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Calculation, Life and Temporality: on Some Elements of Consonance Between Cryptoeconomy and Techno-Manipulation of Nature[2]

Introduction

The debate about the so-called cryptoeconomy develops on very different planes: from the inquiry on the strictly economic meaning of some controversial projects to the interpretation of the socio-political frameworks of the blockchain revolution. In particular, one layer of the debate touched upon the ecological implications of the innovation paths, examining the potential of new objects such as the environmental tokens, as well as the appalling environmental impacts of some of the darkest facets of the crypto universe, such as the extraordinarily energy-consuming functioning of Bitcoin.

This paper, though, reflects upon the relationship between cryptoeconomic innovation and environmental dynamics from a peculiar perspective. The work starts, in fact, from identifying, at the heart of some areas of cryptoeconomy, a cybernetic movement, which has some deep implications on the conceptions of economic life and its temporality. On one hand, cryptoeconomy characterizes itself as the locus of a relentless production of artificial certainties and of a cybernetic assurance of socio-economic processes. On the other hand, at the core of some ideological cryptoeconomic apparatuses we find a project aimed at transcending the reference to the human as the main agent of economic life, in a framework where agency is built around the unconditional and unlimited hybridization between the human and the machinic.

Now, these tendencies manifest some assonances with what is happening in the field of the techno-manipulation of nature. The intervention on nature proceeds under the insignia of constantly new enhancement and transformation forms, which are intrinsically connected to capitalist exploitation processes. The exploitation of nature cannot be understood, though, but in the framework of contemporary *ontological politics* (see the sociological reflection of Pellizzoni, 2016); in the framework, in other words, of the movement within which a number of ontological boundaries are called into question, including the ones between the natural and the technical, the living and the non-living, the human and the non-human.

Therefore, if the cybernetization of the economy and the techno-exploitation of nature represent two frontiers of contemporary capitalism, the task – as I claim in the paper, as a mere provisional contribution to preparing a space of theoretical debate – is to read, without stretching the analogies too far, the meaning of the assonances between the two macro-domains. One of the privileged fields for such a task concerns, in my opinion, the interrogation on what the techno-capitalist movement – in all its configurations, including the crypto-economic and environmental ones, and in its ever more intense "ontological" torsion – seems most intent on denying: the dimension of *limit*.

The paper begins with a general profile of the cybernetization of economic-monetary life that is occurring in some domains of cryptoeconomy, with a specific focus on Bitcoin. Afterward, the analysis highlights how the relationship between building artificial certainties and pulling the agency in the transhuman direction manifests itself in a set of monetary and non-monetary applications of the blockchain; such applications are aimed at turning an ever-expanding range of social phenomena into algorithmically treatable items. I will then retread some themes of the contemporary discourse about the manipulation of nature and its ontological dimension, in the perspective of interpreting the analogies that connect it to the cryptoeconomic sphere.

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Finally, in the last section of the paper, I will discuss on how certain strands of thought that look at perspectives that are other to the unconditional unfolding of techno-capitalist power can find, in the dimension of the economic and environmental limit, a common field of inquiry. This field could accommodate the reflection on certain alternative experimentation practices, both in the monetary and environmental fields.

1. Notes on the Cybernetic Stances and the Transhuman Imaginaries in some Domains of Cryptoeconomy

1.1 The Project of Cybernetic Assurance of Economic Life in Monetary and Non-Monetary Applications of Blockchain

As an intense media debate on Bitcoin and other cryptocurrencies unfolds, considering them as scaringly volatile assets, many lines of scholarly research inquire into the socio-political demands that characterize the blockchain revolution and into the strictly monetary meaning of this innovation (see Amato, Fantacci, 2020).
The sociopolitical side of Bitcoin has been examined in a wide range of interdisciplinary studies. The Bitcoin project has stemmed from a radical deconstruction of the institutional architecture of official money; an architecture which, with its hierarchies, its opacity and its power encrustations is seen as congenitally corruptible. The sociotechnical artefact of blockchain, which is the basis of Bitcoin, manifests itself, then, as the space where a revolutionary promise builds itself around an ideological arsenal. Blockchain is a distributed ledger that allows the registration and the storage of operations, processes and transactions: a ledger that is not governed by a central body and founded not upon "traditional" forms of management and control but on the incorruptible logic of the algorithm. Blockchain, in fact, is a specific form of *Distributed Ledger Technology,* which concerns ledgers distributed among networks of peer-to-peer nodes, where each node, independently, registers transactions, until a collective consensus is reached, which ultimately updates the ledger. This way of registering transactions became such a dominant technological innovation due to the fact that it allows to handle an incredibly wide variety of transactions, overcoming the traditional notions of trust. At the heart of the blockchain revolution, a movement (eminently controversial and problematic) can be pinpointed, that replaces trust with algorithmic logic; the latter would offer, regardless of the parties' reliability, secure, irreversible and inalterable transactions (see on these issues *ibidem*). Blockchain, as a system of decentered accounting entries, by eliminating the need for a third-party tasked with verifying transactions and keeping a record of them, gives voice to a general need for autonomy and, specifically in the monetary field, allows to fulfil – as Sartori (2020) highlights in a sociological perspective – the desire to be independent from the control of the state and of banks.
Now, the relevance of the blockchain revolution must be understood considering the wider framework of the growing utilization of algorithms in socio-economic life (under the insignia of the controversial algorithmic social and economic governance), which originated an extensive social science literature. According to its technical meaning, an algorithm is a codified procedure to transform a certain input into an output (Mazzotti, 2015). Algorithms, as codes, act as programs that regulate the functioning of a wide variety of social mechanisms and practices through action on data (Campo *et al.*, 2018); they select relevant information, discard what is considered irrelevant, structure priorities, help in search and decision-making processes through complex selection and recommendation systems (*ibidem*).
The themes of algorithmic opaqueness, inscrutability and "objectiveness" (Mazzotti, 2015, *op. cit.*) join the ones related to the treatment of algorithms within a social discourse which supports,

legitimates or discredits them (see Campo *et al.*, 2018, *op. cit.* mentioning Beer, 2017 on the different dimensions of the social power of algorithms). These themes are central to the increasing sociological attention on the matter, which also concerns the specific field of algorithmic management (Stark, Pais, 2020). According to Mazzotti (2015, *op. cit*), the nascent sociology of algorithms raises theoretical, methodological, and policy questions in many ways analogous to those already discussed in STS studies of other logical-formal knowledge, concerning their credibility, the attribution of agency and accountability, the materiality of abstraction processes, or the ambition to mechanize the rules. But, at the same time, in this field of research we encounter new structural conditions - the pervasiveness of numbers, for example - and new practical and conceptual problems - secrecy, the trade-off between interpretability and accuracy, the governability of algorithms - which will put to the test our sociological imagination (*ibidem*).

As for one of the most notable configurations of algorithmic processes – the one that concerns blockchain – around the idea of *distributed power* that blockchain materializes, a powerful debate has developed, that assumes the controversial notions of decentralization[3] and disintermediation as cornerstones. What is at issue is the bypassing of a well-determined set of *middlemen* and *gatekeepers* that occupy the stage of the institutional governance of socio-economic life; but, on a wider perspective, the objective is to pursue a general disintermediation goal, within an ideological framework which assumes horizontality and automation as crucial elements.

On the monetary side, the power of blockchain manifested itself with the proliferation of cryptocurrencies[4], i.e., monetary entities managed through cryptographic treatment of information, which represent one of the most noteworthy phenomena of the contemporary monetary innovation. If we focus, specifically, on the main cryptocurrency - Bitcoin[5] - every centre, every mediation and every hierarchy is overcome through a sort of cybernetic-algorithmic purification of "old" institutional dynamics, with the aim of creating a "private" and "automatic" currency. It is a currency managed in a flat mode, in the horizon, i. e., of a *horizontal* distribution of power, capable of deconstructing the hierarchies based on the control which banks and states exert on the life of money; all this in the wake, as Sartori (2020) highlights, of the illusion of being able to draw a monetary architecture freed by social and political influences.

Bitcoins circulate indeed without bodies that regulate their course and their production, thanks to the *peer to peer* structure: there is no third party that issues money and warrants its validity. This comes at the price of what is interpreted as a de-socialization and de-institutionalization of money, or, in any case, as a profound reformulation of the sociality of money itself, which is based on a deep transformation of the grand issue of trust – on the fact that trust phenomena can be found in the Bitcoin universe, even though trust mainly becomes «trust in technology and in the automatic functioning of a shared system of rules and procedures», see Corradi & Höfner (2018, p. 203).

3 For a critical reading of the notion of de-centralization in the blockchain universe, which also considers the plurality of the meanings of the notion and its contested character, see Becker (2019).

4 The concept of cryptocurrency is at the center of a complex and incessant debate. The Cambridge Dictionary defines cryptocurrency as «a digital currency produced by a public network, rather than any government, that uses cryptography to make sure payments are sent and received safely».
https://dictionary.cambridge.org/dictionary/english/cryptocurrency (last accessed on 30th May 2023).

5 Bitcoin is the name of the cryptographic technology of payment and registration of information, and the currency itself, created and distributed by that technology. This currency is electronic money, whose maximum issued quantity is pre-determined. The mining activity is essential for the Bitcoin existence. In fact, as Marco Mancini (2015) underlines, the activity that leads to the generation and attribution of new currency units is defined as mining. The new currency units are generated as a reward granted by the network to users (miners) who contribute, in competition with each other, to its management and security, making the computation capabilities of their computers available, in order to verify, through the resolution of complex mathematical operations, the uniqueness and security of the transactions carried out. As underlined by Novella Mancini (2016), the progressive diffusion of bitcoins has required more and more computing power and has forced miners to form collaborative groups: through specific programs, the pools of miners combine the power of their computers to carry out as many verification operations as possible. For an analysis of the Bitcoin phenomenon, see also Amato and Fantacci (2020, *op. cit*).

Now, the extensive debate that cryptocurrencies[6] has sparked, sees the presence of an argumentative line that radically critiques some cruxes of the socio-political discourse of Bitcoin, unveiling their ideological trait, questioning representations of Bitcoin as a flat and de-socialized currency[7] (when, instead, its life would show dynamics related to identitarian and communitarian phenomena; see, in a sociological perspective, Dodd, 2018) and highlighting the emergency, among other things, of power asymmetries in the processes concerning the functioning of the cryptocurrency (*ibidem*).

The arguments aimed at deconstructing the ideological apparatus of some cryptocurrency vanguards are undoubtedly appropriate (see for a discussion on related matters and for a critical reading of Bitcoin as a private and automatic currency, characterized by disintermediation Doria, 2020), but they are not specifically relevant for the theme I am presenting in this paper. What I'm going to discuss concerns the assonances that some of the dynamics in the environmental field share with a basic demand that can be seen in Bitcoin. Such a demand could be interpreted as techno-utopic, but it deserves consideration, also due to its capacity of performatively creating new economic realities; it blends the faith in the algorithmic certainty with a post/transhuman imaginary[8] and points to (a movement which, in itself, is filled with problematic contents) a way of conceiving economic life and temporality. The reach of this project, of course, is not measured neither in relation to the possibility that Bitcoin might one day actually become the official currency at an international level, nor in relation to Bitcoin's actual capacity of producing a replacement of the human, in the context of a final dehumanizing automation of money; moreover, as it will be discussed afterwards, what is at issue is the constant hybridization between the human and the non-human, rather than substitution.

In order to fully understand the sense of the Bitcoin innovation one must naturally look at the strictly monetary meaning of the issue. The way with which Bitcoin answers to the many and severe inadequacies of the official currency is related to a sort of "calculative" stiffness of the institutional life of money, which, by algorithmically predetermining its issuing process and issued quantity, produces an artificial scarcity (see on these issues Amato, Fantacci, 2020, *op. cit.*). Bitcoin, therefore, proposes itself as an artificially scarce currency whose life is not in any way related to the dimension of debt, not even to the disfigured notion of credit and debt that is characteristic of capitalism (see on these issues Doria, 2020, *op. cit.* and on credit in capitalism Amato, Fantacci, 2012). Bitcoin is not the passivity of any issuer: it is simply a digital object whose issuing happens in relation to the certification of blockchain transactions, i.e., as proof of a computational process lacking any properly economic meaning.

Capitalism has to handle its relationship with debt by constantly postponing the moment of payment, in a context where debts are systematically translated, thanks to a powerful dogmatic-calculative apparatus, whose intrinsic fragility manifests itself in financial crises. In the face of such fragility, Bitcoin's answer takes the shape of a radical refusal; the new currency is a currency

6 On the phenomenon of cryptocurrencies see Vigna, Casey (2015).

7 For a critique of the idea that the Bitcoin and blockchain universes might contain a technical agency that is separated from socio-economic reality, see Zook, Blankenship (2018).

8 The posthuman tends to outline a complex and not always coherent set of processes and stances. The common thematic nexus of different conceptual positions concerns (Rugo, 2020) the blurring of boundaries between human, technology, and nature in favor of more hybrid and fluid configurations. In particular, the term is used both with reference to modes of being resulting from potential enhancements to human nature produced through applied science and technology, and with reference to the decentering of human exceptionalism and the overcoming of the principles of humanism (*ibidem*). Within the posthuman horizon, transhuman stances look toward the possibility of an evolution brought forth by human technology. One of the pillars of transhumanism refers, then, to an idea of human enhancement based on a set of techno-scientific pathways, such as those concerning biology, artificial intelligence, nanotechnologies, etc. According to Bostrom (2003, p. 493) «Transhumanism is a loosely defined movement that has developed gradually over the past two decades. It promotes an interdisciplinary approach to understanding and evaluating the opportunities for enhancing the human condition and the human organism opened up by the advancement of technology». See also Bostrom (2001) «For transhumanism is more than just an abstract belief that we are about to transcend our biological limitations by means of technology; it is also an attempt to re-evaluate the entire human predicament as traditionally conceived».

which, in a radical way, does not want to have anything to do with what official capitalism must constantly run away from, i.e. the dimension of the closure of economic relations. And it is a currency that sees itself as *safe* because artificial scarcity protects it from any inflation risk, erasing at its roots the risk of generating *too much money*. Within this horizon, Bitcoin (see Amato, Fantacci, 2020, *op. cit.*) is bound to amplify the most problematic traits of capitalist money - *in primis* the conception of money as an *appropriable thing*, ultimately leading to a monetary scenario that is socially and economically unbearable.

We might say that Bitcoin, therefore, is about building artificial certainties, with reference to both a general ideal of certification and assurance of socio-economic processes, and a specific project for assuring money, its life, and its temporality – a project which, paradoxically, saw the creation of a hyper-speculative cryptoasset as one of its most tangible achievements, and that seems to materialize an extreme form of financial speculation (see on these issues Doria, 2022).

The demand for a "cybernetic" assurance of the economy, though, covers domains that go far beyond Bitcoin. There is little reason in identifying the whole of cryptoeconomy (an entity which has uncertain and unstable boundaries) as a univocal and recognizable project. In fact, blockchain has been the stage where currencies that are (as for conceptual apparatus, monetary meaning and operative architecture) radically distinct from Bitcoin have been and can be created. It is true, though, that a cybernetic stiffening of economic life can be easily pinpointed not only in the cryptocurrencies that share Bitcoin's ideological and conceptual apparatus, but also in some configurations of the so-called non-monetary applications of blockchain and in related ideological constructs. The range of these applications is also rapidly expanding: one of the most glaring manifestations undoubtedly concerns the *smart contract* sphere, since blockchain promises to deeply reshape the semblance of one of the main institutional pillars of modern societies. According to Allen (2022, p. 27, italics in the original), a smart contract is a «(i) recording of a *legal agreement* between parties that is (ii) written in a *formal, ultimately machine-readable language* rather than a natural language such as English, and whose text incorporates (iii) an algorithm which *automates some or all performance* of the agreement». Within the smart contract horizon – dominated by the principle of *automatic* execution of contractual processes – a complex range of quite relevant "operations" are set to be replaced by algorithmic processes: interpretation, enforcement, jurisprudential evaluation are all destined to be radically remoulded. The traditional roles assigned to lawyers, notaries and judges are also risking to be bypassed by the power of the algorithmic protocol.

The debate on the definitions of *smart contracts* (see Allen, 2022, *op. cit.*) is quite lively; and so are the discussions on the extent to which the validation process is still, actually, embedded in social interactions. Herein, though, I aim at highlighting the extraordinary speed with which the range of institutional processes treatable through the *smart contract* logic has widened. This range, of course, comprehends property ownership (the so-called *smart property*) but tends to reach out to an unlimited number of fields of governance, while looking at redefining the very definition of governance itself, in light of a general demand for the *automation of the rules*.

The project of building an algorithmic governance of social and economic (as well as political, especially, but not exclusively, in relation to electoral dynamics) realities is going forward on the privileged pathway defined by the phenomenon of DAOs (Decentralized Autonomous Organizations). A DAO is «a blockchain-based system that enables people to coordinate and govern themselves mediated by a set of self-executing rules deployed on a public blockchain, and whose governance is decentralized (i.e., independent from central control)» (Hassan, De Filippi, 2021, p. 2). At the heart of some ideological apparatuses that are developing around DAOs we can find the trust in the safety and auditability of the code, which can guarantee the coordination of the action of people, machines or combinations of both (Wright, De Filippi, 2015).

In the most extreme visions of the algorithmic automation of governance, the latter could end up in touching upon every social domain, generating an indefinite range of social contracts, from nongeographic countries, to transnational lending programs, from universal plans of basic

income, to marriage contracts and so forth (Garrod, 2016). Even a DAS (*Decentralized Autonomous Society*) is envisaged, where the form and the role of the nation-state could be completely changed by technology – see Garrod (*ibidem*) for a critique of some of the scenarios circulating among the DAS discourse.

Generally speaking, one of the pathways that the blockchain-based technological management of social processes has taken is, as it is known, the one that concerns the production of tokens[9], the so-called tokenization. «Tokenization refers to the process of transforming the rights to perform an action on an asset into a transferable data element (named *token*) on the blockchain» (Rozas *et al.*, 2021, p. 5, italics in the original). This is a process of digitalization of value, an «encapsulation of value in tradeable units of account» (Freni *et al.* 2022, p. 2). The very plasticity of tokenization has drawn a growing analytical interest:

> «In simplistic terms, tokens can be seen as privately issued currencies used to exchange value within an ecosystem (e.g., Bitcoin). In reality, their usage has gone far beyond mere currency applications. The roles that a token may play are manifold and include, among others, giving access to a service, granting the right to contribute to a community, regulating the governance through voting rights» (*ibidem*).

Not every token, then, can be considered as a paramonetary item – i.e., as an entity which, like cryptocurrencies, performs, even if only partially, monetary functions. Actually, intense debates have been sparked around the difference and the relations among the different kinds of tokens, which include, for example, the ones similar to cryptocurrencies, the ones related to financial securities, to the *utility-tokens*, i.e. tokens that grant the right of utilizing or benefitting from a product or a service.

Tokenization[10], then, manifests itself as a process, with remarkably fluid and open borders[11], which by incorporating value in units of digital accounts *creates* socio-economic entities; and it does so, naturally, in the register of decentralization and disintermediation that is typical of the blockchains, and thus without a center that can be deemed accountable for the meaning of the process. The finalization itself of the tokenization operation is also indetermined and open, in a manner of speaking. Of course, within a determined context of practices and meaning (which sometimes coincides with a space of digital commoning), a certain token and the rules that are behind its functioning can be fixed with a well-defined goal in mind. However, if we broaden our perspective to the extraordinary proliferation of tokens, the latter seems to take the shape of processes of digitalization of value that overlap each other, in search, to a certain extent, of a finalization.

It's worth mentioning, finally, that the space of urban studies and policies is also deeply affected by the proliferation of the power of distributed ledgers as a technology that can play an important role as «administrative layer and actuating agent in various assemblages of technologies and use practices» (Gloerich *et al.*, 2020, p. 12). Such systems (*ibidem*) «allow for new models to monitor, manage and actuate all kinds of urban processes. Examples vary from smart city services such as the management of parking spaces to the organization of local, commons-based peer-to-peer economies».

Some of the domains of local socio-economic action where the blockchain experiment is taking place concern, specifically, the lively space of sharing economy (see Fiorentino, Bartolucci, 2021) and the complex discourse that surrounds smart cities (on blockchain as «an indispensable layer of trust in a smart city» see Kundu, 2019, p. 42). The potential of distributed ledgers in an urban context are so relevant that some scholars proposed the image of the city *as a license* (Gloerich *et al.*, 2020, *op. cit.* p. 12):

9 The debate on the profile and types of tokens is very lively and complex. The Financial Stability Board (2019, p. 10) defines a digital token as «any digital representation of an interest, which may be of value, a right to receive a benefit or perform specified functions or may not have a specified purpose or use».

10 For some considerations on the phenomenon of tokens see Doria (2023).

11 The existence of tokens that grant the right of participating in the governance and planning of the activities of a specific organization is an element that contributes in making the sphere of tokenization wide and complex.

> «We introduced "the city as a license" as a lens to explore these platforms or smart city services from a perspective of governance. As such we proposed to think of automated blockchain-based platforms as actors that give out licenses to temporary make use of resources, based on conditions encoded in smart-contracts through algorithmic governance. The city, seen through that lens, becomes a rights management system, or more likely a system of systems of rights management, and that perspective brings out questions in relation to power, agency, accountability and transparency».

This potential algorithm-based reshaping of the urban space opens up new perspectives, even diametrically opposed. In the horizon of the peculiar ambivalence that characterizes the critical perspectives of social sciences on the matter, democratic empowerment scenarios go with risks related to opaqueness or privacy threats.

> «Whereas, blockchain-based ledgers are envisaged as empowering to citizens because of their decentralized character, and their architecture that can invoke "trustless trust," there is also a risk that these networks will become dominated by a few central actors again, not unlike the internet itself. How these actors and their code could be held accountable by local legislators is not directly clear. Likewise, the trust that citizens may have in these systems could be undermined by their multiplicities and opaque form of algorithmic governance» (*ibidem*).

12. *Between* Artificial Certainties and Transhuman Indetermination

At the heart of the diversified scenario of cryptoeconomy we find, then, a movement that creates spaces of "algorithmic assurance" for an incredibly wide array of phenomena.
How can we understand the position of this movement of automatic assurance within the overall horizon of cryptoeconomy? Do we face a particularly potent version of the techno-prosthetic apparatus wielded by contemporary socio-economic actors – an apparatus which, though, would leave those actors basically unchanged, as human actors? This seems indeed the representation that we find (with particular regard to the gray area of media narrative) in the sphere of Bitcoin and similar cryptocurrencies, regarded as assets handled by a new species of capitalists, still possessing human attributes.
In reality, though, the situation is quite different than the one defined by technological artefacts wielded by human agents, proposing, instead, at its core, a condition of confusion and hybridization between the human and the machinic, in a context where the borders are increasingly blurry.
A twofold movement can be found at the basis of an important part of cryptoeconomy: going beyond human weaknesses and corruptibility through building artificial certainties and freeing ourselves from human finitude with the project of an economy that features a hybridization between the human and the non-human (for considerations about related themes see Doria, 2020, *op. cit.*).
If the "official" finance is deeply influenced by the algorithms' role, the Bitcoin experience takes a step forward in the direction of an increasingly complete interchangeability between human agents and technologically autonomous ones: the trend toward anonymity and protocol automation, featured in cryptocurrency dynamics, seems to preconize a completely legitimate and normal role for non-human or hybrid agents, such as a DAO. This theme, though, goes way beyond the boundaries of cryptocurrencies. The entire cryptoeconomy scene (from smart contracts to the mirage of DAS) has been explicitly and programmatically assuming as its own horizon of meaning the hybridization between the human and the non-human. The forms of organization of economic life based on the blockchain seem to be populated by humans, mechanical agents and endless combinations of the two.
At the heart of the debate, we find the idea of an agency that is more and more fully *distributed* between the human and the non-human, to the point where the two forms of agency are so strictly imbricated, overlapped, intertwined that they cannot be separated anymore. In the expectation of the complete fulfilment of the transhuman project, though, what is at issue in sev-

eral argumentative lines surrounding cryptoeconomy is the acknowledgment that certain tasks that the human can perform in the blockchain economy are still irreplaceable. This leads to an argumentative thread that considers the human element as a valuable asset, since it's not substitutable, for the functioning of a new kind of decentralized autonomous organization which «lives on the internet and exists autonomously, but also heavily relies on hiring individuals to perform certain tasks that the automaton itself cannot do» (Buterin, 2014).
Rather than in the register of the substitution of the human element with a machine, some lines of interpretation (see Nabben, 2021, referring to strands of thought in the field of cybernetics) thus develop with reference to the notion of autonomous human-machine systems, as entities in the context of which humans «are always in the loop of complex systems engineering, whether that is establishing initial settings, deciding what objectives to optimise for, or training algorithms» (*ibidem*, p. 10). What becomes at issue, therefore, (*ibidem*) is the emergence of a co-constitutive relationship between humans and algorithms and (see on this point *ibidem,* p. 9, with regard to a case study concerning a blockchain-based DAO) of a co-constitutive human-machine ensemble «in which humans determine algorithm rules, and human outcomes are thus determined by algorithms».
The whole picture could be observed, in my view, with regard to an unconditional and indetermined process by which the human makes itself into the algorithmic and vice versa, whereby algorithms, in some interpretations (see on these and related issues Amoore, Raley, 2017 and Raley, 2016) are meant as holders of *generative* and *world-making capacities*[12].
I believe that the movement, in its entirety, should be understood by focusing on its "vital" feature, in a context where the machinic lends itself to be assumed as a subject with vital capabilities; and this life, that pulsates to the beat of hybridization and fluidity, carries within itself a conception of temporality as an intrinsically *open* phenomenon. The never-ending making of the human in the non-human places at the core of the economic phenomena a demand of emancipation from the ideas of finitude and closure. If, on one hand, the algorithmic code seeks, in a way, to pre-determine the temporal evolution of socio-economic processes and to "immunize" future uncertainty, on the other hand, the temporal horizon is affected by a dilation (that is indeterminate and produces indetermination), in which the algorithmic life can simply live *forever* or at least until the energy that powers computer networks runs out.
Contemporary capitalism proceeds through the refusal of the element of closure[13] and by an ever-increasing weakening of the dimension of limit. Within the dream (or, according to one's stances, the nightmare or the mirage) of the algorithmic economy, it seems that the issue of closure could be, instead, hollowed out at its very roots. The reverie of some cryptoeconomic projects, apparently, outlines an economic life shaped around the indefinite and immortal interchanges between the human and the algorithmic, while keeping the dimensions of the closure of relationships and of limit in the domain of artificial simulation games.

1.3 Between Capitalism and Post-Capitalism: the Transversal Fascination of the Algorithmic Transhuman

The multiform post/transhuman discourse is one of the frontiers of contemporary capitalism and develops on several sides, including the ones regarding biocapitalism (Cooper, 2008) and the ones concerning the paths of the algorithmic cybernetization of economic agency that I

12 On the process of *technogenesis* that concerns the co-evolution between humans and technical elements see the volume of Hayles (2012) mentioned in Amoore, Raley (2017).

13 On a strictly monetary-financial level, this refusal happens through a conception of money based on liquidity and through an understanding of finance that severs the etymologic bond with *ending* (see Amato, Fantacci, 2012, *op. cit.*). The reverie of some cryptoeconomic projects proceeds, in primis, by removing the link with debt-credit relations that call into action debtors and creditors as mortal beings. On the nexus between mortality and debt/credit relations, see *ibidem*.

mentioned in the previous paragraph. It is true, though, that the fascination of the transhuman pervades very wide domains of post-capitalist commoning (on the ambiguities surrounding the contemporary discourses on commoning, see Pellizzoni, 2018). The reference is about the discourses and practices that recognize in the distributed ledgers a formidable chance to outline new forms of governing digital commons (characterized by transparency, efficiency and flexibility) and that thus promote so-called crypto-commonist projects (Fritsch *et al.*, 2021), that are other to the capitalist horizon. In this framework, the demand of emancipation from the dominion of the institutional apparatus of capitalist markets tends to get together with the liberation from conceptions of agency shaped around the human actor and not around the hybridization between the human and non-the human. Many lines of research and experimentation connect the two sides of emancipation in a more or less explicit way (for example, on the topic of the relationship between blockchain and food commons, see Heitlinger *et al.*, 2021). The power of algorithms, then, breathes new life into the redefinition of commons as human/non-human assemblies, intrinsically open toward new enrollment possibilities – see on enrollment Gibson-Graham *et al*. (2016), with regard the notion of commoning-community: «As social scientists we have a role to play in helping to identify the human and more-than-human actants of the commoning-community. This may involve working with technologists, scientists, biota and so on to enrol members of the commoning-community» (*ibidem*, p. 207).
Besides, it's on the very field of some fundamental theoretical references that the transhuman twist of post-capitalist commons becomes tangible, with a specific focus on the machinic non-human. One example is the parable of post-workerist thought, especially the works of Hardt and Negri. If the fascination with the cyborg was already present in the elaboration on the biopolitical and the multitude in previous works (Hardt, Negri, 2000), the emphasis on the mutual interplay between the human and the machinic has become (on these topics see Pitts, 2020) peculiarly apparent in some of the most recent contributions and, specifically, in *Assembly* (Hardt, Negri, 2017). In this last work, in a horizon of ontological equivalence between humans and non-humans, the transformative potential of *machinic assemblages* (as ensembles of human and non-human singularities) is praised. When facing a capitalism that keeps on extracting value from the new configurations of commons, the role of the autonomous production of value and resistance against capitalist reappropriation is assigned to *human machines*. These theses are partly consonant with some post-capitalist lines of thought with post-humanistic implications (for example, consider the *accelerationist* thesis of Srnicek, Williams, 2015), which have been recently the topic of a heated-up debate, both in the scholarly and political field (for a critical analysis see Cruddas, Pitts, 2020). The risk, in my opinion, is that in this cultural climate, the only legitimate temporality could end up being the one that beats at the accelerated rhythm of the unlimited, *endless* vitality of human-machinic assemblies. Every reference to the experience of breath and rhythmicity in the economic (and so to the dimensions of waiting, of promise, of closure) risks to be regarded as something belonging to a sterile attitude, discordant with the only possible emancipatory perspective.

2. Techno-Manipulation of Nature and the Role of the Ontological Issue

2.1 The Proliferation of Operations of Nature Manipulation and the Role of Environmental Tokenization

Defining the profile of the processes of nature manipulation (Pellizzoni, 2016, *op. cit*) is a particularly complex task. A number of lines of action interlap, overlap and intertwin, in a framework where enhancing, transforming and "inventing" portions of nature goes along with a constant, ever-provisional redefinition of the ontological features of the natural. A first dimension con-

cerns the scenarios of the "tangible" manipulation of nature, that proceeds under the insignias of bio-genetic technoscience, nanotechnology and computer science. What is at issue is a number of processes that articulate themselves in multiple operative fields, such as the ever more intense genetic manipulation in agriculture. These interventions do not have to do with the mere register of natural enhancement, but with a movement that continuously recreates nature with new shapes and configurations. The ideological-argumentative framework of this process of technological recreation of reality is often placed around the impossibility of distinguishing between techno-genesis dynamics and the evolutionary work of nature. As Pellizzoni (2019) writes, for agribusiness companies, nature is ontologically and not only interpretatively "technical", given that there is no substantial difference between the hybridizations that nature makes spontaneously, those of traditional farmers and those (more precise) that biotechnologies make.

There is a second dimension, which is related to the multiple forms with which nature is translated in a determined techno-scientific dimension, where it lives a parallel life, also by virtue of decomposition and reconstruction operations. A specific configuration of the phenomenon is found in the pathways of geo-engineering (*ibidem*), where the power of technology allows the transfer of environmentally crucial matters on new operational fields; an example is the attempt of answering to the climate crisis through solar irradiation with gigantic mirrors (*ibidem*). The scenario of the techno-capitalist treatment of the environmental issue is then certainly deeply marked by *compensatory* discourses and practices. The compensatory approach takes form as a bundle of practices and specific markets (*carbon markets* are at the helm, naturally) which, in their ever-constant transformation, outline the scenario of ecological modernization and of its numerous business frontiers. Furthermore, the bond between the calculative stance and commodification finds one of its most prominent manifestations in what is a crucial area for contemporary capitalism, the field of derivatives. While derivative markets have been one of the main frontiers of capitalism for many years, derivates related to environmental dynamics (on this matter see Cooper, 2010) have been developing spectacularly, which is relevant both in terms of financial volumes, and in the ways with which it legitimates conceptions of the relation among environment, time and value.

In general terms, the pathways of commodification and financialization keep on multiplying, opening a number of critical perspectives. A particularly significant case, as highlighted by Pellizzoni (2021a), is the one concerning the so-called PES (payments for ecosystem services). They are based on processes that identify a set of environmental performances that nature might be able to provide (carbon sequestration, availability of habitats for protected species, landscape and water protection), isolating them from the relations that they have with other operations and other practices (*ibidem*). On these pathways, nature tends at configuring itself as a potential deposit (plastic, or even liquid) of an unlimited set of environmental performances/resources, just waiting to be acknowledged (*framed*, *enacted*) through a complex cognitive labour; the latter, in the very moment it defines them as specific items, also qualifies them as commodified entities.

Now, some of the issue I mentioned may take a particular shape in the domain of tokenization. The latter, as already highlighted, is a field (quite lively and, most of all, quite confusing) of processes which has extended its course of action toward environmental themes for quite a long time already. The proliferation of different kinds of ecological tokens[14] is linked to the great flexibility of tokenization, both on the issuing and awarding criteria, and on the utilization of tokens. The latter can be granted as a "reward" for certain environment-friendly individual behaviors, in determined contexts[15], or distributed within specific incentive strategies aimed at companies, in a horizon that is potentially more open to the financialization of environmental dynamics. Tokenization involves, then, a cognitive work aimed at outlining of the boundaries of services and behaviors to be incentivized and, on the other hand, a "computational work" that allows the awarding and utilization of the tokens on the blockchains.

14 For some examples of these tokens see Howson (2019).

15 See the reference to a project concerning the Milan context in Pettinaroli (2020).

The range of the possible configurations of environmental tokens[16] is quite diversified, even if we focus on critical approaches toward the global commodification of nature. See Heitlinger *et al.* (2021, *op. cit.*), who read in tokenization the chance of reconfiguring the theme of relationship between value and food in a *more-than-human* key (attentive, then, also at recognizing human and non-human stakeholders), within a perspective which, in my opinion, configures an important relationship plane between two features of the non-human, the algorithmic non-human and the bio-physical one. The types of conceptual prototypes (see *ibidem* for details about them) which could substantiate the idea of *algorithmic food justice* are, indeed, quite different. They range, for example, from an initiative concerning a currency exchange for community currencies – in which the «exchange rate is set automatically according to the soil health data of each community, as measured by networked sensors and AI, and calibrated over time» (*ibidem*, p. 11) and the «better the quality of the soil, the higher the value of that local currency» (*ibidem*) –, to a project in which people are rewarded with tokens for spending time with plants, as well as for caring for them and non-exchangeable reputation tokens are used to make new proposals on the management of the commons (*ibidem*).

In general terms, it is the potential variety of the forms of environmental tokenization that makes reading them under the lens of *monetization* and *commodification* problematic; and it also makes the overall scenario of the critical interpretation of the phenomenon particularly difficult and thorny, also when considering the fact that, tokenization pathways that are in the beginning not market-oriented may be re-assimilated into financial logics.

One thing is sure: tokenization promises to deeply reshape the issue of the intervention on natural environment. The extraordinary potential variety of the rules concerning the issuing and circulation of environmental tokens (which, moreover, can connect different scales and different contexts of exploitation) introduces in the already intense sphere of nature manipulation an additional element for even more dynamism; the latter results in the generation of new fields of framing, assembling and connecting environmental resource and "performances". In the movement of digital encapsulation of environmental value, what risks to be reinforced is the configuration of the natural as a source of an indefinite flow of exploitable forms of nature itself. And the fact that the process develops in a diffused, distributed and decentralized way makes the overlapping of exploitation processes particularly fluid, and makes it harder to focus the lenses of critique, compared to situations where exploitation itself is inscribed within traditional institutional frameworks.

2.2 The Ontological Dimension of Nature Manipulation

The background of old and new operations of manipulation and exploitation of nature is, as rightfully highlighted by Pellizzoni (2016, *op. cit.*), the one that is marked by the redetermination of a set of ontological boundaries; a movement that mostly proceeds riding the same wave of the new materialisms (see, for a critical read, Pellizzoni 2017) and of the ways with which, sometimes quite easily, they go beyond anthropocentric approaches and dualistic stances, considered as dominative. Thus, the processes of technical intervention on nature should be also read considering *ontological politics* and the theoretical-ideological frameworks that binds together anti/post naturalistic positions and post/trans-human stances.

On one hand, the natural world keeps on being perceived as constitutionally hybridized with the techno-artificial one; nature is defined by its relationship with a never-ending flow of socio-technical operations, including the very operation of abstaining from intervention. As Pellizzoni (2019, *op. cit.*) writes the "natural" appears as a sort of internal differentiation of the social, the technical, or of capital itself: almost like a moment of breathing or Hegelian contradiction necessary to make a further leap forward.

16 On some issues concerning these tokens see Doria (2023, *op. cit.*).

What is radically put into question is the distinction between the human and the non-human, between the human being and the non-human matter (animal, vegetal, mineral, etc.), which is also considered as holder of vital potential. In this framework, some crucial challenges, such as the climate one, are redefined in a perspective that aims at overcoming each and every form of *environmental anthropocentrism* and *human exceptionalism*. All this with one provision: the irrepressible "specificity" of the human as the entity capable of (since it possesses reason, with all that this entails) taking a peculiar role compared to other *vital matters* in environmental policies. Here we can find a truly questionable rhetoric thread that very closely recalls (and the consonance deserves a critical analysis) the arguments we saw in action concerning the specific human contribution to algorithmic economy. As written by Fox & Alldred (2020, p. 272) «Indeed, (post) humans have been demonstrated to acquire capacities that are unusual (though not necessarily unique) for planet Earth [...] Some of these unusual capacities (not least the capacity to generate "policy") will be of specific utility when addressing climate change».
The human element involved in non-hierarchical relationships with non-human matter risks, in my opinion, of being constituted as an indefinably malleable object in a post-human scenario; it risks to fluctuate in a space where every possible declination of the post-human transition appear as obvious. It is by considering this that, in my view, we must read the following declaration, which is inserted in an approach in line with the theoretical arguments that recognize that (post) humans are fully part of the environment:

> «This posthuman standpoint on environment and climate change, we have suggested, supplies the means to avoid human exceptionalism (Dunlap, Catton, 1994, p. 24) - a position in which the "environment" is treated merely as a resource to sustain human existence. Instead it acknowledges the diverse capacities of matter (non-human and (post)human) to affect and be affected, but that these capacities are not fixed attributes but relational and emergent» (*ibidem*, p. 280).

Within a perspective aimed toward the complete transcendence of every remnant of dominative approaches, the environment is conceptualized as the ensemble of the natural and social worlds (Fox, Alldred, 2017), and is seen as populated by (post)humans in a bijective relationship of influence with non-human matter.
I cannot properly discuss here the deep theoretical issues that are flourishing around the post-human and postnatural twist of ecological thought. Herein I just wish to draw attention to the fact that the project of rewriting the relationship between human life and nature clearly evokes – on various paths, that are consonant with what is happening in the cryptoeconomic world – the issue of temporality. Amid the proliferation of relations among the vitalisms of the different forms of matter, what stands out as a crucial trait is the deep transformation of the conceptions of temporality. What matters, indeed, is the constant, undefined, recurrent capacity that matter has *to affect and be affected* in relationships; but this matter – *in primis* the (post) human one – is already constitutively projected beyond itself, because it constitutively refutes any kind of boundaries. In this framework, the abyssal enigma of the relation between the finitude of human life and the finiteness of the natural world tends to play to a new tune, or even to ring empty. A number of dimensions of temporality[17] (the ones that refer to cyclicity, but also to irreversibility, non-procrastination and even *urgency*) are at risk of being obscured. If we stretch the interpretation of a very deep issue, we might even say that, in the neo-materialist project of emancipation, it seems like there is no time to have an experience of limit, which is in tune with the relationship between time and finitude, and, according to that relationship, meets the challenges of ecological thought.

17 I have addressed some related issues, from the perspective of the debate on anticipatory governance, in Doria (2022, *op. cit*).

3. Conclusion: the Meaning of a Joint Questioning

The algorithmic cybernetization of socio-economic life and the manipulation of the environment are two frontiers of high-tech capitalism.
The cryptoeconomic revolution is fueled by the power of algorithmic technology, which prefigures a cybernetic translation of ever-wider domains of socio-economic life. Within the mirage of "assuring" the economy – and overcoming the "too human" fundamental economic uncertainty – the technological investment ends up with continuously generating unprecedented and often controversial economic realities.
In the scene of techno-manipulation of nature, there are a series of different processes taking place (which are not always readable within a coherent perspective), which, on the one hand, are moving toward enhancing and transforming the bio-physical reality, and, on the other hand, are demanding an incessant, whirling redetermination of the very profile of nature.
These two macro-movements are both permeated by the ontological issue; and the posthuman and postnatural configurations of the latter tend to call into question the conceptions of temporality and economic life. This matter, moreover, in its profound ambiguity, has also an emancipatory colouring, under the heading, in one case, of the post-capitalist posthuman, and in the other, of an anti-dualistic postnaturalism.
Precisely on the ontological terrain, cryptoeconomy and environmental processes seem to echo each other, on the basis of a deep similarity. And this happens just when the two macrofields are connected – a connection that is strong, direct and rich of consequences – by the environmental tokenization process.
When facing this scenario, my opinion is that one of the tasks of the economic and ecological critique is to carry out a joint inquiry, searching for an ever more precise reading of the aforementioned consonances. The appropriateness of this effort is testified by the fact that some ecological and economic strands of thought, today, are already working on what *both* the posthuman *and* the postnatural turn risk to drive to irrelevancy, i.e. the dimension of limit.
Let us think of some lines of sociological theory, in which the critique to new materialisms and their actual potential of emancipation from techno-capitalism (Pellizzoni, 2017, *op. cit.*) is joined by a reflection on limit (Pellizzoni, 2021c), which is a particularly challenging theoretical item. Limit, in fact, rather than being explicitly refuted, tends to be the object of a constant, and sometimes difficult to spot, remodulation. Within that movement, it risks to present itself (on these matters see Pellizzoni, *ibidem*) as an element compatible with the capitalist project and, particularly, to be re-purposed as a trampoline for new exploitation waves. Despite this, the issue keeps alive and finds a field of experimentation in a number of alternative practices (which often take *prefigurative* features, Yates, 2015) that aim to step outside of the grammar of capitalist goals, values and relations and of the way with which they inform social relations and the relation with the natural world. This is the take of Pellizzoni (2021b, p. 375-376) concerning phenomena such as farmers' markets, community-supported credit systems, participatory plant breeding, frugal innovation or permaculture: «Where is the difference with business-as-usual? Goods are sold and bought, money is lent, plants are grown, research and technology development proceeds. To get the difference one has to look at telling clues, especially those 'alternative value practices' (Centemeri, 2018) which run counter capitalist chains of equivalences and (self-) valorizing thrusts».
This project, if we read between the lines of Pellizzoni's contribution, is a frail and delicate one, since it has to work on some non-apparent differences, or, rather, on the ones that capitalist dominion seems to relegate to the rank of mere shades of the way of thinking and living the economy and which, instead, are nuances that hint at an abyss of difference.
It is around the theme of limit (and the hard task of rethinking economic limit at the core of the abyssal issue of the nature of money) that an interpretive pathway of monetary innovation practices is developing. These practices speak a *radically different* language (as for the concep-

tions of money and the economy) compared to some cryptocurrency experiences, Bitcoin in particular. One example are complementary currencies based on *clearing*[18], which is an extraordinarily important "principle" for economic theory and practice and is at the core of proposals for reforming the international monetary system (the Clearing Union of Keynes), which keep on stimulating contemporary monetary thought (see Amato, Fantacci, 2012, *op. cit.*). Around local clearing a lively debate has developed, filled with sociological contents (see, for example, Sartori, Dini, 2016); it touches upon the interpretation of the economic meaning of projects and their implications in terms of social and institutional dynamics.

In some experiences based on clearing, money is created and "destroyed" in a dynamic that breathes at the pace of commercial transactions, under the command of the systematic closure of debt and credit positions. Incorporating the clearing system in a local currency experiment, therefore, generates a monetary form with a peculiar relation with the dimension of limit (see on related issues, Doria, Fantacci, 2018). This dimension manifests itself, first, as a functional limit; a clearing-based currency, unlike an official currency, doesn't carry out all the functions that the manuals assign to money; in particular, it doesn't carry out the reserve of value function[19], which is one of the pillars of the power and controversiality of official money. Local clearing circuits, though (which are based on a determined and carefully-wrought network of participants), have to deal, naturally, with a territorial limit, which opens up the question on the economic sense of monetary *localness*. The possibility that is unfolding in the future of these monetary experiments – as well as some alternative practices of ecological nature – concerns a limit that is not experienced in the dimension of simulation (meaning in the context of artificial constraints that can be generated in the economic-algorithmic games) nor in that of a defensive closure.

The road toward a joint questioning on ecological and economic limit is not easy and its outcomes are not predeterminable. The very threads – vivid, confused and surely not univocal in their meaning and breath – of contemporary economic and environmental innovation, though, make the inquiry urgent and potentially very fertile for sociology and other disciplines.

18 *Clearing* is a principle of functioning of economic relationships of extraordinary importance in the history of economic theory and practice. A clearing system «simply makes it possible to register (1) a debt owed by someone who is required to make a payment but cannot do so immediately; and (2) the corresponding credit in favour of the party to be paid. This is, however, from the very outset a trilateral rather than a bilateral relationship: both sums are registered as debit or credit *with respect to the system as a whole*. In virtue of its tripartite structure, the system permits the use of credits to make payments also towards third parties. In this way debit and credit are not individual and fungible positions, but acquire their meaning in relation to the entire set of relations constituting the system. Within a clearing system, credit takes the form, not of a bilateral relationship represented by a negotiable security, but that of the net position (positive or negative) of each member with respect to the set of all the others. What ensures the actual clearing, in other words the effective meeting of debtors and creditors, is therefore not a price (a rate of interest) such as to balance the supply and demand of money, but rather the multilateral compensation of profits and losses and the tendency to converge towards parity for all the participants» (Amato, Fantacci, 2012, *op. cit.* p. 34, italics in the original). For an analysis of how clearing works in experiences of monetary innovation, see the contribution of Fama, Musolino (2020), written in a perspective that is attentive to the social implications of the initiatives.

19 This function concerns the fact that money «allows us to preserve the share of income that is not used for the immediate consumption of goods and services for later use. In other words, it enables a share of current income to be kept (saved) for spending in the future» (Banca d'Italia, 2017).

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