third party to decide [...] and these rules are automatically applied without the need for agreement.

(O3) User participation in changing the operational rules that govern the common pool

O3 advocates developing collective choice mechanisms that include most of the individuals concerned. Although the collective rules encoded in the blockchain are theoretically modifiable (O3), our interviews indicate that a concentration of power and the knowledge of a handful of developers prevents their modification in practice: “The software that runs this blockchain is maintained by very few people and, as a result, there is a concentration of power in the hands of these people.” Yet, some emphasize the importance of spreading authority and responsibility and avoiding abusive concentrations of power: “They could do much more according to the wishes of the community, with more support from the community.”

In practice, therefore, the Duniter blockchain does not directly support O3. However, some actors raise the possibility of doing so anyway:

They [the rules] can be flexible. With some software work. If, for example, a locality that wants to fork to make an intermediate $\tilde{G}1$, there is nothing to stop them. In fact, they can do it, after that it is development work.

This solution, often considered by the actors, which consists of separating the community into two distinct computer branches (forks), is often evoked even if it is, at the moment, considered too costly for the community:

If one day there are people who want to change the rules, who do what we call a fork, that is, they change the software and they call people to follow them. [...] So, it’s a kind of democratic vote. In this case, it’s flexible, but it’s significant.

(O4) Monitoring of the exploitation of the common resource by individuals, themselves accountable to the community

O4 is very clearly supported by the transparency feature (F5): “It is a passive technical monitoring. In the end, it is the software that does it.” As for the role of community members, “it’s more the second part, [...] there are people who scan the blockchain to check if topologically there are no statistical anomalies, which would finally show that people are trying to cheat.” The self-enforcement (F2) and the decentralization of power (F4) enabled by the Duniter blockchain also act on O4 insofar as “the blockchain makes it possible to automate the verification of the correct application of common rules” and that “it is not Big Brother, but Big Other, in a decentralized way; [...] the more it is extended, the more power is diluted.”

(O5) The existence of gradual sanctions for non-compliance with operational rules

Often following on from the fourth principle, O5 refers to the existence of graduated sanctions towards individuals who transgress the rules contained in the blockchain (F2). In the case of the $\tilde{G}1$, the main sanction is the non-renewal of certifications that are only valid for two years. Thus, there is “no immediate sanction but simply, when the time comes, there will be no certification.”; “This is really the active form” because, as this member points out, “there is another form that is

a little less obvious, but it is that when a cheater is discovered, it is revealed [...] is that you risk not being a member at all or even outright excluded as a cheater.”

(O6) The existence of conflict resolution mechanisms (with quick access to inexpensive local arenas)

Open data is employed in discussion forums as part of the conflict resolution mechanisms. O6 relies on the transparency of the blockchain (F5): “Yes, transparency, since anyone can verify the blockchain.”

(O7) Recognition by external government authorities of the right to self-organization

Principle O7, which refers to the need for recognition by external authorities of the self-determined rules of the managing community of a commons, does not apply in the case studied. Indeed, at the moment, “the members of the Ĝ1 do not recognize any authority outside the Ĝ1” and “it is fine as it is”.

(O8) In the case of large communities, there is nesting of several institutional layers with small local communities at the base

Finally, O8, which questions the need for a good nesting of local institutions within larger scale institutions, is largely supported by the contribution of trust induced by the codification in the blockchain of egalitarian and transparent rules (F6). Indeed, “codification provides confidence that the rules defined in the technical protocol are necessarily followed”. For the Ĝ1 members, “a simple rule acts as an authority: the rule is the code”. Asset exchanges can take place securely without other trusted third parties and thus facilitate interoperability and interactions between different local Ĝ1 communities (O8).

These results finally allow us to better understand how the Duniter blockchain’s functionalities support Ostrom’s principles. They also underline that the Duniter blockchain technology has allowed a shared goal to emerge and to set dynamics in motion specific to the *Faire Commun* in the sense of Bollier and Helfrich (2019). The openness of the community is reflected in a great diversity of skills and profiles, all directed towards a common goal: “There is quite a pronounced heterogeneity in the Ĝ1, of all ages, of all professions.”

The members of the Ĝ1 invest themselves voluntarily in a collective design of tools developed in FLOSS, which appear coherent and user-friendly. This process, along the way, strengthens the community in its capacity to act by giving it meaning which, in turn, foster the management of the commons. The community has thus acquired a form of heterarchical organization that favours inter-relationships and cooperation between members: “the most similar, would be something like Wikipedia. So, I think that this kind of libre and decentralized system with control by everyone can be interesting.” This control and organization are directly supported by IT tools that bring transparency into a sphere of trust and allow peer review: “It’s not the developers themselves who are going to be able to see. The developers themselves make tools for everyone to see.”

Ultimately, the development and use of the Duniter blockchain, and its association with the web of trust, is consistent with the peer governance issues and needs of the Ĝ1 community commons.

4 Discussion

This paper focuses on how the integration of distributed ledger systems of the blockchain type participates in the process of commoning. Stemming from the analysis of the case of the Ĝ1 libre currency and its Duniter blockchain associated with a web of trust, our results enrich the literature

on the governance of the commons and the role of the blockchain type of distributed ledger systems. In particular, their originality allows us to identify three points of discussion, detailed in the following sections, concerning monetary creation as a commons, the role that blockchain technologies can have in the process of commoning, and, finally, the contribution of blockchains to materializing Ostrom's principles.

4.1 Money creation as a commons

The libre currency community engaged in the Ğ1 experiment in 2017 to embody a collective desire to address contemporary sustainability challenges and issues. Our results show that the actors in this community share a desire to take action to confront the market's monopolization of money creation. To do so, they have developed a socio-technical device of money creation that can be viewed as a commons in the sense of Ostrom (1990) and Bollier and Helfrich (2019). Indeed, our results highlight the presence of the three constituent elements of the commons. They allow us to identify the shared resource, namely the production of the universal dividend. They highlight the importance of the collective rules of access to the resource developed by the community and specify how they are comparable to bundles of rights in the sense of Shalger and Ostrom (1992) and Orsi (2013). Finally, they show that the governance structure makes it possible to regulate individual interests while ensuring that project obligations and collective rules are respected.

Note here that the association of the theoretical framework of the commons with the analysis of alternative currencies is not new. In particular, Meyer and Hudon (2019) have worked on three types of alternative currency, including cryptocurrency. Their results highlight that this type of currency and the organization around it can be considered a commons insofar as it promotes the common good by creating new communities and shared values and goals. However, our results are original because they show that, in the Ğ1 community, it is not the cryptocurrency as such that is the commons but the socio-technical device of money creation. In particular, they put into perspective the importance of bundles of rights and the collective rules that govern the community, as well as the respect of the governance principles of the commons in the sense of Ostrom (1990).

The analysis of the case of the Ğ1 community also highlights the importance of the initial consensus that will govern the community in the definition of bundles of rights and the construction of the community's boundaries that are drawn around monetary creation. If money is indeed freely accessible, the question of access to the universal dividend should be regulated. Here, the reliance on the principles of libre currency, as defined in the RTM (Laborde, 2011), allowed for the definition of collective rules in the community and the rights of participants. In the case of the Ğ1, the certification of members is the basic element that allows the boundary between the use of the currency and its production to be drawn. The RTM principles for libre currency also address the problem of currency rivalry by balancing its scarcity through an egalitarian distribution law. Specifically, the deployment of a socio-technical device around the RTM makes it possible to regulate the rivalry of money creation in order to maximize access to the public good, money, for the greatest number of people over the long term.

Finally, Our results highlight that community self-management and the production of the universal dividend are supported by an ecosystem of FLOSS tools. Extending Benkler's (2006) analyses, our study confirms the importance of digital tools in CBPP. Adapted to the case of the Ğ1, we suggest referring to this practice as commons-based peer universal dividend production. This novel

result, which identifies and designates a new type of CBPP is, moreover, intrinsically linked to the emergence of DLTs.

4.2 Commoning with blockchain

Our results empirically highlight the contribution of blockchain technologies for CBPP communities. They confirm and extend the theoretical analyses of Arvidsson et al. (2017) or those of Rozas et al. (2021). Indeed, for the latter, decentralization, the shared information system and the exploration of new forms of value enabled by the blockchain make it a suitable tool for this mode of production. Our results indeed show that the Duniter blockchain allows the necessary trust to be established so that the members of the community can self-organize without a trusted third party. It is the technical characteristics of blockchain, such as decentralization, transparency and security, that appear essential to the community in order to manage the complexity of implementing the money creation protocol.

The Ğ1 case also reveals the value of a formalized prior agreement, here in the principles of the RTM. Indeed, the community's broad adherence to these principles of money creation facilitated the development of the Duniter blockchain. The community did not get bogged down in divisive discussions during the design of the blockchain and a whole ecosystem of coherent tools around the Duniter blockchain was thus able to be quickly developed. The analysis of the bundles of rights of participants in the case of the Ğ1 libre currency shows that roles are not as clearly defined as in the digital collective projects analysed by Jullien and Roudaut (2020). While it is easy to distinguish between the roles of entrants (non-certified members) and users (certified members), it is more difficult to assign the roles of claimants, proprietors, and owners in the case of the Ğ1. These roles seem to rely on a responsibility that is more collective. Indeed, in the Ğ1 community, no member has a priori the power to enforce sanctions or is in a position to exclude another person from the commons. It is the rules implemented in the digital tools by the members when the project was initiated, and in particular the rules of automation that grant an ephemeral validity of the certifications (two years), that allow for these regulations. Members must establish communication with another certified member to request a new certification or a renewal of their certification.

On this point, our results highlight the full potential of blockchain's functionality to develop heterarchy in the sense of Bollier and Helfrich (2019), that is, a non-pyramidal structure that allows power to flow dynamically through multiple and changing nodes in a social network. Furthermore, node-hosting members are co-owners of the blockchain which results in a distribution of power to alienate the shared resource. Finally, there is co-responsibility in the validation of transactions and certifications through the operationalization of the blockchain's consensus mechanism among the members hosting blockchain nodes.

The interdependence between the Duniter blockchain and the web of trust, thought out from the very beginning of the project, has allowed the community to develop a blockchain with an algorithmic consensus mechanism that requires little energy (unlike the Bitcoin blockchain, and, to a lesser extent, the Ethereum blockchain). This interdependence reinforces the coherence of the community and is strongly in line with the philosophy of the commons. It would be interesting to investigate further, in new research, this complementarity between the blockchain and the web of trust to foster the commons. It is important to note, however, that the association of the Duniter blockchain with a web of trust in the case of the Ğ1 only partially protects against the risk of free-

riding (the creation of fake accounts with the intent of personal enrichment). The design of the technology means that a risk persists in the human management of certifications since each member, who has the ability to certify, is responsible for the certifications they issue.

Our results highlight elements that allow us to question the contribution of blockchain functionalities to the process of making things together and, more specifically, to Ostrom's principles (1990). In particular, they show that Ostrom's principles are largely supported by the functionalities of the Duniter blockchain and its web of trust. The originality of our results lies in the perspective of the relationship between the principle (O1) that evokes the boundaries of the community and the functionality (F2) that concerns the self-enforcement and formalization of rules. This result, not present in the initial model of Rozas et al. (2021), is related to the intrinsic complementarity of the Duniter blockchain and the web of trust that is meant to manage the community's boundaries. The association between the blockchain and the web of trust technology thus seems to open up new perspectives which could help support the self-governance of communities to access collective resources.

Note that we were not able to observe all the relationships highlighted by Rozas et al. (2021). The potential link between the principles and the autonomous automatization functionality (F3), for example, has not been investigated insofar as the Duniter blockchain is not technologically advanced enough for this functionality to operate. Secondly, the principle of rule modification (O3) is, as we have previously noted, relatively weak. Indeed, to date, no collective mechanism for modifying the rules has been set up by the community and only the possibility of a fork has been mentioned. However, this solution seems expensive and does not meet Ostrom's principle of low-cost modification. Indeed, this fork solution would be even more costly if this desire came from non-computer science community members since it would require the creation of a new team of computer science developers to maintain and evolve the socio-technical system. Moreover, the principle of subsidiarity (O7), which advocates minimal recognition by external authorities of the right to self-organization, does not apply in the case of the Ğ1 experiment. Indeed, this principle appears, for the time being, as non-essential in the eyes of this CBPP community. This result is perhaps not definitive and may evolve in the future knowing that it is an indispensable element for engaging the sustainability and durability of the commons (Ostrom, 1990). Our results also reveal that several interviewees were beginning to express their desire to move towards this external recognition (O7), which nevertheless runs counter to the primary motivation of the community members, namely, to emancipate themselves from state or market relations.

In the same way as other digital commons (Jullien and Roudaut, 2020), the Ğ1 libre currency project could reach a critical size that would allow the commons to be globalized and extend its diffusion beyond the circle of insiders or founding members. Such a development should make the need for recognition by public institutions even more salient, a determining stake for the sustainability of the project. Moreover, the institutionalization of the project would make it possible to offer a real alternative to existing currencies, the primary objectives expressed by the members of the Ğ1 libre currency during our field survey. Particular vigilance will then have to be exercised over the risks associated with an overly political reuse, "commonswashing" in the sense of de Rosnay (2020).

Our results also underline the limitations of blockchain technologies for commoning. Indeed, our research reveals that decentralization, normally supported by the blockchain, is not ensured since

the computer code is only controlled by a small group of members, the developers. This limitation of cryptocurrencies has already been raised by De Filippi and Loveluck (2016) especially in the case of Bitcoin. It is currently an inherent limitation of most blockchain-based alternative currencies (Meyer & Hudon, 2019). Our analyses also show that if the blockchain could be used as a tool to serve the community, the rules chosen and configured could be even more collectively chosen and configured to meet certain demands of commons participants. This is particularly the case for the collective rules of the licence which, different to the RTM rules, are supposed to constitute the set of rules that the members commit to respect. It thus seems necessary for communities to have more efficient collective choice mechanisms which developers and volunteers could rely on to facilitate their tasks and modify these collective rules. However, it should be remembered that this experiment is recent, which may explain why the collective choice mechanisms are not yet fully developed. It would be interesting to continue the analysis of this community in order to see the evolution of its collective choices and, following the proposals of de Vaujany et al. (2018), to analyse the evolution of the triptych rules, practices and digital artifacts.

Finally, our case is specific because it focuses on a community that has recently engaged in an experiment to create a blockchain to manage a commons. This characteristic makes it still too early to talk about sustainability in the sense of Ostrom (1990) even if, as we have shown, the Ğ1 fulfils all the conditions of a commons. This thus questions the universality of Ostrom's (1990) principles in line with the work of Bollier and Helfrich (2019). Indeed, the framework of Ostrom's (1990) principles does not really allow us to understand the dynamics of CBPP communities, from their genesis to their maturity, and to see the engagement in the commons as a process in perpetual evolution. In this light, it seems appropriate that the participants of the commons can mobilize more flexible models based on the patterns proposed by Bollier and Helfrich (2019).

Conclusion

Our goal in this article was to put into perspective the role of DLTs in the process of commoning. To do so, we mobilized the latest research linking the governance of the commons to blockchains using a particular case, that of the Ğ1 libre currency community. This case study proved to be rich in results. First, we explained the functioning of the Ğ1 libre currency community, which is working to deploy money creation as a commons, relying on the Duniter blockchain it is developing. We have also highlighted the role of the Duniter blockchain's features in the process of commoning as activators of Ostrom's principles. As such, our results enrich the literature on blockchain-based governance in commons management communities by empirically proposing and highlighting the effective functioning of a blockchain for commoning.

However, our study is not without its limitations. The first is the singularity of the case. It is a case study of the use of a blockchain specifically designed by and for the community. The specificity of the design does not allow us to extend our findings to different types of blockchain technologies. It would be interesting in future research to extend the observations to the use of other types of blockchains with other technical properties or other types of DLTs that may offer new opportunities for CBPP communities. Interesting results could come from cases that mobilize DAOs or new generations of DLTs to support peer governance of the commons. It would also be interesting to observe other types of commons in the field to compare how blockchain technologies are used in the process of commoning. The second limitation is related to the temporality of our

analysis. It would have been interesting to provide a processual analysis of the functioning of the Ğ1 community, the contribution, and even the evolution of the Duniter blockchain over a longer time. Finally, note that while we share the Ğ1 community's enthusiasm for blockchain technologies, a deeper look at the negative affordances of blockchain functionalities, as mentioned in the work of Rozas et al. (2021), would provide a better understanding of some of the limitations of these technologies.

Whether tangible or intangible, the commons propose that we move from an extractive economy to a generative and protective economy (Bauwens & Niaros, 2017). Blockchain technologies suggest the possibility of the emergence of a true collaborative economy (Bauwens et al., 2019) in which the collective and self-organized management of the commons would be possible. In this article, we wanted to shed light on such a scenario where blockchain technologies can support the commons. Let us emphasize here the interest in strengthening the links between the philosophy of the commons and the world of free software. Indeed, while the intentions may be similar, these links are not yet obvious to the members of these two communities (Broca & Coriat, 2015). Yet, the theory of the commons provides deep reflection on governance issues and we believe, after meeting with the Ğ1 community, that a schema of commons thinking in the sense of Bollier and Helfrich (2019) and in line with Ostrom's work would be beneficial to the collective action of these communities and likely to strengthen cooperation for the sustainability of the commons.

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Appendices:

Appendix A. Monetary parameters of the Ğ1

Parameter	Symbol	Value
Target theoretical growth by reset period	c	4.88 %
Universal Dividend revaluation period	dtrevalue	6 months (182,625 days)
Date of the first revaluation	t0revalue	2017-03-17 12:00
Calculation of the Universal Dividend	UDday(trevalue)	$UDday(trevalue - dtrevalue) + c^2 * (M/N)(trevalue - dtrevalue) / dtrevalue$

Appendix B. Parameters of the $\tilde{G}1$ web of trust

Parameter	Value
Number of certifications required for membership	5
Deadline for consideration of an application for membership	2 months
Lifetime of a membership that has been taken into account	1 year
Time limit for taking a certification into account	2 months
Lifetime of a certification that has been taken into account	2 years
Maximum number of certifications issued per member	100
Minimum waiting period between two successive certifications issued by the same person	5 days
Maximum distance, by certifications, between a new entrant and the referring members (stepMax)	5
Number of certifications (issued and received) to become a referral member	5
Number of certifications (issued and received) to become a referral member (formula)	$\text{CEILING} (N_t^* (1 / \text{stepMax}))$
Minimum percentage of referring members to meet the distance rule	80 %

Appendix C. Table of the interviewees

Interviewee	Profession	Involvement in the Ğ1 project
ia	Engineer and event organizer	Creator of the RTM at the start of the Ğ1 libre currency project
ib	Trained engineer, digital artist, independent researcher, consultant, entrepreneur	Sympathizer and theorist of the Ğ1
ic	Converted computer scientist. Former Ministry of Defence in aeronautics. Head of a computer company for ten years	Sympathizer and local facilitator for the Ğ1
id	Independent computer scientist for ten years and communication consultant	Co-organizer of an edition of the libre currency meetings, IT contributor and local facilitator for the Ğ1
ie	Computer developer employee	Computer contributor to the Ğ1
if	Retired physics and chemistry teacher	Computer contributor to the Ğ1
ig	Computer developer for SSII	IT contributor to the Ğ1, creator of the Duniter blockchain behind the Ğ1 currency project
ih	Engineer in aeronautical materials	Local animator and Ğ1 facilitator
ii	Free software activist	Local sympathizer and Ğ1 facilitator