Political and Economic Implications of Blockchain Technology in Business and Healthcare

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Chapter 3
Blockchanging Money: Reengineering the Free World Incentive System

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ABSTRACT

Blockchain technology is changing the world incentive system, making programmable money. This kind of money is only fruitful and democratically livable in a transparent political environment. Otherwise, instead of unleashing innovation and collective action with the market's visible hand of qualified money, the new internet of value will deliver a digital money with the same algorithmic fate that social media met on the previous internet. The latter allows digitizing users' data and has been used to manipulate consumers and public opinion (possibly in the last two U.S. Presidential elections). Similarly, the former will let states and corporatocracy cross-reference social media and digital money's data, hurting privacy even more. As blockchains disseminate, having the crucial economic advantage of reducing transaction costs, only free-market competition between private and public blockchains guarantee transparency and democracy. Blockchain technology is the real McCoy, and decentralizing digital money is the free world's best shot, especially in the new normal triggered by COVID-19.

INTRODUCTION

"Technology comes in packages, big and small." (Kranzsberg, 1986) Kranzberg's Third Law

This chapter's main objective is to show both auspicious and worrisome implications of *Blockchain Technology* (BT), which has recently empowered money as the newest type of economic media (Beller, 2020) aired on the *Internet of Value* (Twesige, 2015). Several central banks are making efforts to develop their digital currencies (Náñez Alonso et al., 2021), and it will be discussed how to deal with the *blockchain* kind of money. It is thought that digital money's implications will be crucial to society in a

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post-pandemic new normal (Berwick, 2020) that requires a watchful consideration of "how institutions are designed and formed, and how the balance between institutions' control and the public's freedom is negotiated in society" (Tam, 2021, p.9).

As stated by Ebadi et al. (2020), "The idea of a secure digital currency that is not managed by a central authority has been an interesting field of research for decades. Bitcoin showed this ideal is reachable" (p. 54).

Whatever consumers may say, in the end, they want quality before anything else. […] To keep in pace with this growing trend, initiatives flourish to help increase transparency and traceability. […] More than just a buzzword, a blockchain is an opened ledger of every transaction between the stakeholders. The records are permanent and verifiable, and are not managed by a central authority. (Tonin et al., 2018, p. 3)

Following a rationale shared by economists like Keynes and Friedman but going against the conventional belief about *money* and not following the orthodox theory of most economic books, one can draw a line between one-dimensional centralized, traditional money and multi-dimensional programmable tokens. Not complying with rulers' perspective (see *Seigniorage* in Key Terms and Definitions), BT allows decentralizing money globally in a structured and secure way for the first time in history (Nakamoto, 2008). To understand such a paradigm shift is convenient to begin investigating what *money* is.

Although we usually assume a sharp line of distinction between what is money and what is not, and the law generally tries to make such a distinction so far as the causal effects of monetary events are concerned, there is no such clear difference. What we find is instead a continuum in which objects of various degrees of liquidity, or with values which can fluctuate independently of each other, shade into each other in the degree to which they function as money" (Hayek 1990, p. 56)

BT's predictable diffusion makes it possible to envision a "political transformation [that] requires the possibility of a redesign of the protocols of money" (Beller, 2020, p. 217), diversifying humans incentive systems and assuring freedom of choice on the *Internet of Money* (Peters & Panayi, 2016; Antonopoulos, 2017; Pocher, 2019; Srivastava et al., 2021).

It should be mentioned the author's liberal perspective. The investigation method was based on qualitative research, and the methodology chosen was the literature review, which is adequate to overview several thematic areas on a given topic. Among the literature review methods available, the most used for business studies are systematic review, semi-systematic review, and integrative review (Snyder, 2019). Considering the need to carry out a synthesis conducive to envision the economic and *crypto-economic* implications of BT, the author chose the integrative literature review, which is indicated to frame a study from new perspectives, especially when it comes to research themes and topics little explored (Torraco, 2005). As far as it was possible to observe, the author concludes there are few studies regarding specifically the economic impact of cryptocurrencies and other *crypto assets*.

This chapter is organized as follows. It begins demystifying money's nature and checking if cryptocurrency has the necessary properties to redesign money's protocols. It will be shown that these protocols are changing, and it is still pretty much unsure that it will be for the best. After providing a background regarding BT and observing some critical elements of the blockchain ecosystem, digital money's competitive advantages will be presented. It will be argued that *blockchain money* should not remain solely

a creature of the state (Reiners, 2020). It is thought that besides changing society's fundamental ethical dilemmas (see the same book, Chapter 1 - *Blockchanging Trust: Ethical Metamorphosis in Business & Healthcare*), BT will make-or-break democracy (see Chapter 4 - *Blockchanging Politics: Opening a Trustworthy But Hazardous Reforming Era*), offering a civilizational opportunity to nurture community ecosystems by equipping multidimensional financial incentives systems with *qualified money* (Helbing, 2014). A liberal scenario of decentralized markets will be introduced where a new breed of socio-financial incentives will be the *economic media hyperlink* to Friedrich Hayek's premonitory vision of private currencies backed by free competition (Hayek, 1976).

BACKGROUND

The Essence of Money

According to economic books, money fulfills three core functions, performing as (i) a medium of exchange, intermediating trade by paying for goods and services; (ii) a reserve of value, maintaining its value to be reliable spent later; (iii) a unit of account, measuring value and setting the price of goods, services, assets, and liabilities (Monroe, 1923; Ingham, 2013; Mattke et al., 2020).

Supposedly, trading without using a medium of exchange would always demand business parties' compatible desires since barter always requires coincidental interests. However, as will be seen below, this presumed inevitability is truly a misconception, which is crucial to correct in the dawn of the *blockchain era*.

It is thought that is useful drawing a parallel between digital money and social media, the two modern types of *economic media* (Beller, 2020). Social media comes from a long time ago. As stated by Hurlburt & Voas (2011), "our walls are just more likely to be on Facebook than deep inside caves" (p. 11). In a certain sense, cave painting constituted prehistoric *posts*, and cave walls of human ancestors were the social media *murals* possible to edit and program with the technology then available (Safko, 2010). Therefore, for thousands of years, an economic *value-of-use* (see Key Terms and Definitions) is being created and signalled by attention and reputation raised in social media. Firstly, through physical and handcrafted work, then industrialized, and finally digitalized, an increasing network effect enhanced this economic media (Beller, 2020).

Money is the main economic media, and while "likes and retweets are a form of "voting" but are not optimal [because] there is no scarcity of likes and therefore no real value beyond signaling" (Martinelli, 2017, p. 4), digital money is a new breed of valuable economic media.

Several authors trace money's path from ancient times (Szabo, 2002; Zelmanovitz, 2011; Martin, 2013; Lannoye, 2020). As in the social media case, it may be useful to observe this economic media's past. In the article "Banking on Stone Money: Ancient Antecedents to Bitcoin," published in the field of economic anthropology, Fitzpatrick & McKeon (2019) compare the *stone money* system of the small islands of Yap, in Micronesia, which has been studied for many decades (Furness, 1910; de Beauclair, 1963, 1971; Friedman, 1991; Fitzpatrick, 2004), with the modern financial sector given similarities between such *stone money* and cryptocurrencies. As stated by Fitzpatrick & McKeon (2020), "stone money was a conceptual precursor to Nakamoto's Bitcoin white paper, which introduced a modern invention to solve similar societal problems." (p. 13).

Yap Islands' *stone money* consisted of stone discs, many with several tons, called *fei* or *rai* (the name *rai* was used in the northern part of Yap, and *fei* in the southern part). This *stone money* was not easy to transport, and it certainly would not have been a smart choice to move around as a medium of exchange (Martin, 2013).

Regardless of transactions and money transfers that took place, the physical transportation of *fei* from one owner's home to another was infrequent, as the debts incurred were typically only offset with the expectation of further exchanges later on. Albeit the character of *stone money* was strictly symbolic, when it was associated with the Yap's natives' *oral ledger*, either the *stone money'* value and changes in its ownership could be tracked, and trade went fine on the Yap Islands. As stated by Furness (1910), "after concluding a bargain which involves the price of a "fei" too large to be conveniently moved [some of these "coins" weighed several tons], its new owner is quite content to accept the bare acknowledgment of ownership and without so much as a mark to indicate the exchange, the coin remains undisturbed on the former owner's premises." (p. 96.).

Yap's *stone money* may seem just anecdotal, but prominent economists like John Maynard Keynes and Milton Friedman thought it would be more than that. These two brilliant minds recognized that Yap's monetary system could hold an essential and universal lesson that defied conventional money theory. Keynes would state the following about what was written, in 1910, by the American anthropologist, William Henry Furness III, in a book describing his travels to Borneo and the Yap Islands (located where are today the Federated States of Micronesia):

[Furness' book] has brought us into contact with a people whose ideas on currency are probably more truly philosophical than those of any other country. Modern practice in regard to gold reserves has a good deal to learn from the more logical practices of the island of Yap. (Keynes, 1915, p. 281)

As it was referred, Keynes was not the only worthy of twentieth-century economics to exalt Yap's inhabitants for their clear understanding of the nature of money (Martin, 2013). Also, Friedman (1991) praised the people of the Yap Islands' discernment, saying that they have escaped the conventional obsession with money-merchandise and recognized that money is not a commodity but a system of credit and clearing. So, the basic assumption that money has evolved primarily as a medium of exchange (the intuitive idea that money emerged out of barter) must be questioned. Pointing out that Keynes and Friedman reverberated Yap's money, Martin (2013) referred that "to win the praise of one of the two greatest monetary economists of the twentieth century may be regarded as chance; to win the praise of both deserves attention…" (p. 14).

This same author also stated that "seek as they might, not a single researcher was able to find a society, historical or contemporary, that regularly conducted its trade by barter." (p. 14). As told by the American scholar George Dalton, in 1982, "Barter, in the strict sense of moneyless market exchange, has never been a quantitatively important or dominant mode of transaction in any past or present economic system about which we have hard information" (p. 183).

Also, the Cambridge anthropologist Caroline Humphrey concludes that "no example of a barter economy, pure and simple, has ever been described, let alone the emergence from it of money; all available ethnography suggests that there has never been such a thing" (Humphrey, 1985).

If one villager needed a pig for a feast, he may be able to obtain it from another villager for four clay pots, or a different villager for ten pairs of shoes. Constantly making mental calculations to determine

the best value for a pig, or whatever else you are trying to acquire, is time consuming, thus, money is "born." The problem with this story is that it is simply not true. In reality, these villagers know one another, and rather than exchange ten pairs of shoes for one pig, the villager who provides the pig simply takes note of the contribution and that his fellow villager owes him something of comparable value. This is the same thing as credit, and the archaeological record reveals that credit systems of this sort preceded the invention of coinage by thousands of years. (Reiners, 2020, p.2)

Hence, it is considered appropriate to ask the following question: if the *stone money* from the Yap Islands were not a medium of exchange, how did it work well as being money for so many years? What is the secret so that the physical movement, from person to person, of the specific thing considered to be the money has proved irrelevant? The answer is that money itself is not a specific thing or object with intrinsic value, but rather it is an underlying system of credit and clearing accounts that these objects help represent and keep in track. The stone disks were just tokens portraying how the entire accounting record was kept in place at any given moment. Yap's oral ledger was the real money, *i.e*., the credit accounts' system and their clearing that currency represents (Martin, 2013).

Thinking of money as a *thing* or commodity whose *intrinsic value* constitutes the incentive to exchange goods and services by such a thing (currency) could be intuitive when coins were minted in precious metals or money was backed by gold. However, this is no longer the case, and today should be easier to understand that fiduciary currencies or *fiat money* (see Key Terms and Definitions) are just symbols or tokens. Additionally, since the last century, most currencies exist in an electronic version, obviously being intangible and without *intrinsic* value, and the physical version of these coins is a minority (Prinzs, 1999). Moreover, some authors think that *fiat currencies* soon will cease to have a physical format (Quian, 2019; Bindseil, 2019).

A dollar, whether under a Gold Standard or not, is something that would be intimately familiar to the faceless bureaucrats of the International Bureau of Weights and Measures: it is a unit of measurement—an arbitrary increment on an abstract scale. So, like a metre or a kilogram, a dollar itself doesn't refer to any physical thing at all—even if the length or mass or value of some particular physical thing has been agreed on as its standard. (Martin, 2013, p. 51)

As Keynes and Friedman soon understood, Yap's economic and financial worldview considered *stone money* as tokens of an underlying credit relationship, being the former nothing more than a way of representing the latter. The sound money was the oral ledger.

The weighty argument provided by the heavy *stone-money* of the Yap Islands, praised by no less weighty figures of the economic thought, perhaps will be able to shake out the idea that *intrinsic value* has to exist and go from hand in hand to make money work as a portable medium of exchange. Even after the gold-standard, the *intrinsic value* false belief helped keep the prerogative of currency-issuing in sovereign hands. However, the source of trust created by blockchain technology (BT) dismantles such wrong allegation with mathematical precision.

The idea of a technology for recording and transferring monetary obligations from one person to another, dispensing central coordination, may appear to be subversive and dangerous to some. After all, the invention of coins in the Kingdom of Lydia, located in what is now the western part of Turkey, nearly three thousand years ago (Weatherford, 2009), ushered in the conversion of traditional social obligations into financial relationships, a giant step in individual emancipation, challenging the previously

undisputed authority of a centralized economy and a historical immutable social hierarchy. However, this enfranchisement process is by no means complete. Today, societies face the historical inevitability (because BT is not neutral) of taking another giant monetary step, and one should be keen this new step would be given towards freedom, for there is a considerable risk of following the opposite direction which entails the risk of a complete loss of privacy, and subsequently the demise of democratic regimes.

Understanding cryptocurrency requires letting go of the notion of money as an incentive system made up of things with intrinsic value. Practicing barter requires an available credit and clearing system, a language with which people can negotiate without intermediaries. In this sense, BT allowed creating a global ledger or *hyperledger* of digital tokens. These tokens are recognized as money; likewise, the natives' *oral ledger* and *stone money* were hundreds of years ago in the Yap Islands. A decentralized money system made it possible to offset obligations without reference to a central authority in both cases. As stated by Fitzpatrick & McKeon (2020), there are striking similarities between bitcoin and the Yap Islands' *stone money*:

The principles by which Blockchains—in oral and digital forms—operate and how Yapese stone money (rai) can be considered analogous to modern cryptocurrencies along several dimensions. In many ways, the process through which these monetary units are created, transacted, and recorded is similar, demonstrating that the concept behind Bitcoin and the underlying blockchain technology have their roots in the ancient past. (Fitzpatrick & McKeon, 2020, p. 13)

Therefore, Yap's *stone money* shows how a small island society crafted an effective system for monitoring asset ownership and trade. In a very similar way, albeit using a digital *hyperledger* instead of an *oral ledger*, information about money' ownership is managed collectively with cryptocurrency, even without their owners physically possess any medium of exchange. Hence, both systems ensure financial transparency and security with no central bank.

Long before the Internet and BT protocols were created, the protocol of money (6th century BC) allowed people to start negotiating with each other something essential to individual freedom: *the offsetting of obligations without reference to a centralized authority* (Martin, 2013). This decentralized negotiability was responsible for the pioneering idea of an objective and lifelong economic space, and probably then the *market* concept was born.

For markets to work, a shared concept of value given by a standardized unit is needed. For the market's sake, it does not matter if there is or not a preconceived collective idea about the value for a product or a service since that value's determination is, itself, the essential market's task. What is required then is just a shared idea on how to measure the market's value. Without such a common language, trade is not possible.

The costliness of information is the key to the cost of transacting, part of the transaction costs in any deal is associated with the gathering of information about the best opportunities for trade. (…) So, a unit of exchange was introduced in order to make transactions easier among barterers by lowering their transaction costs in acquiring information about the relative prices among their respective goods and services. (Zelmanovitz, 2011, p. 76)

Therefore, *money* and *market* are inseparable concepts, in the absence of which ancient people used to depend on a central authority to receive directives on how to act. These two concepts brought the

powerful and emancipatory notion of a new political-economic reality: due to money, traditional social obligations started to be valued on a universal scale and became transferable between individuals.

The great fear associated with violating rules of conduct has always been that the result would be anarchy. This fear is why conserving social order may be at odds with innovation, ambition, entrepreneurship, and social mobility. Hence, the introduction of money into society was undoubtedly disruptive, daring to combine political stability with social mobility:

Money made its miraculous promise to combine apparent opposites on the personal level as well. It catered to two fundamental aspects of human psychology: the desire for freedom and the desire for stability. The ethics of the traditional society had sacrificed the former on the altar of the latter. The new world of monetary society promised both. Money's claim that its new way of organising society would not end in disaster, but would combine the power of social mobility and personal freedom with that of social stability and economic security (Martin, 2013, p.62)

No wonder that the notion of *hyperledger* as a *distributed ledger* replicated on a network of computers that is able to decentralize trust due to a common cryptographic language, will find resistance coming from those who do not want to give up of central power. Understanding that money is an accounting system and that tokens are merely symbolic and not mandatorily made of specific *things* with intrinsic value is crucial to grasp into cryptocurrencies' nature and realize how digital money's intangibility is not by no means a limitation. On the contrary, such intangibility can be a considerable advantage given the desirable characteristics of money (see the next sections).

Distributed Ledger Technologies (DLT), such as BT, are digital versions of Yap Islands' oral ledger (Fitzpatrick & McKeon, 2020). It was that same kind of trust that Yap Islands' natives used as money during centuries, a *distributed trust* that was really the essence of their money. Although natives' network was not digital, Yap's money was based on a trustable collective memory, *i.e*., on the tribal knowledge about the property whereabouts of the conspicuous *stone-money*. Some of the stones were marked upon after transactions, but most changed hands verbally without being moved around. The truth is that Yap Islands' monetary system relied above all upon an oral ledger.

In the Pacific Islands, as in many other societies, "money" developed from locally available, but comparatively rare resources that were assigned value and exchanged, primarily for foodstuffs and other goods. Some common examples of money in the Pacific include thorny oysters (Spondylus sp.) and pearl shells (Pinctada sp.) […] It is important to note that in none of these or other cases in the Pacific did the exchange of shells or other resources evolve into what would strictly be defined as a currency. (…) only in the case of Yapese stone money did an exchange valuable have its ownership recorded orally in a social ledger that allowed possession of an object to be tracked and henceforth "titled" to an individual or group. (Fitzpatrick & McKeon, 2020, p. 5).

Thus, the *stone money* shows that the widespread belief in money's intrinsic value indispensableness is historically false. Nevertheless, several authors are convinced that "Bitcoin has no fundamental value and that sooner or later the market will recognize this fact." (Andolfatto & Spewak, 2019, p.1). Although such causality notion can be intuitive and shared enough (Sanz Bas, 2020), it was soon denied in the Yap Islands where during centuries *stone money* worked just fine (Fitzpatrick & McKeon, 2020) despite being nothing more than bulky rocks with no intrinsic value.

Finally, another essential lesson about cryptocurrencies can be learned by looking at Yap Islands' *stone money*. It is known that several authors do not consider cryptocurrencies as being real currencies (Mittal, 2012; Grant, 2014; Lo, 2017; Passinsky, 2021; Brummer & Yadav, 2018), mainly due to their high volatility, which is usually attributed to the fact that the states and the central banks do not backed them. For example, Andolfatto & Spewak (2019) state that "the price dynamic of an unbacked asset is likely to be highly volatile" (p. 2). However, disproving this belief, it is observed that it was exclusively the difficulty of producing the *stone money* of the Yap Islands that backed its value, and this money has worked for centuries even though its acceptance was exclusively dependent on perceived rarity. The truth is that any authority or other third party never backed the *stone money* of the Yap Islands.

As mentioned by Fitzpatrick & Diveley (2004) about the Yap Islands *stone-money* production process, "This would have required months of planning, extensive labor, and significant energy to complete the process" (p. 133). Later, Fitzpatrick would recognize that the same production difficulty characterizes cryptocurrencies like Bitcoin, with such a guarantee of value working similarly. In his words, "the same [costly production process] could be said of today's digital blockchains, which need tremendous computing power to create and verify new cryptocurrency units along with other ancillary considerations (mathematical and computer programming expertise)" (Fitzpatrick & McKeon, 2020, p. 9). The production difficulty underlying the bitcoin creation process was explained in the first white paper that introduced Bitcoin to the world, where one can read that "the steady addition of a constant amount of new coins is analogous to gold miners expending resources to add gold to circulation. In our case, it is CPU time and electricity that is expended." (Nakamoto, 2008, p. 5)

The Bitcoin protocol limits inflation, and these limits are visible to all market participants. Analogously, supply of new rai [(the stone-money of the Yap Islands)] was also constrained. The constraints were not imposed by a digital protocol but rather by physical means since limestone was not present on Yap. Creating new supply required a trip over open ocean to neighboring Palau and the exertion of manual labor. Additionally, Palauans controlled access to suitable limestone deposits, and a discussion or negotiation was required for new production, further limiting new supply. In a sense, this process is similar to other monetary stores of value throughout history in which there was a constrained stream of supply. (Fitzpatrick & McKeon, 2020, p. 8)

There is little doubt that it was the constraints and difficulties in issuing the Yap Islands 'stone money, prominent determinants of the respective rarity, that were at the origin of the respective perceived value: "[the stone-money] were transported around jagged coral rock islands, through labyrinths of reefs, and over an ocean filled with often unpredictable winds, currents, and swells. (Fitzpatrick, 2004a, p. 23).

It becomes clear that both ancient and modern forms of consensus-based ledgers require immense power to operate. The Yapese version relied on human power to construct boats; sail to Palau; negotiate with Palauan clans or chiefs for access to limestone; carve the rai; construct stone docks, platforms, and other architectural features to facilitate manufacture and movement of stone within and outside of the quarries; and then return home with their [heavy] cargo using some type of watercraft (Fitzpatrick & McKeon, 2020, p. 9).

Therefore, it is necessary to demystify the belief that money will inevitably have to be backed up by the state or any other entity. Although the persistence of such an idea may be convenient for coin issuers,

given the income resulting from *seigniorage costs* (see Key Terms and Definitions), it does not seem to be true, nor in the pre-industrial age at the isolated Yap Islands, nor in the digital age at the global village where everyone lives. Although a seal granted by third parties may be a sufficient condition to classify money as so, it is not anymore, a necessary one. Furthermore, in the *blockchain era*, as it will be seen below, in addition to being unnecessary, this wrong belief can be dangerous for democracy and freedom (see Chapter 4).

Private Money

From what was exposed in the previous section, trust on the correct accounts 'memory (oral or digital) is the basis of money, i.e., *trust* on the more or less distributed ledger that ensures such right balances. In *fiat money* trust is ensured by the issuing entity's credibility, which mainly depends on states' ability to collect taxes. This prerogative is the most significant guarantee of confidence underlying the currencies of sovereign states, and therefore "every such country declares at least one type of fiat money to be legal tender for taxes (and contractual debts)." (Goldberg, 2012, p. 23), as well as a way to ensure that state currencies will always be needed. As stated by Goldberg (2012), "Given that the government collects taxes in any case, it can easily promote any money by merely insisting on accepting only that money. (P. 27).

In the 70s, Friedrich Hayek, winner of the Nobel Prize for Economics (1974), for his work on the monetary theory of the trade cycle (Boettke & Prychitko, 2011), proposed what it would be like to replace confidence in the currency issuer (*e.g.*, the state) by confidence in the currencies' competition process itself. In his view, the market share dispute for competitive currencies supremacy will result in the *mutual supervision* of private currency issuers themselves (Hayek, 1976). According to Hayek, this would be enough for that the "gold standard would re-emerge as a result of the competitive process" (Garrison & Kirzner, 1989).

Hayek considered that an intrinsic guarantee of quality would emanate from the competitive struggle among the various private currencies, which is the case of cryptocurrencies "since they have emerged from a private initiative, not from a state" (Sanz Bas, 2020, p. 19). With more than 5000 private cryptocurrencies competing in the market (Fousekis & Grigoriadis, 2021), it is thought that Hayek's words about private money should be taken into due account. Besides competition, further considerations about private money's confidence should include the fact that cryptocurrencies are issued accordingly to algorithmic rules and advanced encryption techniques. For example, Bitcoin's algorithm defines a maximum number of units which is slightly less than 21 million and can never be exceeded (Nakamoto, 2008).

Thus, one can consider that trust in the issuer is now advantageously replaced by trust in cryptographic math operating in a distributed way. As it will be seen, there are good reasons to anticipate that such *distributed trust* (Bellini et al, 2020) will support an epic shift in money creation prerogatives, which can lead to unprecedented financial democratization (decentralized scenario) or to the end of consumer privacy (centralized scenario). As stated by Birch (2020), "Digital currency is a political issue as much as a technological issue." (p. 10) and it is thought that such a change in the foundation of money will have paramount importance to society's development.

Programmable Money

Programmable money comes in different types. For instance, Central Bank Digital Currency (CBDC) is defined by some authors as "a digital representation of a sovereign currency issued by and as a liability of a jurisdiction's central bank or other monetary authority" (Kiff et al., 2020, p. 9). However, it is thought that CBDC is much more than that, and one should emphasize that such centralized digital money should require "a traceable, transferable and divisible digital currency system that protects user's privacy while enabling the retrieval of user's identity in case of suspicious transactions, e.g., suspicion of fraud or money laundering activities" (Barki & Gouget, 2021).

CBDC is not the only programmable money let alone the first. Cryptocurrencies are tradable peer-to-peer (P2P), eliminating the constraints associated with centralization and intermediation, taking advantage of the positive network effects of a structured decentralization. Thus, they can benefit from the cross-pollination, creativity, and intelligence of civil society, including, of course, all qualified programmers in different ecosystems and communities of interest on a planetary scale.

Cryptocurrency is a virtual currency that is used as an alternative currency that the currency is produced and traded through a cryptographic process. The most of the cryptocurrency is decentralized in computer-based networks and is based on peer-to-peer technology and open source cryptography that does not depend on central authorities such as central banks or other administrative institutions. (Adiyatma & Maharani, 2020, p. 71)

It is judged that non-programmable money is outdated and has to go. "Denmark, for example, has adopted legislation that calls for a cashless economy within five years" (Turi, 2020). Nevertheless, the departure of traditional money can both be good or bad news. As it will be seen, even though there is a severe risk of dealing with new centralized money that compromises privacy and freedom, society also has the chance to create a much better version of money. As stated by Helbing (2014):

Currently, money is a scalar, i.e., the simplest mathematical quantity one can think of. It is neither multidimensional nor does it have a memory. But mathematics offers a much richer spectrum of concepts to define exchange processes, such as vectors, i.e., multidimensional quantities, and network graphs. In fact, money comes from somewhere and goes somewhere else. Who transfers money to whom defines a network of money flows. Therefore, money should be represented by network quantities. And money should be multidimensional to allow other things to happen apart from the eternal ups and downs. (p. 3)

Money that comes from somewhere and goes somewhere else is not fungible because it is traceable and has an identity. In fact, "fungibility and anonymity are effectively synonymous" (Berg, 2020, p. 11). So, defending privacy rights in a blockchain world requires balancing transparency and anonymity, and one can agree with Helbing (2014) when he says that money should be multi-dimensional and have a memory for creating the right balance between transparency and anonymity. In his words, "Such money could earn reputation and, with this, additional value!" (p. 3). Therefore, it can be supposed that non-fungibility will allow money's programmable reputation to contribute to an ethical monetary system's faithful balance.

Central banks basically only can print more money and change the interest rate, as banks control the custodian game and governments control banks (Ammous, 2018). However, this is not enough because more control variables are needed, like in any ecosystem.

This problem [of few control variables] is actually well-known from control theory. (…) It is also instructive to compare this with ecosystems. The plant and animal life in a place will not just be determined by a single control variable such as the amount of water, but also by the temperature, humidity, and various kinds of nutrients such as oxygen, nitrogen, phosphor, etc. Our bodies, too, require many kinds of vitamins and nutrients to be healthy. So, why should our economic system be different? Why shouldn't a healthy financial system need several kinds of money? (Helbing, 2014, p. 7)

Since programmable money is here to stay, it is advisable to examine how society reached this point-of-no-return. Once gone digital, money will never go back to a one-dimensional mindless form again, and this is why present stakes are high in the author's perspective.

The two modern economic media, *social media* and *digital money* (Beller, 2020) can be affected by Internet protocols. The 2020 United States Presidential Election dramatic events have shown a pungent example of how disruptive social media and data centralization can be. Social networks are selling the influence that they indeed have over their users on the *Internet of Information*, and it is considered that Washington D.C. riots were largely induced by algorithms "that are telling lies" (O'Neill, 2017. p .7), exacerbating opinions and polarizing society to better segment users and feed rapacious business models.

If the dramatic and violent attempts to take over the Capitol building in Washington DC in January 2021 amount to a historically significant or crucial 'event', much of the subsequent attempts at analysis, explanation, and public debate have focused heavily on the role and influence of the contemporary media system, social media in particular. Fingers were quickly and consistently pointed at social media platforms, such as Twitter and Facebook (…) were widely blamed for "polarising political opinion, normalising extremism and mobilising violent protest (Thornhill, 2021).

It is thought that things can even worse. The Internet of Value (Twesige, 2015) globally distributes the next level of trust, the distributed trust created by BT, which can be a good thing or damaging privacy even harder than has happened so far on the Internet.

It is thought that Blockchain Technology is a game changer that allows the emergence of an Internet of Value by making the digital integration of two very different levels of confidence a reality. The first level is necessary to deal with information and to share its value, but it is not enough to deal with transactions which demand a second level of trust. (De Oliveira Rodrigues, 2021, p. 46)

This time there is a severe risk that the main economic media will serve the political agenda with a never seen granularity, turning corporate or state-sponsored digital currencies into powerful instruments to conditioning citizens' political opinions.

China was the first country to launch a CBDC, the *Digital Yuan*. It is not unreasonable to notice that this is a nation with "normative power and global governance reform aspirations" (Breslin, 2021). One should notice that this digital currency is a second programmable economic media whose semiotic value can be cross-referenced with the first one: social media (*e.g.*, WeChat). Such data matching is now being

done in China. Thus, it is thought that Digital Yuan can be simultaneously a currency and an influential political vector, coming from a high-tech central bank sponsored by the most potent authoritarian regime worldwide. Of course, this is not good news when decentralization of finance and cryptocurrencies' free competition is highly recommended to preserve freedom and democracy (Antonopoulos, 2017; Harrison, 2018; Jain, 2020).

Observers have criticised China's social credit scoring system. Called "Sesame Credit," it's billed as mostly a credit score, but it may also function as a way of keeping tabs on an individual's political opinions [(for instance on the WeChat social network)], and for that matter as a way of nudging people towards compliance. (O'Neill, 2017)

Blockchain technology (BT) represents a historical milestone and a crucial crossroads to humankind. BT's *hyperledger* has a social structuring role digital emulation of the *oral ledger* who backed the Yap Islands' natives' stone money for centuries, whose confidence is now digitally extended to the *global village*. Once again, *the medium is the message*, and artifacts as media will affect society by their characteristics or content (McLuhan & McLuhan, 1994). Digitally orchestrated this time, if data centralization prevails, dark times for freedom of thought may be repeated:

In the Soviet communist bloc, and other sectors where state-controlled broadcasting prevailed, systems of broadcasting were intended to reproduce the dominant national culture or state ideology, while serving as instruments of social integration and conformity. (Kellner & Durham, 2001, p. xix)

On the contrary, a very different political-economic history will be written in the following years if decentralization prevails. Thanks to BT, the decentralized requirements underlying the uncensored and non-corruptible transactions on the Yap Islands can now be globally fulfilled over the Internet. A *hyperledger* based on *distributed trust* has just arrived in the Internet's *global village* (McLuhan & Powers, 1989), whose inhabitants can now speak to each other a dealing language, and not just a chat one.

The unusual monetary granularity, provided by the blockchain protocol, together with the seamless integration of the production factors *labor* and *capital* in the same unit of value, which is a cryptocurrency, is paving the way for incorporating in money other values besides *trade value* (Helbing, 2014), a fact that is thought to constitute a notable landmark in the evolution of money itself (Antonopoulos, 2016).

Programmable money allows a much more fine-grained control of a monetary system: token supply can be capped or non-capped leading to deflationary or inflationary currency; tokens can be destroyed ("burnt") and removed from the supply; demurrage, expiration, and many more characteristics can be made inherent properties of a token. However, as these possibilities did not exist before, it is hard to predict the potential of large-scale, bottom-up, open cryptocurrency systems, that are democratically governed and accessible to anyone. (Dapp, 2019)

Programmable money should cause considerable disruption at the political-economic level (Eikmanns, 2019). If threats to privacy and freedom are overcome, it is believed that digital money will create a myriad of opportunities for innovation that can be seized by civil society.

Digital currencies are more competitive than traditional ones, allowing individuals and organizations, including *decentralized autonomous organizations* (DAOs), to make self-executing contracts or *smart*

contracts (see next section and Key Terms and Definitions), decisively reducing transaction costs and streamlining transactions by diminishing uncertainty and increasing confidence in business.

In 1937, Ronald Coase (Economics Nobel Prize, 1991), in a remarkable statement, said that companies are formed to reduce transaction costs (Coase, 1937). Today, it is known that business competitiveness is determined by the ability to do so, and this is precisely what cryptocurrency and *smart contracts* are expected to deliver. Thus, probably these new monetary and contractual instruments will become the preferred way for making deals and bindings agreements considering their decisive advantages, namely:

- Efficiency: they are fast and low cost.
- Trust: they are safe and accurate.

Blockchain adoption will increase the scale of economic activity coordinated through *distributed trust*, and *smart contracts* will create what can be considered a more polycentric economic order (Aligica & Tarko, 2012), further away from the single thought regimes, and governments coordination and oriented in a market perspective. As referred by Aligica and Tarco (2012), "[the market] should be seen as a polycentric system involving a web of many agents that constantly adjust their behavior to the decisions made by others. [In turn,] socialism implies the transformation of the system into a monocentric one." (p. 238). Therefore, the *crypto-economy* is oriented towards the diversity of thought of economic agents and probably will "unfold as a process of disintermediation and dehierarchicalisation." (Berg, 2018, p. 9).

As mentioned above, the acceptance or liquidity of Yap Islands money was never due to the intrinsic value or portability of such stones, which were, in fact, giant and heavy. Nevertheless, such *stone money* worked well for centuries as a medium of exchange, thanks to Yap's oral ledger ability to register the collective memory of natives' financial movements. Of course, an *oral ledger* has little scalability, and such a monetary system could only function (providing sufficient liquidity to their users) in a limited geographical scope, as was the case of such then isolated Pacific Ocean islands. Thus, as time went by and after some entangled adventures regarding the English crown's difficulties to tax the Yap's natives (Furness, 1910), the stone money was naturally replaced by more available money. Therefore, the Yap Islands' official money (nowadays is the dollar) success never had anything to do with a supposed intrinsic value but with factors that increased its liquidity or "salability."

It is important to note that media of exchange do not become money because of their direct utility (consumption) but rather because of their salability (liquidity). Many goods served as money until they were demonetized because a new more salable and less costly (to transact) money emerged. (Thagapsov & Kozlovskiy, 2020).

Like most economists, businessmen, and academics, David Yermack, in his article "Is Bitcoin a Real Currency? An Economic Appraisal." referred to "currency functions as a medium of exchange, a store of value, and a unit of account" (2015). These functions determine the functional currency requisites. As stated by Harrison (2018), "while some scholars still maintain that cryptocurrency does not qualify for this categorization, when analyzed in depth, cryptocurrency does satisfy each of these criteria and can therefore be classified as a currency." (p. 1-2)

Money has six attributes: *durability, portability, fungibility, scarcity, divisibility, and recognizability* (Vassiliadis et al., 2017). Cryptocurrency has them all, as shown by pioneer Bitcoin (Thagapsov & Kozlovskiy, 2020).

Today it is conceded that bitcoin possesses the characteristics of money (durability, portability, fungibility, scarcity, divisibility and recognizability) based on the properties of mathematics rather than relying on physical properties (like gold and silver) or trust in central authorities (like fiat currencies) (Vassiliadis, 2017, p. 3)

Indeed, Bitcoin shows outstanding performances regarding several attributes of money, such as *durability* (bits can last forever, which is reassuring), *portability* (data has no weight or physical volume, which is convenient), and *scarcity* (bitcoin units are programmed to be less in number than 21 million, which give it immunity to inflation).

Considering the *divisibility* attribute: each bitcoin unit is programmed to be divisible in one hundred million sub-units called *satoshis* (Bjercke & Finlow-Bates, 2020, p. 1). It is thought that cryptocurrencies that allow straightforward transactions on the Internet-of-Things (IoT), will be a marketing must. The "servitization of consumption" (Wilczak, 2018, p. 298) will rely on *self-servuction interactions* (De Oliveira Rodrigues, 2021, p. 49), which are a digital type of self-service where *prosumers* (see Key Terms and Definitions) participate in the *servuction process* (Eiglier & Langeard, 1987) by giving intellectual inputs which can be integrated into atomized transactions thanks to BT. Hence, cryptocurrencies' micropayment features will eventually be highly marketable. Using products *as-a-service* instead of owning them, consumers' behavior will form a *pay as you go* and *pay only for what you use* consumption pattern (Perera et al., 2014). These patterns should translate into consumers' preference for highly fragmented cryptocurrencies tailored to make micropayments on the IoT (Tennant, 2017), as is the case of the IOTA cryptocurrency (www.iota.org).

Crypto will form the foundation of a new micro-subscription economy, with our wallets constantly feeding a vast and shifting array of goods and services and media.[...] You'll top off a wallet and fractions of a cent will flow out of it over time to watch various videos or play games or rent an app. The payments will be so small that you won't really pay attention to them, until you login to your dashboard to see what you spent. (Jeffries, 2021)

As for Bitcoin's *recognizability* attribute, it seems to be a work in progress. Companies, entrepreneurs, and public figures like Elon Musk and Mark Cuban accept *crypto payments* for their products and services, namely Bitcoin and other cryptocurrencies. In May 2021, Elon Musk showed his preference for Dogecoin. "Launched in December 2015, Dogecoin started as a joke" (Ghaiti, 2021) but was later accepted to buy goods as valuable as luxury real estate (McIntosh, 2021; Jha, 2021; Mack, 2021). Thus, it is not too risky to say that cryptocurrencies will enter the financial mainstream, perhaps sooner than expected, if there is no political repression, which is not sure, of course. After all, as mentioned above, "Digital currency is a political issue as much as a technological issue." (Birch, 2020, p. 10).

Finally, regarding *fungibility*, two supposed paradoxical aspects must be considered. On the one hand, BT allows avoiding cryptocurrencies' *double-spending* (Nakamoto, 2008). On the other hand, unlike conventional currencies, different cryptocurrency units may look equal but, after all, be unique. For example, each traded bitcoin unit or sub-unit carries the history of its previous transactions and has its own identity (Möser et al., 2014). Thus, Bitcoin and many other cryptocurrencies are not fungible because they are traceable, which can be an advantage in fighting crime.

The cryptocurrency Bitcoin is an example of a pseudo anonymous currency, where encrypted accounts can theoretically be traced back to their successive owners while remaining anonymous for everyday practical purposes. Value can thus be held and exchanged in cryptocurrencies without public disclosure of personal identity (Dierksmeier & Seele, 2018, p. 2).

The fact that digital currencies are programmable allows to assign them with specific properties, which can be translated into an unusual convenience and granularity, hopefully serving to catalyze innovation and encourage entrepreneurship. Despite its increased convenience in terms of liquidity and privacy, which are reminiscent of anonymous living cash characteristics, some authors think that bitcoin features will give rise to fraud and crimes over the Internet, such as money laundering and tax evasion (Kethineni & Cao, 2020).

However, unlike traditional cash, cryptocurrencies are not all the same, and their traceability facilitates the criminal investigation. Nothing can be altered or deleted from a blockchain, as the records inserted in it are immutable (Nakamoto, 2008). It is crucial to understand this reality because the alternative to cryptocurrencies is centralized digital money, programmed in closed source code. Misrepresenting Bitcoin with the antithetic and surreptitious ideas of insecurity and opacity is gaining strength by feeding itself on people's fears, which can be good for the *status quo* but very dangerous for freedom and democracy.

Our freedom of choice in a competitive society rests on the fact that, if one person refuses to satisfy our wishes, we can turn to another. But if we face a monopolist we are at his absolute mercy. And an authority directing the whole economic system of the country would be the most powerful monopolist conceivable… it would have complete power to decide what we are to be given and on what terms. It would not only decide what commodities and services were to be available and in what quantities; it would be able to direct their distributions between persons to any degree it liked. (Hayek, 1944)

Bitcoins are not alike. Each transaction is a descendant of a unique transaction history, which is readily available in the public block chain. Therefore, markets participants can, in principle, scrutinize the history and become selective in which transactions they accept; or, with more granularity, how much they value it (Möser et al., 2014)

Bitcoin is based on a *public-permissionless* blockchain (see Chapter 4), which means that any technically savvy person or entity can verify how its protocol is encoded and securely access its transaction features by using private cryptographic keys. Thus, Bitcoin transactions can be openly carried out, safely and reliably, directly between individuals, without the intervention of banks or other intermediaries, which has been happening since 2009 with Bitcoin price climbing considerably, although showing high volatility (Jain, 2020).

Bitcoin's non-inflationary protocol makes it immune to hyperinflation (Nakamoto, 2008). Friedrich Hayek argued that states will always have tremendous difficulty maintaining *fiat* currencies' purchasing power in the long run. Therefore, it is not difficult to imagine what he would think about nowadays risks of uncontrolled inflation since the Federal Reserve's printing orders for dollars, in 2021, have an increase of more than 35% to the year 2020, from 7.6 billion notes to 9.6 billion notes. (Federal Reserve System, 2020).

Adding up to the seigniorage costs inconvenience (Buiter, 2007), Hayek revealed his disbelief regarding the ability of governments to control inflation due to the continued temptation to manipulate the

currency to please interest groups or achieve political-economic objectives (Hayek, 1976). His thought on the matter is evident, as quoted by Ametrano (2016): "I do not think it an exaggeration to say that history is largely a history of inflation, and usually of inflations engineered by governments and for the gain of governments." (p. 7)

Seigniorage refers historically, in a world with commodity money, to the difference between the face value of a coin and its costs of production and mintage. In fiat money economies, the difference between the face value of a currency note and its marginal printing cost are almost equal to the face value of the note – marginal printing costs are effectively zero. Printing fiat money is therefore a highly profitable activity – one that has been jealously regulated and often monopolized by the state (Buiter, 2007)

During the XX century, and particularly after World War II, the international community grew from a few dozens to over 200 independent territories and countries, most of which started printing their own money. The incredible growth of central banking and the extensive use of fiat money resulted in many terrible episodes of high inflation and outright hyperinflation. (…) We sometimes forget that central banking, as we know it today, is, in fact, largely an invention of the past hundred years or so, even though a few central banks can trace their ancestry back to the early nineteenth century or before. It is a sobering fact that the prominence of central banks in this century has coincided with a general tendency towards more inflation, not less. (Cordeiro, 2003, p. 110)

Ultimately there is a finite number of Bitcoins that can ever exist. Avoiding inflation through an algorithmic limitation established by consensus between thousands of people is something new in the political and financial world, and, in these times of *fiat money*, it eventually constitutes one of the reasons behind Bitcoin´s value appreciation.

Hyperinflations have never occurred when a commodity served as money or when paper money was convertible into a commodity. The curse of hyperinflation has only reared its ugly head when the supply of money had no natural constraints and was governed by a discretionary paper money standard. (Hanke & Kwok, 2009, p. 353)

I would say, we cannot take it for granted that the current financial system will still work in 10 or 20 years from now. Most industrial states have debts of the order of 100 to 200 percent of the gross domestic product (GDP), sometimes even a multiple of this. Controlled inflation has been considered to be a recipe to reduce these debts. The trick can work, if applied by a single country or just a few ones. However, if the USA, Europe, Japan, and further countries are all trying to reduce their debts in such a way at the same time, this may trigger an inflationary spiral that can get out of hand. (Helbing, 2014, p. 5)

A fundamental aspect of cryptocurrencies is the nature of the mechanism that controls its offer, namely the automatic, transparent, and rigorous process of applying the algorithms that regulate each cryptocurrency's existing quantity. This aspect constitutes a precious asset, obviating the need to trust the issuing entity (that is why the expression "trustless" is used to suggest the lack of need for third-party verification). Thus, even though cryptocurrency has no *intrinsic value* in the tangible and conventional sense of the term, it can be recognized, in a pragmatic way, that the referred mathematical trust can be

understood as a valuable attribute of them. The only relevant intrinsic value is that of trust, in this case, that of *distributed trust*.

One should remember the Yap Islands' people discernment, who decentralized its financial system, recognizing and proving, during centuries, that money is not something with intrinsic value but a system of credit and clearing. The algorithm responsible for trusting such a system did not have the BT's mathematical accuracy, which relied on the collective tribal memory and the good word of the Yap's natives. Nowadays, thanks to BT, credit and clearing systems can be globally decentralized. Not only can digital money be programmed to be immune to inflation (let alone hyperinflation), as it is also possible to mint digital tokens and cryptocurrencies as multidimensional incentives that integrate both *labor* and *capital* in their toolbox. Hopefully, it will be possible to use the conspicuous market *visible hand* acknowledging sustainable innovation and ethical entrepreneurship to induce collective action, as seen in the following sections.

Tokens, Smart Contracts, and Decentralized Autonomous Organizations

Blockchain Technology (BT) allows the creation of cryptocurrencies and other digital tokens.

Just as some protocols or languages are communication standards on the Internet (*e.g.*, HTTP) and other protocols are standards for formatting digital content (*e.g.*, JPEG), the blockchain protocol allows the creation of transaction standards to store and deal with data safely.

Unlike most of the Internet's data, which are mere copies (the "copy-paste" digital function replicates data with a neglectable marginal cost), blockchain encrypted data keep its originality. Therefore, such data can be directly traded on the Internet rather than merely shared. This feature can be a reality today because BT's encryption method guarantees data authenticity, immutability, and confidentiality (Nakamoto, 2008). Thus, it has become doable to use the Internet to store and transfer digital assets without third party intervention.

A token is not a financial asset but rather a digital good (Shin et al., 2019). There are multiple token formats (Lipusch et al., 2019). For instance, the Swiss Financial Market Supervisory Authority (FINMA) established the following token classes:

Payment tokens (synonymous with cryptocurrencies) are tokens which are intended to be used, now or in the future, as a means of payment for acquiring goods or services or as a means of money or value transfer. Cryptocurrencies give rise to no claims on their issuer. Utility tokens are tokens which are intended to provide access digitally to an application or service by means of a blockchain-based infrastructure. Asset tokens represent assets such as a debt or equity claim on the issuer. Asset tokens promise, for example, a share in future company earnings or future capital flows. In terms of their economic function, therefore, these tokens are analogous to equities, bonds or derivatives. Tokens which enable physical assets to be traded on the blockchain also fall into this category. (Mueller et al., 2018, p. 16)

FINMA points out that the individual token classifications are not mutually exclusive and that hybrid tokens are possible, which leads to legal uncertainty in practice.

It is essential to understand that digital tokens only exist conceptually as entries in a ledger, the blockchain *hyperledger*. In other words, an individual has a *token* because he or she has a key that allows the creation of a new entry in the ledger, reassigning ownership of that token to another person. Thus,

having a certain amount of tokens is not having them stored on a computer but knowing the keys that reassign ownership of that same number of tokens (Lewis, 2015).

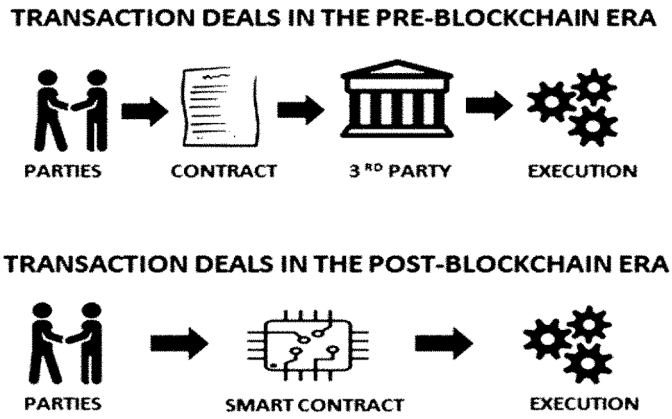
Some several standards or protocols determine programming logic for tokenizing digital assets. For example, the ERC-20 standard, created in 2014 (Buterin, 2014), makes it possible to ensure that tokens are fungible. The Merriam-Webster dictionary defines fungible as "of such a kind or nature that one specimen or part may be used in place of another specimen or equal part in the satisfaction of an obligation; or capable of mutual substitution." In other words, the ERC-20 standard guarantees that tokens have properties that make them equal one to another in terms of their type and value, thus making them replaceable (the same number of tokens of a given type) will always have the same value. As stated by Perez (2018), "a token is "a unit of value (…) a specific amount [or number] of digital resources which you control and can reassign control of to someone else".

There is also a standard to endow tokens with properties that allow representing non-fungible assets. These are the Non-Fungible Tokens (NFTs), which are one of a kind, like a signature, and can be used to represent *virtual memorabilia*, which are virtual objects that can be made unique by "a class of tokens introduced in late 2017 with the ERC-721 standard" (Regner et al., 2019, p. 4). This standardization is a way to turn originals (*e.g.*, paintings) into collectibles, capturing the art of the moment by catching past events to owning them in marketable formats. So, tokens can represent a wide range of digitalized assets and play many essential roles in *crypto-economics* (see Key Terms and Definitions). Its market value "depends on the value of the underlying assets and services they represent [and] can be transferred easily among users or traded for other cryptocurrencies such as Bitcoin and Ether" (Chen, 2018, p. 569).

Besides empowering digital currencies, blockchain technology has given innovators the capability of creating digital tokens to represent scarce assets, potentially reshaping the landscape of entrepreneurship and innovation. Blockchain tokens may democratize entrepreneurship by giving entrepreneurs new ways to raise funds and engage stakeholders, and innovation by giving innovators a new way to develop, deploy, and diffuse decentralized applications. BT and tokens have sparked a new wave of innovation, which may start to revolutionize entrepreneurship and innovation. (Chen, 2018, p. 567)

Tokens have the particularity of performing both the functions they are programmed to and being a financing platform to quantify the participants' commitment to new projects. Such fund-raising operations are called Internet Coin Offering (ICO). Besides being a global crowdfunding financial instrument, ICOs are a new way of engaging early stakeholders in building an ecosystem (Massey et al., 2017). Therefore, tokens "reshape the landscape of entrepreneurship [and] allow innovators to build developer communities." (Chen, 2018, p. 573). It is undisputed that cryptocurrencies and other tokens represent a different breed of value (a programmable one) and, as stated by Mueller et al. (2018), "tokens are qualified for decentralized, open-sourced and community-based projects, which do not need a centralized issuer" (p. 17). As stated by Muzzy (2018), "as all tokens of a particular blockchain are created equal, multiple transactions can occur rapidly and instantly without the participants worrying if the tokens all store the same value." It is this mathematical certainty that makes tokens the critical element to set self-executing contracts. Without the tokens, the so-called *smart contracts* would not be possible. The expression *smart contract* was invented in the 1990s by Nick Szabo, a US lawyer, and computer scientist. He defined *smart contract* as "a set of promises, specified in digital form, including protocols within which the parties perform on other promises" (Szabo, 1997). Smart contracts enforce the computer code they have been programmed for (Jaccard, 2018).

Figure 1. Using "smart contracts" to make efficient and trustable deals.



As stated by Dwyer (2017), "If Bitcoin tries to obviate central institutions for the management of money, the smart contract works to obviate the institution of law, [because] much of the work required to implement, observe, verify and enforce contracts between parties might be delegated to cryptographic protocols." (p. 15) (see Figure 1).

The first and most popular blockchain protocol that supports a *Turing complete* scripting languages is Ethereum (Buterin, 2014). A blockchain is characterized as *Turing complete* if it can perform any computation. Ethereum, which is a *public-permissionless* blockchain, uses a language that is "Turing complete" (Wood, 2014), allowing any user to create and deploy programs on its shared global infrastructure Today, a vibrant community has evolved, running many pieces of software code (*smart contracts*) on the Ethereum blockchain (Regner et al., 2019, p. 3).

Smart contracts are event-driven computer programs running on the public ledger. [They] can handle and transfer assets of considerable value. (…) Specifically, smart contracts are some scripts or codes that are deployed in blockchain. Once the predefined conditions are activated, the scripts on the contract content could be executed without the help of an external trusted authority. The entire process is automated, and the executed transactions are recorded in the public ledge for auditing (Liu et al., 2018, p. 2).

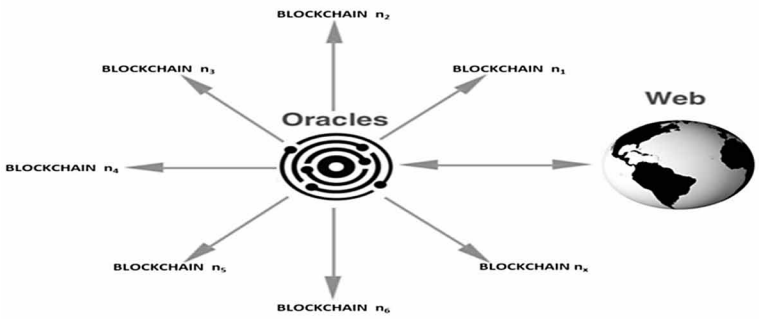
According to the consensus mechanism established in a *smart contract*, prescribed programming codes are executed *on-chain*, *i.e.*, the correspondent transactions occur on a blockchain whenever such smart contract's mathematical conditions are met:

[Smart-contracts] implement forward-chaining operational semantics for Condition-Action rules where changing conditions trigger update actions, like IF/THEN/ELSE (derivative reasoning), IF/DO (production rules), ON/DO (trigger rules), ON/IF/DO (Event-Condition-Action or ECA) or a variation of ON/IF/DO and IF/THEN (Knowledge Representation). (Kruijff & Weigand, 2018, p. 152)

The accuracy and security of *smart-contracts* depend on external data (*off-chain*), which acts as inputs that change the *hyperledger* by executing blockchain state transitions (*on-chain*). These data feeds

are provided by the so-called *validation oracles* (Xu et al., 2016). Thus, oracle systems constitute a link between blockchain's data and external data resources (see Figure 2).

Figure 2. Oracles: bridging blockchains and the outside world



As stated by Heiss et al. (2019), "oracles are middleware systems situated at the edge of the blockchain that intermediate between smart contracts and external systems." (p. 497). *Oracles* provide *smart contracts* with external information. They serve as bridges between blockchains and the outside world. As stated by Beniiche (2020), "the data transmitted by oracles come in many forms, *e.g.*, information, the successful completion of a payment, [digital asset prices, exchange rates, real-time flight information] or the temperature measured by a sensor." (p. 606).

Smart contracts are executed in code that no party controls or can shut down (Nakamura et al., 2020), opening a whole new range of possibilities for defining and engaging stakeholders around innovative projects and building decentralized applications to create value. The ecosystems thus created are called *decentralized autonomous organizations* (DAO), a new kind of electronic communities (see figure 3) that smart contracts cast together (Norta, 2016). As stated by Wang et al. (2019), DAOs are organizations whose management rules are typically encoded on blockchain in the form of smart contracts and can autonomously operate without centralized control or third-party intervention.

A DAO is nothing more than a series of smart contracts to which all participants choose to refer, locking some of their resources and letting the code enforce the rules they have collectively formulated. These organizations can be programmed to spend common funds, modify their own algorithms (i.e., intervention patterns), claim rights, activate machines and devices, enhance/restrict the abilities of some members' accounts, let in/kick out some members; the input would be the fulfillment of some pre-set conditions, probably with the aid of IoT applications. […] In a DAOs, law is replaced with digital contractual relations […] any action that is reducible to algorithmic relations (if x happens, then y happens) regarding registered data can be organized with no third parties, as a matter of principle. (Martinelli, 2017, pp. 3, 5).

Through polls carried out with their tokens, the DAO's constituents can trigger update actions and automatically configure management acts, carrying out events such as hiring staff, making payments, or adjudicating a work, among many other possibilities. One should note that these actions also reach the physical world, being able to trigger actions as mundane as locking or unlocking a door depending on

whether a property's rent is paid or not, as well as connecting equipment or preventing a vehicle from starting its march if its driver delays the payment of the respective lease (Reisenwitz, 2014).

The Internet of Things (IoT) will lead people to live surrounded by intelligent digital artifacts (Lindley et al., 2019), and it is believed that BT's cost reduction will be decisive for optimizing transactions related to the data that will be collected and issued by such ubiquitous artifacts. Hence, it is thought that most of the data will be processed on blockchain networks. After all, these networks have the tremendous competitive advantage of sharing information and allowing straighforward trade with low transaction costs and without intermediaries. Enabled by BT, DAOs can run themselves alone under the control of code rules and business decisions, determining their execution regardless of human involvement. (see Figure 3).

Figure 3. Decentralized autonomous organizations
(Adapted from [Yablonskaya, 2018]).

To have a clear explanation of DAOs, see the same book in Chapter 5 - *The Real Blockchain Game Changer: Protocols and DAOs for Coordinating Work to Provide Goods and Services*.

BLOCKCHAIN ECONOMIC IMPLICATIONS

Crypto-Economy: Upgrading Collective Action

Crypto-economics can be defined as "the optimization of incentive design to evoke social behavior in a decentralized token-based economy" (Hülsemann & Tumasjan, 2019, p. 4). It is thought it is about emancipation, decentralization, and collective action. Thanks to blockchain technology (BT), personal

data and private digital assets will hopefully be dealt with together only when that conjoint operation proved to be advantageous for the individual. Everyone will never lose their *crypto identity*, always retaining its privacy and data ownership privileges (see Chapter 1).

Institutional economics predicts that the adoption of blockchain technology will increase economic activity coordinated through markets and reduce demand for hierarchic organisation, including firms and government. Many sectors of the economy will be disrupted by this growth of markets and networks, with new types of market forms emerging, such as data markets, and more direct P2P exchanges for newly "tokenised" assets and services. (Berg et al., 2018, p. 8)

BT will have profound economic repercussions. However, it is thought that only free competition between private and public cryptocurrencies will conveniently stimulate innovation, aligning individual entrepreneurship with collective interests. Such diversity is fundamental, augmenting the motivational range of monetary incentives and eventually making consumer behavior contribute to community ecosystems' sustainability (Dapp, 2019).

One of the major problems of the current economic system is that it causes systemic sustainability failures called *externalities*. According to Padfield (2019), *externalities* are "a manifestation of a failure to assign property rights, then, when feasible and under certain conditions, assigning property rights would allow for efficient trading." (p. 291). Due to BT's civilizational impact on privacy and ownership trade-offs, c*rypto-economics* brings the possibility of representing and dealing with *externalities* in the market. This *financial chimera* is technically feasible because, on the one hand, it has become possible to create monetary systems accessible to anyone on the Internet and, on the other, *digital tokens* are programmable and can be endowed with special features to accomplish specific goals like optimizing the supply chains:

The solution to the problem of minimizing negative externalities within the framework of the current model of the economic system is associated with the creation of a mechanism for recording externalities and a mechanism for stimulating economic entities to minimize the negative external effects produced by their activities and maximize positive external effects. Tokenization on the supply chain platform creates the possibility of forming this mechanism. The system of tokenizing the externalities includes: (a) the formulation of the target behaviour of economic agents, (b) the creation of a supply chain platform that provides token issuance, (c) the determination of the exchange rate of tokens by economic agents for economic incentives (tax breaks, grants, investments, etc.), (d) an assessment of the effectiveness of economic agents in reducing negative externalities and increasing positive externalities. (Safiullin et al., 2020, p. 1)

It also can be financially interesting for individuals and communities to design incentive systems focused on externalities, namely, to encourage production and consumption behaviors beneficial to community ecosystems and discourage harmful ones. On the other hand, as Helbing (2014) states, "a considerable fraction of people care about ethics and fair products [and] financial investors are getting interested in ethical investments, as they tend to be more sustainable." (p.12).

Some of the tension between ethical and pragmatic business considerations becomes aggravated by the fact that humanity's primary incentive system is limited to a fungible one-dimensional type of money, whose market value rests alone on the undifferentiated prerogative of being exchanged for scarce goods.

The current system of frictionless convertible currencies reduces the number of money-related control variables effectively to one. (…) this one dimensionality is the cause of the recurrent bubbles and crashes in the financial system for thousands of years. But now we can create new, complementary forms of money that enable a better self-organization of our economy. (Helbing, 2014, p. 1)

A one-dimensional incentive system is very limited in its options, as the legendary Midas King of Greek mythology felt when cursed to turning everything he touched into gold. By reducing value to just one dimension, the money someone wins is always equal to the money someone loses, which leads to a *zero-sum game* (Fisher et al., 1991). However, in the *blockchain* era, it does not have to be like that. Incentive systems composed of cryptocurrencies and "purpose-driven token that produces a common good as a side product - a positive externality" (Fritsch et al., 2021) may incorporate other value dimensions than the single *value-of-exchange* monotonously exhibited by the non-programmable traditional money, as is the case of reputational value. It is thought that digital currencies will enrich the monetary system thanks to a savvy combination of value propositions relating to *capital* and *labor*, two production factors that can be integrated into the same unit of value once registered on a DLT, creating diversity enough to bring about multidimensional reputational *trade-value* and *win-win* business situations (Fisher et al., 1991).

Reputation changes the transaction from a single-stage zero-sum game into a repeated positive-sum game. The value that is created in the transaction is that the reputation of both parties is improved in a harmonious profit-able transaction for the long-term. (Calcaterra & Kaal, 2021)

Hence, it is thought that BT paves the way to engineer *smart monetary systems* that may contribute to foster collective action leading to more sustainable human development. Therefore, in the *blockchain* era, a *crypto Midas King* could make an even more valuable wish without regrets, as he would not be cursed with a one-dimensional *golden touch* but blessed with untouchable cryptographic money protocols.

Several ways of integrating reputation and community values into financial incentive systems will be looked at in the following sections in a conceptual and prospective approach. The exploratory idea is seeking out a brighter future overcoming the limitations of one-dimensional money, which invites more speculation than production (French, 2009), impoverishing humanity's motivational spectrum.

Tailoring Monetary Policies

Cryptocurrencies and other digital currencies can increase the granularity of monetary policies and also sharpen political power. They are actionable through *smart contracts* programmed to exert precise effects, for example, depending on the time elapsed until the respective use, the economic sector, or the interest rate. Thus, they can reach specific sectors on any stipulated dates and with discretionary loan rates adapted to many market vicissitudes. Due to blockchain technology (BT), these and other conditions will always be met with mathematical certainty.

It is believed that many governments will try to sponsor and launch digital currencies. After all, the money supply will no longer need to be aggregated, and digital currencies will allow the allocation of financial assets with *ballistic precision*, giving a new meaning to the very expression *monetary policy*. For example, central banks will set interest rates depending on the sector, the transaction date, and market

fluctuations. Of course, that all of these conditions can be optimized insofar as "all digital currencies can be programmed" (Kiff et al., 2020, p. 10).

In a free market system, centralized and decentralized digital currencies will be able to compete. In another scenario, cryptocurrencies will not compete freely in the market, nor public blockchains with free and unconditional access for law-abiding citizens will thrive. Eventually, only the state and corporatocracy will issue digital currencies and private blockchains will dominate. In this case, digital money can lead to a *new normal* (Tam, 2021) where the *post-covid-19* and *blockchain* realities will come together for an even stronger centralization of political-economic power, increasing the risk of people losing their privacy and even their freedom. This scenario is already confirmed in China, where at least some consumer behavior traits are already carried out according to citizens' social ranking (Troshchinskiy, 2021). Thus, it is believed that digital currencies will make it possible to refine the control over citizens, and some authoritarian states and powerful companies maybe will use digital money as an exportable *app* to extend their influence (see Chapter 4).

Even in the so-called free world, it is believed that public digital currencies, sponsored by states such as the USA and Japan, or economic blocs such as Europe, will make it possible to create absolute obligations and specifically targeted monetary policies, rather than recommendations. Thus, it is considered that the states will be able to implement monetary policies with granular effects that were never seen before.

Regarding community ecosystems, one agrees with Dapp (2019) when he refers that "one of the core problems is that today's economic system is creating systemic market failures in the form of so-called market externalities." (p. 156). As mentioned above, *externalities* are the side effects of a decision for those who do not participate in it (Dahlman, 1979), which can be negative or positive. The idea is to "expose such priced externalities to new (dis)incentive systems (*i.e.,* markets) [extending] the economic system itself by systematically including externalities and making them tradable on markets" (Dapp, 2019, p. 157). This author considers that BT enables a new governance paradigm, "which would motivate people to act more sustainably while remaining decentralized, self-organizing, multi-layered, and circular." (p.157).

On the other hand, in what is considered an irreversible process pushed by the pandemic crisis, more and more online services are being consumed with an increasing number of devices connected to the *electronic cloud*. It is believed that this new reality will contribute to making digital currencies and cryptocurrencies more convenient than traditional money. Due to their extreme divisibility and the fact that they can be incorporated into *smart contracts*, such digital tokens may be the preferable way for people and machines to manage the countless number of transactions and micro-transactions that will have to be dealt with in the IoT.

It is thought that the foreseeable development of IoT will be facilitated by new sensory capabilities, which will allow measuring many physical phenomena representing the above-mentioned economic externalities. The also referred to *oracles* will be used to introduce those measurements into blockchains using suitable tokens. Also, it will be possible to encumber or relieve token transactions according to smart contracts' rules using artificial intelligence (AI). Hopefully, a free-market scenario will allow private initiatives to continuously launch innovative cryptocurrencies to contribute to more sustainable human development, as seen in the following sections

Tokenization, Innovation and Entrepreneurship

The creation of tokens is called *tokenization*. In addition to financing projects, it allows to design multifaceted incentive systems. Hopefully, such incentives will ethically reconcile individual profit with collective action favoring the communitys' ecosystems.

Tokenization refers to the issuance of smart contracts tokens, conventionally (but not necessarily) through the ritualized event of an Initial Coin Offering (ICO), which allows access to the existing or prospective value generated by a specific asset – such as gold, computing power, storage, even artworks, and, more generally, an alluring value proposition for a decentralized ecosystem. (Lotti, 2019, p. 287)

Tokens are digitally programmed, allowing financial and economic attributes to be integrated into seamless value propositions that can fit community ecosystems' goals. It is thought that token's properties will contribute decisively to redefining societies' value creation in the *blockchain era*.

[Tokens] introduce differences in kind in the ways in which value generation and distribution are expressed and accounted for in digital environments. [Tokenization] opens up new ways to reimagine and reprogram financial and social relations, and gesture toward new opportunities and challenges for a practice of digital design focused on the ideation and realization of cryptoeconomic systems. (Lotti, 2019, p. 287)

To understand the blockchain economic and the new financial reality, one should know that digital tokens, including cryptocurrencies, are more resourceful than traditional money. Tokens can be thought of as digital financial instruments capable of triggering events in both the digital and physical world. Digital money's features may seem like magic to some but are just technology. While traditional currencies can only trigger automatic actions in a few cases (for example, a physical coin can trigger a self-service vending machine or release a shopping cart in a supermarket), digital tokens can be designed to aggregate and deliver *value-of-exchange* and *value-of-use* (see Key Terms and Definitions). It is thought that market competition will distinguish the most creative and innovative digital tokens, which will be scrutinized by fulfilling people's needs in decentralized markets for which they have been designed. Hopefully, these tokens' value propositions will be appropriate for a more sustainable human development. After all, not being necessarily fungible, tokens do have a memory. They are traceable, so they have an identity. Unlike his analogic predecessor, digital money can carry a reputation (of being done good or bad deeds), potentially affecting its value in every transaction.

In addition to serving as a bargaining chip, digital tokens can have a functional or utilitarian dimension, hopefully corresponding to community members' expectations. In other words, they can represent community benefits, hitherto financially unattainable, allowing quantifying positive externalities like recycling, education, cooperation, community service, and negative externalities like pollution, pathological contagions, and waste of food or energy and deforestation. The idea is to sum or discount cryptocurrency's transactions with those externalities' values, encouraging behaviors that contribute to ecosystems' sustainability and discouraging the harmful ones. One should note that these externalities can be related to production or consumption and be positive or negative. For example, pollution from a factory is a negative production externality. In the same way, the Washington DC riots (2020 US Presidential Elections) can be understood as a negative externality derived from pernicious digital platforms' business model, which was denounced by whistle-blowers (Beever et al., 2019) (see Chapter 1). In turn,

considering consumption, traffic congestion and passive smoking are two examples of negative externalities. As positive externalities, at the production level, one can refer, for example, R&D synergies and recycling. In terms of consumption, it can be mentioned the protective effect that a particular vaccinated individual offers to others, especially in his or her community, and the added utility that some private appliances provide even to third parties not involved in its acquisition. For example, when an individual installs a collaborative application on his smartphone, anyone with whom he is interconnected also can use this functionality. Hence, in all these examples there are externalities, triggered either by production or consumption, that can be encouraged or discouraged. Hopefully, next generations will use *smart contracts* and *ethical tokens* to act proactively in many economic situations.

Therefore, digital tokens allow programming new incentive and reward systems. This monetary approach can expand financial capital accounting to capture social and environmental capital (Bakarich et al., 2020). In a free market, the most valued tokens can help community members guide collective action pragmatically. In the bottom-line, tokens' market capitalization will represent the total value of specific assets or rights featured as a whole in such communities' ecosystems.

It is essential not to confuse collective action with collectivism. Digital tokens can have specific uses, acting as individual incentives even if programmed from a community perspective. This feature of digital money is critical to let individuals pursue their interests and seek personal profits, which is natural and human. The good social news is that when transacting digital tokens whose value can be indexed to factors linked to human development and communities' sustainable progress, individual behavior impacts collective action positively. Also, the concept of personal profit needs to be expanded to quantify the individual reputation.

Using programmable tokens in incentive systems enables the creation of metrics akin to reputation. For example, maintaining a consistently above-average balance of "CO2 coins" would indicate that an individual has made a credible effort to keep his/her ecological footprint low (if the user decides to make this information public). Several externality measurements combined would gradually form a rich user profile with some degree of reliability and accuracy. Under the control of the user, such profiles could be used for job interviews, political campaigns, insurance policies, etc. (Dapp, 2019, 164)

One can think that performing all these features may seem difficult or even impossible due to their complexity. However, it is essential to consider the vertiginous evolution of information technologies like *Big Data* and *Artificial Intelligence*. Berg et al. (2018) stated that "in the near future personal artificially intelligent machine agents will be able to conduct exchanges with a matrix of liquid digital assets (such as [tokens and] cryptocurrencies)" (p. 4).

Hybrid blockchains of the *public-permissioned* type (see Chapter 1) already offer agility, transparency, and speed (when operating the consensus-building mechanism), while simultaneously favor stakeholders' reputation visibility. These rewards can be translated into individual incentives helping each person to climb Maslow's Pyramid, satisfying a well-established hierarchy of psychologic human needs (social affiliation, self-esteem, and self-realization) (Maslow, 1943). Moreover, it is considered that a myriad of decentralized applications (dApps) probably will make this whole reputational process seamless and user-friendly.

Although crypto-economics (see Key Terms and Definitions) is still poorly understood, the new programmable money can encourage building circular economies (Narayan, 2020), aligning individuals with collective interests and favoring ecosystems thanks to a network effect (Metcalfe & Metcalfe, 2013).

It is thought that a healthy tokenized economy should stimulate the circulation of tokens within an ecosystem (Dapp, 2019). For example, in a given dental ecosystem, if the circulation of tokens only results from purchases done by users/patients and sales done by providers/dentists on currency and tokens' exchange platforms, those tokens' life cycles will be too short. In this case, the exchange platform will be the only way for users to acquire the tokens necessary to pay for dental service and for the providers to exchange the tokens received from their customers. In other words, tokens will practically do not circulate among the members of such a system, just entering and exiting the system before and shortly after each transaction. Therefore, this system is not an ecosystem, as the respective tokens representing community members' symbiotic interests do not flow inside the system. In such a dental system, the tokens' value is one-dimensional, maximized at transaction moments, and *individually* captured just at the exchange events, like traditional money does, reducing all value to a single tradable dimension.

For instance, in the dental ecosystem called Dentacoin there are several ways for members to earn tokens, for example, using the *Dentacare App* or writing comments on the platform itself using *Dentavox* and *Trusted Reviews* platforms (Salah et al., 2019).

The platform will reward patients in the form of Dentacoins tokens (DCN) for participating. The program will ultimately help users save money by using DCN to pay for their dental treatment or to purchase dental products. In the long run, it envisions that dentists could potentially consider DCN as a financial investment. For example, they could use it to remunerate employees or to pay suppliers with no middlemen and no high international transaction costs. This direct connection between producers and dentists will ultimately allow dentists to provide lower prices to patients. (Fang, 2021, p. 4)

Therefore, for the cryptocurrencies of a given ecosystem to work, their tokens must circulate and be sufficiently moved for various reasons and in several directions. Thus, buyers and sellers of products and services must spend and earn tokens within the ecosystem, namely by interacting and transacting with each other (Dapp, 2019).

The competitive power of networks should not be underestimated (Metcalfe & Metcalfe, 2013), and *decentralized autonomous organizations* (DAO) will probably create more value to society than traditional organizations. In a scenario of political freedom, *blockchain* technologies will digitally extend network effects to both *economic media*, leading communities to use *social media* and *digital money* for, respectively, sharing information and transacting value. Hence, transactions will be increasingly done in a decentralized way rather than relying on the intermediation provided by hierarchically structured companies. Thus, the DAOs may be the source of a new breed of products and services entirely committed to a community-based marketing perspective (see the same book, Chapter 5 - *The Real Blockchain Game Changer: Protocols and DAOs for Coordinating Work to Provide Goods and Services*). In this scenario, the commercially programmed obsolescence of products and services and other unethical corporate quests for unilateral gains according to blind monetization schemes may have their days numbered for the sake of a more fair and sustainable society.

Cryptocurrencies and other digital tokens may represent an entirely new way of guiding society contributing to the algorithmic institution of community-based capitalism. This political-financial chimera may be possible to achieve by letting individual economic behavior align itself with *the visible hand of the market* endorsed by civil society and ethical entrepreneurship, only possible to attain once the premises of collaborative and sustainable development are tokenized. In this case, individual financial incentives may be synergetic with the public interest due to multidimensional tokens that are very dif-

ferent from the unidimensional traditional money. Therefore, it is thought that free competition between such tokens is essential to encourage innovation, entrepreneurship, and value creation, simultaneously avoiding the privacy risks due to data centralization inherent to Central Bank Digital Currency (CBDC).

SOLUTIONS AND RECOMMENDATIONS

The first recommendation is that states themselves use cryptocurrencies to diversify their financial reserves strategically. Not only to set up a new range of intervention in the money markets but also to have a hedging instrument (see Key Terms and Definitions), given the risk of global crises and the possibility of a conflict escalation (Ghabri et al., 2020; Mamun et al., 2020). Nowadays, the world can change quickly. Berwick (2020) stated, "tectonic changes in health care mirror similar ones in societies overall," and who could have imagined billions of people willingly sheltering in place or social distancing barely 2 two months after almost no one knew those terms?" (p. 2126). Moreover, several studies indicate the convenience of doing hedging using Bitcoin to emulating gold's traditional role.

Evidence supporting the particularity of Bitcoin in the cryptocurrency market as a valuable asset in terms of providing a shelter to political risk, which is in line with previous studies (Aysan et al., 2019). (…) finding nicely complements previous studies arguing that Bitcoin is a hedge against geopolitical risk. (Bouriey al., p. 9)

Bitcoin could provide the sought-after diversification benefits during turbulent times. A similar result is obtained for gold, confirming its well-recognized status as a haven when a crisis happens. Furthermore, we find a low extreme correlation between bitcoin and gold, which implies that both assets can be used together in times of turbulence in financial markets to protect equity positions. Such evidence indicates that bitcoin can be considered as the new digital gold. (Gkillas & Longin, 2018, p.1)

It is thought that cryptocurrencies must belong to the people and be for the people. The only way to do it is by not prohibiting or coarcting each law-abiding citizen from using personal secret keys. Especially when living *new normal* (Tam, 2021) times of fear and crisis, it is considered imperative to keep this in mind. Such cryptographic private keys will always open the door of free-will and democracy, even if someone tries to close it. Of course, they also guarantee cryptocurrencies' free competition. It is thought that individual private cryptographic keys are a pre-requisite of democracy and the only way to deal with the severe risks of losing privacy and freedom. These risks are associated with data centralization harvested from economic media human interactions, firstly social (social media) and now also financial (digital currencies). Private cryptographic keys, decentralized markets, and decentralized applications are considered as essential to prevent bad actors like authoritarian states from using the new multidimensionality of money as a panopticon to control citizens and consumer behavior.

With those new CBDCs, countries will have full surveillance right in your pocket at all times at all times. Every transaction you ever make. Everywhere you ever go. All of it tied to your identity and history and geolocation data. A decade after that you won't file your taxes, they'll get yanked out automatically every time you buy a second-hand toaster at a garage sale. If there's a mistake, you'll call to fight it or have an accountant try to get you a refund while the government takes a free loan from you for a year.

The money won't even pass from central banks to private banking institutions, it will go right into your pocket and those panopticoins will know everything you ever did from cradle to grave. (Jeffries, 2021)

It is though that due to BT it is crucial to liberate human society wit to face present and future challenges. Cryptocurrencies are necessary due to their duality: they have a private genesis, and they are public in their open, transparent, and decentralized market philosophy, making it possible to stimulate an ethical and conscious' entrepreneurship, giving rise to money's programming protocols defined according to society's expectations. So, cryptocurrency probably will attend less to concealed political-economic interests than traditional money.

Giving the floor to civil society will stimulate the talent and shrewdness necessary to design and develop digital currencies particularly useful in communities with shared interests, exploring how individual gains can be correlated with collective successes. This symbiosis can become an essential feature of future monetary systems. It may seem strange to some that any person or group of people now have the opportunity to create a currency, mainly due to the common belief that governments should exercise control over monetary policy and that each country should structure and control its monetary units. However, already the Nobel in Economics Friedrich Hayek had strongly criticized such state control prerogative (Hayek, 1976) even before money becomes a programmable economic media too much dangerous to be centralized.

Objectively, a new prerogative of creating private cryptocurrencies was introduced by blockchain technology (BT). This technology will not be *uninvented*, nor will Internet go back to the time when money was not yet programmable, and more and more people will realize that the Internet is becoming to have several bank features (*e.g.*, Bitcoin). It is thought that such evolution will not be reversed unless democracy, the free-market, and freedom will be reversed as well. However, it would be naive not to realistically consider this worse scenario. It is thought that, unfortunately, from the perspective of democratic development of societies, there is a considerable possibility of repeating in the *Internet of Value*, the same situation verified in the former *Internet of Information*.

Current money issuers will probably try to emulate content publishers' past efforts to protect their business models. These models were quickly made obsolete right in the first phase of the Internet and replaced by others whose algorithms centralize user data with impressive financial results (e.g., Facebook), and lobbying to ban content from being shared on the Internet did little good incumbent publishers. In fact, such prohibitions currently benefit the new digital oligopolies that have been formed to replace the previous players obliterating all competition (Galloway 2017; Ducci, 2020). The same kind of data centralization can now hit digital currencies, and a new digital social contract is of utmost need:

When undertaken in tandem with comprehensive privacy reforms and the institution of transparency into collecting and using personal information, a robust new competition policy regime will necessarily redistribute the allocation of power between the industry, the government, and the individual. (…) What is most of all necessary in this new age of technology is the formulation of a new "digital social contract" that conclusively recognizes the individual's rights. (Gohsh, 2019, p. 11)

It is thought that, again, prohibitions will not work as intended and will turn against the incumbents, probably inviting the appearance of new voracious players whose character, this time, probably will be as economical as political. In the new Internet made possible by BT, the vanishing gap between political and economic power can be closed for good by digitally encompassing the second and most essential

economic media: money itself. It is believed that this is a particularly threatful scenario for democracy (see Chapter 4).

The two modern economic media reached the Internet, *social media*, and *digital currencies* (Beller, 2020). It is thought that the quality of financial incentives attributed to the different routes to share information (using social media) and to transact value (using digital tokens) will dictate the next political-economic paradigm: *collective action* or *collectivism*. The way it will go, of course, will depend on politics. In this author's opinion, in order that freedom and democracy can prevail, digital decentralization should not be by any means constrained. It is thought that the unrestricted use of private cryptographic keys and decentralized applications by law-abiding citizens is a fundamental requisite of democracy in the new blockchain digital era.

As they constitute a new kind of non-replicable data, digital tokens can be programmed to be exchanged only for specific data in particular circumstances. In other words, depending on how and when individuals exchange data with each other (encompassing assets, rights, and functionalities), a token's deal may result, simultaneously, in individual gains and collective benefits (Noyen et al., 2014). In decentralized ecosystems (see *DAOs* in the previous section), according to the smart contract's specifications, tokens may reward merit and encourage productive work and positive externalities, *i.e.,* behaviors with social value and favorable impact on human ecosystems (*e.g.*, recycling). In turn, while also fulfilling ethical principles and social purposes, other tokens can be programmed to limit or penalize the production/consumption of goods and services burdened with negative externalities, *i.e*., harmful productive/consumptive behaviors, with an unfavorable impact on ecosystems (*e.g.*, pollution).

Contrary to today's economic system, agents will use a variety of currencies that represent classes or types of externalities. People do not use one single currency, but many: each currency represents a type of externality and acts as a signal on the market for externalities. These signals will make preferences and priorities in the demand and supply of externalities to a greater extent visible than in today's markets. Besides, agents will be able to participate by trading the different currencies/externalities actively. (Dapp, 2019, p. 162)

Cryptocurrencies and other digital tokens come with built-in memory, as they leave a *digital footprint* of previous transactions. Digital currencies allow tracking its previous whereabouts and applying a *reputation-dependent conversion factor* in the successive financial transactions. Hence, a multidimensional incentive system will result from differentiating tokens and cryptocurrencies. As stated by Helbing (2014), "possible qualifiers could be, how the money was earned, its origin or destination location, the reputation of the product bought [(*e.g.*, is it a recycled product, or a polluting one?)], or the reputation of the producer or seller [(*e.g.*, is it a vegan entrepreneur selling eco-friendly farming products?)].

It should be people and communities to decide about *crypto rewards* relevance transparently, encouraging ethical behavior. As such, the range of choice in terms of cryptocurrencies and digital tokens should not be limited politically. The author thinks this is a way to withdraw money from politics and vice-versa, avoiding promiscuity between the public and private sectors and keeping privacy safe to preserve freedom and democracy. As stated by Berg (2018), alluring to Bitcoin's inventor, "Capitalism after Satoshi will be flatter, more distributed, and less regulated" (p. 12), which is thought to be the formula of letting digital currencies contribute to a sustainable development of society.

From the author's perspective, in nowadays political-economic crossroads, the best hope for humanity is to use the most recent and powerful cryptographic techniques to creatively foster cryptocurrencies

and other applications that use *crypto assets* as a multidimensional incentives system. Hopefully, this will drive the free world through the *new normal* post-pandemic times (Berwick, 2020; Tam, 2021) to a new era of transparency, collaborative innovation, and ethical entrepreneurship, benefiting community's ecosystems and sustainable development.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Bitcoin and other cryptocurrencies are not considered as eligible to be real money by many authors (Mittal, 2012; Grant, 2014; Lo, 2017; Passinsky, 2021; Brummer & Yadav, 2018). Cryptocurrencies' lack of *intrinsic value* and *volatility* are argued as being strong reasons against such classification preventing their acceptance in the market. For example, Sanz Bas (2020), refers that "many experts and analysts believe that cryptocurrencies are not currently money, but rather digital assets", and just a few years ago the European Central Bank (ECB 2015, 23-24) seemed to be sure about such limitation as recently referred by this same author:

Indeed, certainly in the case of Bitcoin, (…), virtual currencies have a limited function as a medium of exchange because they have a very low level of acceptance among the public. In addition, the high volatility of their exchange rates to currencies – and therefore in terms of most goods and services – renders virtual currency useless as a store of value even for short-time purposes, let alone for the purpose of being a longer-term savings instrument. Finally, both the low level of acceptance and the high volatility of their exchange rates and thus purchasing power make them unsuitable as a unit of account. Therefore, although it cannot be excluded that more stable virtual currencies will emerge and be used by a much wider group of users, [cryptocurrencies] such as Bitcoin cannot be regarded as full forms of money at the moment. (Sanz Bas, 2020, p. 18)

However, the acceptance of digital currencies has been growing significantly, as proved by the market price of Bitcoin and other cryptocurrencies. It was so even during the pandemic crisis. As referred by Kurihara (2021), "COVID-19 has promoted risk-on attitudes in financial markets, so Bitcoin prices have gone up" (p. 50). As these lines are being written, more and more businesses and public figures (*e.g.,* Elon Musk) accept cryptocurrencies and tweet about them. As time goes by, one can observe the "significant impact that social media activity of influential and well-known individuals can have on cryptocurrencies" (Ante, 2021, p.1).

Therefore, Bitcoin's *lack of intrinsic value* and *high volatility* does not explain its irregular but overall growing level of acceptance in the market, and it is thought that the best explanation relies on the new type of trust that underlies it, which can be called *distributed trust*. Although very recent, taking into account the history of human trust (see Chapter 1), distributed trust should consolidate as the public opinion catch the thought leadership and gets to know how trustable its mathematical nature is. Therefore, the current volatility of Bitcoin and other cryptocurrencies is coherent with what is considered a concise definition of money given by Niall Ferguson: *money is trust inscribed and portable power* (Ferguson, 2008, pp. 30, 22). Considering that these two prerogatives are undoubtful advantages of cryptocurrencies, it is thought that this nuclear definition of money will endure in the digital realm.

Besides its financial implications, the *intrinsic value* of the new *distributed trust* created by blockchain technology (BT) also justifies the new level of disintermediation that probably will take place in

the coming years globally due to *smart contracts*. As noted by Chambers (2019), "Blockchain isn't just a new technology, it is a political disrupter that takes away the state's monopoly on money. Try as they might, governments won't be able to legislate it away." (p. 13).

Governments may cripple this innovation. They'll want all kinds of tracking and compliance and know your customer/anti-money laundering rules built for old-world finance but there won't be anybody home. There won't be a big compliance department because there won't be a bank, just a lot of open source code running on micro-nodes in the cloud and the fog, doing atomic swaps and matching lenders and borrowers without any people in the mix at all. (Jeffries, 2021)

It can be argued that this independence from third parties establishes new causal relationships for the acceptance of Bitcoin and other cryptocurrencies. Such acceptance, measured by the market price, may depend on the difficulty or cost involved in producing a currency based on distributed trust, whether this trust is spoken over oral ledgers or digitally encrypted on blockchains. Both in the case of Yap Islands's stone money and Bitcoin, it was and still is the cost or difficulty of coinage that establishes a perceived value linked to scarcity.

As stated by Hayes (2017), "[once analyzed] the causes of relative value formation among cryptocurrencies, it was found that relative differences in costs of production on the margin are the main determinants. […] Cost of production drives value." (p.1319)

[To determine the causal direction between the two variables], a Granger causality test was run on price and aggregate hashpower. The results strongly indicate that causality runs one-way from mining effort to price and not the other way. […] Hypothesis H1 is supported in that the coefficient is positive as expected a priori (prices increase as computational power increases), and the t-statistic indicates that it is highly statistically significant that computational power influences price. (Hayes, 2017, pp. 1312, 1313)

The more aggregate computational power employed in mining for a cryptocurrency, the higher the value. (…) First, the more mining power there is, the more acceptance for that 'coin' can be inferred – since mining also serves to verify transactions, the amount of mining power in use is a proxy for overall use and acceptance of that altcoin. A cryptocurrency with no acceptance or usage will have neither value nor computational power directed at it. Second, a rational miner, motivated by profit, would only seek to employ mining resources to a profitable pursuit. Therefore, if the marginal cost of mining exceeded the marginal product of mining, that miner would redeploy his resources elsewhere, removing the computational power from the network of that altcoin and into another. (Hayes, 2017, p. 1312)

The causal relationship between the cost of production and market acceptance also invalidates another argument against Bitcoin, namely the allegedly excessive energy consumption necessary to carry out the Proof-of-Work (PoW) mechanism required to establish consensus, which demands considerable computing effort. As stated by Sedlmeir (2020), "participation in the mining process is only profitable as long as the expected revenue from mining is higher than the associated costs [(e.g., electricity)] (p. 601). Thus, considering that production costs are driving cryptocurrency acceptance, as confirmed above, energy costs will only be paramount if Bitcoin reveals itself successful. However, in this case, energy consumption will be avoided at other significant levels, so this issue must be considered in a broader perspective. For example, "by enabling the digitization of supply-chain processes, blockchain can substantially reduce

the amount of paperwork and transport, including air-freight (Jensen et al., 2019). Furthermore, as was also mentioned above, cryptocurrencies can be used to nurture communitarian ecosystems' and manage sustainability through collective action, which ecological effects probably will surpass many times Bitcoin's energetic consumption.

Considering what is thought to be an actual limitation of cryptocurrencies, one should look at the difficulty related to the handling and care required from its users, who have to deal with secret cryptographic keys to store and transact them. As stated by Moniruzzaman et al. (2020), "the software (wallets) used to access any cryptocurrency suffer from serious usability issues, in particular for general users." (p. 642). On the other hand, keychains are different from coin purses, involving other levels of care and attention. Otherwise, individuals will eventually lose or forget their private keys, which, by definition, constitutes an irreversible and irremediable error. Furthermore, the "possession of these alphanumeric codes is not risk-free for their owners since cases of robbery and fraud have been detected." (Sans Bas, 2020, p. 17). Thus, it is thought that more research is needed to create decentralized applications and the right set of usability guidelines to set secure, user-friendly cryptocurrency wallets.

On the other hand, it can be seen in the literature that the demand for Bitcoin and other cryptocurrencies is highly speculative. According to Sanz Bas (2020), "Proof of this is the high number of inactive Bitcoin accounts" (p. 20). However, it is difficult to agree that inactive accounts provide speculation. To hold Bitcoin can mean saving (setting money aside). After all, investing can be a long-term process, as it seems to be the case with Bitcoin (DeMartino, 2018). Inactive accounts do not suggest putting money at risk with the hope of earning a high return in a short period, as it happens in the case of day trading, and such guessing intention obviously cannot be extrapolated from Bitcoin accounts' inactiveness. Meaningfully, "true Bitcoiners use the term 'HODL' to describe holding on to their Bitcoin rather than selling to fiat" (Knittel & Wash, 2019, p. 4). As stated by Drutarovska (2015), "speculation can be defined as the activity of guessing the possible answer to a question without having enough information to be certain" (p. 345)", and the high number of inactive Bitcoin accounts can mean that many of Bitcoin holders will be confident in the value of Bitcoin in the long run. Now, this eventual certainty is objectively dependent on the mathematical rigor underlying the proper functioning of the respective cryptographic protocol. Of course, society at large still does not trust BT's merit, not in the same way, ignoring the contours of this technology which is still very recent and relatively immature. Thus, the high volatility recorded in the cryptocurrency markets must be viewed with relative ease, because there is an entirely new type of trust in society, called "distributed trust" (Bellini et al. 2020). Several authors have reported this contingence for years, warning that the volatility in question may be only circumstantial, like Brito et al. (2014), who mentioned that "Bitcoin may not be inherently volatile, however. So, its volatility is likely attributable to the fact that it is a new currency, still in the process of discovering its stable price." (p. 156).

It should also be noticed that to conducting business deals with *crypto assets*, a more consolidated legal framework is needed. "Business dislikes uncertainty and invests more when the rules of the game are set" (Bate, 2017), and perhaps due to BT's newness, legal uncertainty is a limitation that has been plaguing the *crypto assets* world. That said, it is judged that finding a clear set of legislative solutions will be just a matter of time, either for better or worse, depending on political will and the clairvoyance of public opinion.

Finally, it is believed that the perspective of making direct and operative transactions between individuals is a sufficiently robust political-economic drive to motivate the overcoming of technical limitations. It is thought that, sooner or later, BT will have a significant ethical, political, and financial-economic

impact. Such an implication indicates that BT and digital currencies should urgently deserve further investigation.

CONCLUSION

Humankind arrived at a historic milestone that is also a critical political-economic crossroads. The Internet allowed to put the information in people's hands, at least in theory. Nowadays, the blockchain protocol allows Internet users to do the same with other economic media: *money*. Money is essentially a system to offset financial obligations, a trustable ledger. Blockchain technology created a new distributed trust, emulating digital ledgers to forge secure hyperledgers. Hence, money is now in people's hands. Again, at least in theory. However, sometimes from theory to practice, it goes a big difference, as shown by the centralization that occurred with the first economic media on the Internet, *social media*. With *digital money*, another economic media arrives on the Internet bringing back the hope of decentralization and openness, although Covid-19 triggered a worrying *new normal* (Tam, 2021).

TThe blockchain protocol empowers digital money with a never seen functional granularity, allowing the integration of labor and capital (the two main factors of production) in the same unit of account. Hopefully, such multidimensionality will pave the way to creating cryptocurrencies with innovative value propositions aligning individual economic incentives and social goals. Cryptocurrencies are programmable. They are *apps*, which can be decentralized and represent new *qualified money*. Besides having *trade-value*, the single attribute of traditional money, such *apps* also can represent *use-value*. *Tokens* and other *crypto assets* allow the automated execution of *smart contracts*, streamlining transactions, reducing transaction costs, and diminishing business uncertainty. As a result, cryptocurrencies can be more competitive than traditional currencies.

It is thought that free competition between cryptocurrencies will decentralize value creation, stimulate innovation, and avoid political risks inherent to data centralization. If every law-abiding citizen has the inalienable right to use cryptographic private keys, there will be a massive explosion of decentralized apps, the *big bang* of the digital money *multiverse* (whether or not such universe is called a *bubble*). Private keys are a democracy's safe conduct in the *blockchain era*. They represent the right to own and protect personal data when dealing with economic media, assuring privacy, free-market competition, and eventually free will.

Suppose the *post-pandemic new normal* (Tam, 2021) brings along with its closure premissas the prohibition of private cryptographic keys. In that case, it will be possible to watch the globalization of a political-economic scenario prepared by totalitarian regimes, where consumption patterns will be based on citizen's social ranking and monitored on social networks (*e.g.,* WeChat). Then, *social media* and *digital currency* (*e.g*., Digital Yuan) data will be centralized and cross-referenced, which is not good news as the free competition among cryptocurrencies is considered to be a requirement of democracy. Unlike traditional money, digital currencies and other *crypto assets* can be programmed to exert very granular effects. For instance, these effects can be as auspiciosos as continuously setting interest rates accordingly to niche market fluctuations or as worrisome as clearing consumer payments correspondingly to individual political profiles monitored and cross-referenced in social networks and other applications.

Nevertheless, if freedom prevails, cryptocurrencies will represent an entirely new democratic way of guiding *collective action*, which has nothing to do with collectivism. Such a political-economic accomplishment, paradoxical in the pre-blockchain era, can be now achieved by symbolizing or monetizing

the premises of sustainable development, creating a multidimensional community incentive system to unleash civil society's free initiative. Then, the digital money will be qualified to foster innovation and ethical entrepreneurship.

Hopefully, the digital opportunity to design money will be taken for ethical and sustainability reasons, decentralizing the collective memory to build hyperledgers of disintermediating trust. Following the opposite path will centralize people's data even further, probably reinforcing authoritarian regimes and corporatocracy, seizing privacy, freedom, and democracy.

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KEY TERMS AND DEFINITIONS

Crypto-Economics: Is the combination of cryptographic proofs of past events and economic incentives to encourage future events inside a blockchain system. On the cryptography side, components used centre mainly around consensus algorithms, digital signatures, and hash functions, plus more recently, zero-knowledge proofs, multi-party computation and homomorphic encryption. On the economy side, things are more complex and an active area of research involving game theory, mechanism design, and network economics.

Decentralized Autonomous Organization (DAO): A new decentralized business model (open source) for organizing both commercial and non-profit endeavours.

Fiat Money: Is the government-issued currency that is not backed by a physical commodity, such as gold or silver, but rather by the government that issued it. Its value is derived from the demand-supply relation and the stability of the issuing entity (government) rather than by the worth of a commodity backing it (commodity money). Most modern paper currencies are *fiat currencies*, including the U.S. dollar, the euro, and other major global currencies.

Hedging: A hedge is an investment that is made with the intention of reducing the risk of adverse price movements in an asset. Normally, a hedge consists of taking an offsetting or opposite position in a related security.

Peer-to-Peer (P2P) Network: A group of computers that are linked together with equal permissions and responsibilities for processing data. Each connected machine has the same rights as its "peers" and can be used for the same purposes.

Prosumer: A proactive consumer that voluntarily and when stimulated to do so, participates in the design, creation or improvement of products and services.

Seignoriage: Seigniorage is the difference between the face value of money, and the cost to produce it. The economic cost of producing a currency within a given economy or country is lower than the actual exchange value, which generally accrues to governments who mint the money.

Self-Servuction: The process of production of a service carried out in a strategic partnership and close collaboration with the prosumers.

Smart Contracts: Software programs that code business arrangements and that execute themselves automatically under pre-determined circumstances which are also coded.

Token: An object (either in hardware or software) which represents the right to perform some operation. Traditional currencies are physical "tokens" and cryptocurrencies are virtual tokens.

Value-of-Exchange: The trade value that justify transacting something, for instance in the blockchain stage of the Internet (Internet of Value or Internet of Money).

Value-of-Use: The utility value that justify sharing something, for instance in the pre-blockchain stage of the Internet (Internet of Information).