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Token, Tokenization and Sustainable Development

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Abstract. Financial innovation has given great importance to sustainability. The Sustainable Finance Strategy represents one of the central points of the European agenda, and Fintech offers important opportunities in this field. However, some "valuable" Fintech instruments seem to not have been adequately considered. The reference is to Bitcoin and to the "crypto-industry". The most common public belief about Bitcoin and sustainability is that Bitcoin is polluting the ecosystem. Immediately, the concept is extended to Distributed Ledger Technologies (DLTs), to blockchain and to all related innovations. Notwithstanding this, some research shows that there is still some uncertainty on the precise amount of energy used by Bitcoin-related activities and on how to calculate it. The scope of this paper is to give some clarity on this uncertainly in order to show, on the one hand that DLT is not "polluting", but that pollutions come from the way each miner decides to conduct their businesses. On the other hand, a DLT system can be considered sustainable thanks to its capacity to solve a various number of environmental problems "related" to how businesses are conducted.

Keyword: Bitcoin, token, DeFi, sustainable development.

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INTRODUCTION

Financial innovation has given great importance to sustainability. The Sustainable Finance Strategy represents one of the central points of the European agenda, and Fintech offers important opportunities in this field (Macchiavello and Siri 2020). However, some "valuable" Fintech instruments seem to not have been adequately considered. The reference is to Bitcoin and to the "crypto-industry". At the present day, Bitcoin has a market cap of $731 billion, being at the 9th place in the ranking of assets market cap, immediately after Facebook ($1,012 billion) and before Tesla ($675 billion) (CompaniesMarketCap 2021). In addition, the total market cap of the first 10 crypto-assets is equal to $1,270 billion (CoinGecko 2021), a market cap value near to the one of silver ($1,399 billion).

The most common public belief about Bitcoin and sustainability is that Bitcoin is polluting the ecosystem (Aratani 2021; Rowlatt 2021; Business Standard 2019; McMaster 2017). Immediately, the concept is extended to Distributed Ledger Technologies (DLTs), to blockchain and to all the related innovations.

Research on Bitcoin sustainability started in 2015 (Giungato et al. 2017). The controversial question of Bitcoin sustainability arises from the fact that Bitcoin protocol has been programmed to let this cryptocurrency become a scarce resource. The more Bitcoins are *mined*, the harder it is to mine more. This leads to the increased amount of energy spent in the process of mining (Giungato et al. 2017, 3).

There is a common conception that Bitcoin creation is an energy-consumptive activity. Cambridge University has conducted a comparison study on Bitcoin energy consumption (Cambridge Centre for Alternative Finance n.d.).

The research showed that Bitcoin ranks 39th in annual electricity consumption at 73.0 TWh, which is more than the electricity consumption of the entire country of Bangladesh (at 70.6 TWh), but slightly less than of Chile (at 75 TWh per year)[1]. However, Bitcoin's annual electricity consumption is still far less than that of Gold mining (131 TWh per year).

Notwithstanding the above, some research shows that there is still some uncertainty on the precise amount of energy used by Bitcoin-related activities and on ways of energy consumption calculation (Stoll et al. year).

The aim of this paper is to clarify this uncertainty in order to show, on the one hand, that DLT is not "polluting", but that pollutions come from the way each miner decides to conduct their business. On the other hand, a DLT system can be considered sustainable thanks to its capacity to solve a various number of environmental problems "related" to how businesses are conducted.)

[1] However, the first country is China (6453.17 TWh per year) followed by USA (3843 TWh per year) and India (1277 TWh per year)

1. FUNCTIONING OF BLOCKCHAIN TECHNOLOGY. WHERE DOES THE DANGER FOR THE ECOSYSTEM COME FROM?

1.1. Blockchain and DLT. A brief overview

Blockchain is a form of DLT, a technology based on a decentralized register managed by a peer-to-peer network. This database can keep the record of the transactions made by its participants independently of a ~~unique and~~ centralized authority that manages the system.

DLT allows transparency and full disintermediation.

Transparency is derived from the fact that most blockchain protocols can be consulted by anyone. This means that anyone can read all the transactions made, as well as the number of crypto-assets contained in a wallet or the code of the software (i.e., smart contracts) deployed on it.

Disintermediation means, *inter alia*, that anyone can participate in the network to run a "node". The nodes possess a full copy of the register containing the information on all the transactions made and on all the software deployed within the blockchain. Nodes, also, participate in block-validation activities, checking if the information which can be stored in the next block is coherent with the previously recorded one[2].

1.2. Energy consumption and consensus mechanisms

A distributed ledger requires a secure mechanism to store information. Each node – owning a copy of the register – could *easily* change the data stored, creating potential confusion or, at the worst, cheating. To store information in a secure way, in order to avoid double spending and manipulations, blockchain adopts specific systems known as "consensus mechanisms". According to a common definition a consensus mechanism is "a fault-tolerant mechanism that is used in computer and blockchain systems to achieve the necessary agreement on a single data value or a single state of the network among distributed processes or multi-agent systems, such as with cryptocurrencies" (Investopedia.com n.d.). One of the first adopted (and actually used by Bitcoin protocol) is the one called Proof-of-Work (PoW).

A PoW-based blockchain requires validators to have done *"some works"* to connect blocks of information. For instance, Bitcoin protocol requires to solve a sort of "*cryptographic puzzle*" to find a number with specific characteristics that permits the connection of two blocks of information. Here, the first miner who solves the puzzle receives a payment from the protocol, equal to a specific amount of Bitcoin.

Thanks to this system, each node of the blockchain can verify if the data of the copy of the register has been altered. An alteration, indeed, will imply that each block shall be connected by a number that is different from the one recorded and already shared with the network.

In order to benefit from its protection, PoW requires miners to spend lots of energy. This energy is consumed by the powerful processors used by miners to solve the "cryptographic puzzle" before other miners get *per se* the rewards. The PoW system makes altering the information stored a very difficult activity.

Indeed, in order to alter a sequence of blocks, the PoW system requires the solving of the "cryptographic puzzle" for each block. In order to do so, it is necessary to spend all the energy that has already been spent to "solve the puzzle" of all the blocks that a "malicious" node wants to alter. In addition, this energy consumption activity has to be completed before an additional block is created[3].

1.2. Token and tokenization

The information that could be recorded on a DLT can have the form of (1) tokens and/or (2) smart contracts.

A token can be defined as a record in favor of a participant that lets them be recognized by the entity who released the token as the holder of a precise amount and/or kind of rights. So, from a *technical* point of view, a token is nothing else than a simple registration in favor of its holder. From a *functional* point of view, it is the informatic "instrument" through which the holder may exercise a precise kind of rights towards the offering entity (Furnari 2018). Those rights are, indeed, the subject of the offer itself, that is, what an investor will gain in buying

[2] For instance, if in block no. 8 Alice is recorded to possess 10 tokens, and if she decides to transfer 5 tokens in the following block, the information that needs to be stored is that Alice holds 5 tokens. If a node "writes down" that Alice still holds 10 tokens, that information is not stored because the block is not validated.

[3] This, according to Bitcoin protocol, happens each 10 minutes; 13 seconds is the time to create a new block on the Ethereum blockchain.

the offered token (Furnari 2018, 144). Sometimes they confer access to a service provided by the platform (utility tokens). In other cases, they confer voting or economic rights towards the issuing company (investment tokens).

After being issued, tokens can be sent to or exchanged with other participants. They are easily stored by their owners using a "wallet", that is a software that stores the private key to interact with the blockchain. Wallet services can be offered by third parties, but more often token-holders uses non-third-party wallets. This enables each token holder to maintain a complete power on their tokens. As per the mere holding, the exchange of tokens does not require any third party to be completed. These two characteristics highlight how, not only the infrastructure (i.e., the DLT), but also the "objects" of the infrastructure (i.e., the tokens) are disintermediated.

This high level of disintermediation gives the rise to a phenomenon called *tokenization*. Tokenization is the possibility to turn a specific "right" into a token. The only existing limits are, at most, the legal ones[4]. Tokenized rights can circulate and be held without the limits given by potential gatekeepers (i.e., intermediaries) or technological limitations (Lener and Furnari 2020).

Advantages given by tokenization are various. One of the most important is the ability to transfer the right incorporated in them by just transferring the token.

1.4. Origins of tokens

Tokens are usually created by a blockchain protocol or by a smart contract. Smart contracts are algorithmic sequences (i.e., softwares), elaborated by *virtual machines*, sorts of "big *phantom* computers" created by the power of calculation given by the nodes of the blockchain.

As all information is recorded on the blockchain, smart contracts acquire the same fundamental qualities of the blockchain on which they "run". This fact makes them suitable for the execution of contracts (from which they took their name). Indeed, as on all software, smart contracts are self-executing; but being launched on a blockchain, they are also unstoppable. If a smart contract is programmed to perform a determined action, it will work until the action is completed. If a precise mechanism to stop its functioning has not been "programmed" by the party who launched it, nobody can stop its functioning without taking control of 51% of the power of calculation alimenting the blockchain (Furnari 2019).

This also means that a smart contract completely lacks human interaction for its execution. In this way it can be used to perform obligations deriving from a real contract that could be written within the smart contract itself[5]. A contract of this kind could help the managing of the performance execution since there is no need for the interpretation of the contract terms. The parties to the agreement do not need to trust each other before the conclusion of the agreement since its execution is fully automated. This principle applies particularly to the collection of money through the launch of an Initial Coin Offering (ICO) or to providing different kinds of services (including financial ones). If the collection of money is managed using a smart contract, this program will automatically deliver the token in exchange for the money received.

Finally, smart contracts can be also used by the issuer to "strongly" grant the right attached to the token distributed. For instance, if a token grants access to a specific service of the issuer, and if the access is regulated with the use of a smart contract, the buyer of the token could be sure that they will enjoy the service they paid for.

2. WHAT IS SUSTAINABILITY

Much research has provided different definitions of *sustainability* (Allen and Hoekstra 1993; Moore 2017). However, there is still the lack of a standard one. The lack of a standard definition of sustainability arises from the fact that the topic is being researched in various fields: from ecology to corporate governance and business development (Moore 2017; Ferrarini 2020; De Hoo and Olaerts 2011).

Notwithstanding this, it is still possible to agree on the fact that sustainability is a quality of a system that permits it to (i) reduce or eliminates various kind of costs; (ii) avoid or resolve scarcity problems; and (iii) avoid or react to various type of fragility. The more a system is "sustainable", the more it manages the solution of those difficulties (costs, problems, and fragilities) (Di Paola 2016).

The adoption of this definition to blockchain-based systems leads to the conclusion that it is not true to say that blockchain technology is unsustainable.

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[4] The rights that most commonly are tokenized are credit rights under various forms. Utility tokens and investment tokens are the tokenized version of consumer (the right to obtain a good or a service) or investment (the right to vote or to dividends) rights.

[5] To be more precise, they can perform the role of an "online vending machines" to highlight their basic function of executing a predetermined action in response of a precise input.

At most, what is truly unsustainable is the way some miners conduct their job. Here it is clear that, if the energy used to perform PoW activities comes from carbon fuel, the emissions cause pollutions that are an important *cost* for the environment, creating (instead of resolving) various kinds of *fragilities*. This clarification is fundamental since it demonstrates that blockchain is not polluting *per se*, but its environmental impact depends on how a miner decides to power their engines. Indeed, it is clear that the same environmental problems will not arise if the same activities are conducted using solar or similar energies and more eco-friendly sources.

However, it is still possible to argue that, as far as a system requires great amounts of energy to operate, it could not be called fully "sustainable". This implies the need to take into account some additional considerations in order to show how a blockchain-based system (and so tokenization) can be seen as sustainable.

3. SUSTAINABLE BY TECHNOLOGY

One of the first attempts to solve blockchain environmental issues deals with the substitution of PoW consensus mechanism with more energy efficient solutions. One of these is Proof-of-Stake (PoS) (Saleh 2021; Chohan 2018; He et al. 2020).

The PoS consensus mechanism overcomes the problem of selecting the validator nodes on the ground of the amount of work performed (and so on the energy consumed). Here validators are selected randomly between those who possess a certain amount of tokens (the "stake") and some additional related characteristics (Chohan 2018, 2).

For instance, in the "*Randomized Block Selection*" method, validators are chosen randomly among those who have a combination of the lowest hash value and the highest stake. In the "*Coin Age Selection*" method, validators are chosen based on how long their tokens have been staked[6]. Here once a node has validated a block, he/she must wait a certain period of time before being able to validate another block. In this way it is possible to prevent bigger validators to obtain the control over the blockchain.

PoS mechanism demonstrates the existence of sustainable ways to make a blockchain work. Indeed, as distinct from PoW, PoS is not based on the energy consumed to permit the functioning of the validation process.

Its sustainability, in addition, does not alter its safety from the cyber secure point of view; PoS systems are still secure as PoW (Thapa et al. 2019).

This is true thanks to the fact that the staked tokens function as a "bail" for the validator to not indulge in fraudulent activities. Indeed, fraudulent activities are sanctioned detaining part of the token staked.

The other aspect that increases security in PoS-adopting blockchains is the higher level of decentralization that is possible to achieve. In comparison with PoW systems – where the amount of power that is necessary to validate a block induces the creation of big mining pool, with a clear oligopoly risk – PoS makes it possible for almost everyone to run a node because it lowers the entry barriers of validations activities. This fact favours a wider distribution of the tokens needed to run the node, making attacks more difficult to be performed. This is truer because if in PoW-adopting blockchains, to make a so-called "51% attack" there is the need to control the 51% of the mining power, in PoS it is necessary to possess the 51% of all the tokens issued (John et al. 2020).

4. SUSTAINABLE BY BUSINESS

Apart from technological innovations, a blockchain based system could be considered sustainable thanks to the innovative types of business models, based on tokenization, that they permit to develop.

The use of tokenization can change the way in which businesses is done, making it more sustainable. Wide research exists, for instance, in the field of food and, more in general, on the supply chain. In this sector, the advantages for sustainability in using blockchain systems have already been proved (Lund et al. 2019; Sulkowski 2018; Medhi 2019).

Another sector studied from this point of view is the financial one. This industry can be revolutionized in two different ways. On the one hand, blockchain technology can implement the way in which financial services ~~are~~ have *already* been provided to the public. On the other, blockchain technologies can foster *new ways* to provide financial services.

The first of these two sides of the same coin has been already extensively analysed (Peters and Panayi 2015; Guo and Liang 2016; Wu and Liang 2017; Cocco et al. 2017; Harris and Wonglimpiyarat 2019; Popova and Butakova 2019; Lu et al. 2019; Wang et al. 2019).

[6] Token age is calculated by multiplying the days the token has been held as stake by the number of tokens staked.

With sustainability defined as "the quality of a system to reduce or eliminate various kinds of costs", a technological innovation would be more sustainable, with increased potential capacity to change completely the way a business is conducted.

From this point of view, it should be noted that tokenization allows the offering financial services without the need for *financial intermediaries*. This is possible in what is called "Decentralized Finance" (or DeFi), a new way in which financial services may be offered by algorithmic protocols.

DeFi is a very recent evolution of finance, first appearing in 2017 on the Ethereum Blockchain. It started with the MakerDAO Protocol[7] and rapidly evolved into a rich ecosystem, whose value has reached nearly $87 billion in May 2021.

Taking inspiration from Bitcoin and its underlying technology, DeFi permits financial services to be offered without the need for intermediaries and central authorities to manage and control the system. In this way, protocol-base intermediaries (as opposed to the human-based ones) can reduce the costs for a single transaction while offering users a direct control over their financial assets.

So, DeFi substitutes traditional financial intermediaries deploying unique business models which function using protocols running on blockchain technology. A protocol can be defined as an algorithm or as a software embodied in a smart contract. Protocols offer their services independently from a physical or a legal person, directed by a group of developers through a decentralized organization or even a Decentralized Autonomous Organization.

This circumstance reduces the number of people and the related costs (also for the environment) traditionally correlated with the providing of financial services.

A brief overview of the most common protocols of DeFi ecosystem will be useful to understand how it is possible to offer services very similar to traditional financial services, through a series of smart contracts deployed on a blockchain.

Lending Protocols offer services very similar to the ones offered by banks in lending money. Decentralized Exchanges (DEX) using the Automated Market Makers (AMM) system permits the creation of market infrastructures and the managing of markets for tokens. Launchpad Platforms permits the offering of crypto-assets to the public, resembling traditional IPOs through ICOs.

4.1. Lending protocols

Lending protocols allow users to become lenders or borrowers of tokens. This becomes possible via the use of smart contracts that permit the platform user to "deposit" tokens within a smart contract to receive back (automatically) an interest on the assets deposited (Castro-Iragorri 2021).

The tokens deposited become available for borrowing to other users. Who wants to borrow tokens and provide a guarantee that at the time of the borrowing, they will be valued more than the borrowed tokens? In particular, for each asset lent is associated with a *collateralization ratio* which is the limit a borrow can be obtained providing the asset as a guarantee. This means that, initially, all borrows are over-collateralized. A drop in the value of the collateralized tokens may cause the collateralization ratio limit to be exceeded. If this happens, the protocol sells the assets given as a guarantee, repays the loan, and gives back the difference minus a penalty (that usually is the 10% of the value liquidated).

Lending protocols permits users to obtain liquidity while not selling their token holdings. In this way, they may still benefit from potential increases in value. Another benefit of using a Lending protocol could be simply the intention to increase their leverage on certain trading positions. Finally, the Lending Protocol permits the short-selling[8] of assets.

4.2. DEXes

DEXes are DeFi protocols that let users exchange tokens for other tokens. The most famous DEXes, instead of running a "classic" order book, implement AMM systems to increase their productivity and to avoid lack of liquidity (Mohan 2020; Capponi and Jia 2021; Aspris et al. 2021).

Considering their importance in the functioning of the DEX, an AMM could actually be defined as a type of decentralized exchange (DEX) that uses a specific formula to price assets.

[7] For more information, please see the official website https://makerdao.com/en/

[8] To do so, it is necessary to borrow the asset that the user wants to short sell, changing it on a DEX for a stable coin and then repaying back the borrow buying back the borrowed token when their value just decreased.

An AMM needs the creation of trading pairs to work. Its innovation lies in the fact that there is no need to have an actual counterparty (i.e., another trader) to perform the exchange. Indeed, users interact with a smart contract in which a "pool" of the two assets composing the pair has been created by other users. Those users act as Liquidity providers and receive a fee for all the trades performed using their pooled assets.

When the tokens are deposited, the pool is composed of an amount of assets having the same value. In this way, when an exchange is requested, the protocol exchanges the required asset at the same value as the one provided, less fee, which increases the pool.

If the demand for one of the two assets increases, so does its price. So, the protocol rebalances the amount of tokens composing the pool in such a way that they always have the same value. This mechanism creates a specific risk for liquidity providers called Impermanent Loss[9].

4.3. Launchpads and ICO

Launchpads are platforms that permit users to participate in Initial Coin Offerings (ICO).

An ICO is an offering to the public of tokens for the collection of money. From this point of view, it can be defined as a more advanced technological version of crowdfunding (Furnari 2021).

A particular phase of the collecting procedure, which is worth mentioning, is the so-called "Airdrop", a way of spreading new tokens for free. The scope of airdrops is to speed up token adoption with a clear marketing purpose[10].

An ICO is usually anticipated by the publication of a white paper, a document presenting ICO scope and characteristics. Its content is not pre-established, but it usually deals also with the technical description of the token and of the smart contract involved in the offer.

The participant in an ICO receives in exchange for their participation a token which can be programmed to play a wide range of roles in the functioning of the company. Traditional classifications recognize three main categories: cryptocurrency, utility and investment tokens. But the classification exercise is not always simple, because of the presence of so-called hybrid tokens, tokens which do not fit any of the three traditional categories since they share the characteristics of two or more of them, without being classified as an autonomous category.

The term ICO is generally used as a broader term to refers to the offering of tokens to the market, in exchange for fiat money of other tokens. The DeFi rapidly evolving markets have seen the rise of different ways to conduct this offering.

One of the most common is the Initial Exchange Offering (IEO). IEO can be simply defined as an ICO conducted on a launchpad platforms, traditionally a cryptocurrency exchange.

The first fundamental characteristic of an IEO is the fact that it is *intermediated*. Indeed, ICOs generally are conducted directly on the website of the issuing entity. From the point of view of the promotion of the offer, the launchpad platforms have the same role as a crowdfunding platform. A potential investor within the platform has the possibility of choosing between different "investment" solutions. So launchpads grant important advantages to the issuer, that is, a prepared crowd of potential investors.

The use of an intermediary platform also gives some advantages to potential investors who may trust the fact that the exchange has performed a due diligence on the token offering, in order to avoid fraud or scum offering. Due diligence is usually conducted in the interests of the platform in order to avoid damages to its image.

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[9] Impermanent Loss can be defined as the loss incurred in deciding to participate in the liquidity pool instead of holding the single asset. Indeed, if the value ratio of the two tokens changes a lot, the protocol distributes part of the increased value of one token to the other one, selling the first and buying the second. This implies a reduction of the amount of the token whose value increases. In this circumstance the liquidity providers would have had a grater gain simply holding the tokens instead of adding funds to a pool.

The loss of the liquidity provider increases when the value of one of the tokens drops significantly. In this case, indeed, the liquidity provider suffers a decrease also of the paired token.

The terms "impermanent" means that the loss does not actually suffer by the liquidity provider until he/she decides to remove the liquidity. Changing of the market value of the two tokens may always recreate the conditions before the token dropping value.

[10] This could be possible because additional token creation is free of direct costs for the entrepreneur. Indirect costs are, instead, related to the value dilution of injecting new liquidity into a system.

CONCLUSION

It is immediately obvious that DeFi can be seen as more sustainable than a traditional financial system. This actually can be considered true due to the fact that "DeFi algorithms" do not need buildings and energy consuming computers or people who need to commute to work by cars, trains or aeroplanes.

Protocols consume only the energy of the blockchain, and new blockchains using PoS instead of PoW are more sustainable.

However, as of today, the traditional financial system will not disappear. There is still a considerable number of financial services which cannot be substituted by protocols. These are the ones that still require an important human component to be performed. As for the others, there may be a slow substitution, although initially, some substitutes may not be fully "unpolluting".

Metaphorically speaking, in choosing a transportation method, we do not opt for the horse because the horse is less polluting than the car. We still choose the car, although we are doing our best to spread the adoption of electric cars.

REFERENCES

1. Allen, Timothy F.H., and Thomas W. Hoekstra. 1993. Toward a definition of sustainability. *General technical report RM (USA)* 247: 98–107.
2. Aratani, Lauren. 2021. "Electricity needed to mine bitcoin is more than used by 'entire countries'" https://www.theguardian.com/technology/2021/feb/27/bitcoin-mining-electricity-use-environmental-impact
3. Aspris, Angelo, Foley Sean, Svec Jiri, and Wang Leqi. 2021. Decentralized exchanges: The "wild west" of cryptocurrency trading. *International Review of Financial Analysis* 77: 1–10. https://doi.org/10.1016/j.irfa.2021.101845
4. Business Standard. 2019. "Bitcoin causing annual CO2 emissions comparable to those of Vegas: Study." https://www.business-standard.com/article/pti-stories/bitcoin-use-causing-co2-emissions-comparable-to-las-vegas-study-119071900858_1.html
5. Castro-Iragorri, Carlos, Julian Ramirez, and Sebastian Velez. 2021. Financial intermediation and risk in decentralized lending protocols. http://dx.doi.org/10.2139/ssrn.3893278 Cambridge Centre for Alternative Finance.n.d. https://ccaf.io/cbeci/index
6. Chohan, Usman W. 2018. Proof-of-Stake Algorithmic Methods: A Comparative Summary. http://dx.doi.org/10.2139/ssrn.3131897
7. Cocco, Luisanna, Andrea Pinna, and Michele Marchesi. 2017. Banking on Blockchain: Costs Savings Thanks to the Blockchain Technology. *Future Internet* 9 (3): 25. https://doi.org/10.3390/fi9030025
8. CoinGecko. Accessed July 30 2021. https://www.coingecko.com/
9. CompaniesMarketCap.com. Accessed July 30 2021. https://companiesmarketcap.com/assets-by-market-cap/
10. De Hoo, Sybren, and Mieke Olaerts. 2011. *Sustainable Development and the Need for Sustainable Oriented Corporate Law and Regulation.* University of Oslo Faculty of Law Research Paper № 2011–29.
11. Di Paola, Marcello. 2016. "Lezione sulla Sostenibilità, lesson held at LUISS University". Youtube, March 17, 2016. https://www.youtube.com/watch?v=EJ961feV45s
12. Ferrarini, Guido. 2020. Corporate Purpose and Sustainability. *Law Working Paper* № 559/2020.https://ecgi.global/sites/default/files/working_papers/documents/ferrarinifinal.pdf
13. Furnari, Salvatore L. 2018 "ICO in Italia: applicabilità della disciplina sull'equity crowdfunding e suoi potenziali benefici", in *Fintech: Diritto, Tecnologia e Finanza*, edited by Raffaele Lener. Minerva Bancaria.
14. Furnari, Salvatore L. 2019. "Validità e caratteristiche degli smart contract e possibili usi nel settore bancario finanziario", in *I diversi settori del fintech. Problemi e prospettive*, edited by Elisabetta Corapi and Raffaele Lener. Wolters Kluwer Italia.
15. Furnari, Salvatore. 2021. Trough Equity Crowdfunding Evolution and Involution: Initial Coin Offering and Initial Exchange Offering. *Lex Russica* 1: 101–117.
16. Giungato, Pasquale, Roberto Rana, Angela Tarabella, and Caterina Tricase. 2017. Current Trends in Sustainability of Bitcoins and Related Blockchain Technology. *Sustainability* 9(12): 2214. https://doi.org/10.3390/su9122214
17. Guo, Ye, and Chen Liang. 2016. Blockchain application and outlook in the banking industry. *Financial Innovation* 2(24). https://doi.org/10.1186/s40854-016-0034-9
18. Harris, Wesley L., and Jarunee Wonglimpiyarat. 2019. Blockchain platform and future bank competition. *Foresight* 21(6): 625–639. https://doi.org/10.1108/FS-12-2018-0113
19. He, Ping, Dunzhe Tang and Jingwen Wang. 2020. Staking Pool Centralization in Proof-of-Stake Blockchain Network. *ERN: Other Game Theory & Bargaining Theory.*
20. Investopedia.com n.d. https://www.investopedia.com/terms/c/consensus-mechanism-cryptocurrency.asp

21. John, Kose, Thomas J Rivera, and Fahad Saleh. 2020. Economic Implications of Scaling Blockchains: Why the Consensus Protocol Matters. http://dx.doi.org/10.2139/ssrn.37504672020
22. Lener, Raffaele and Salvatore L. Furnari. 2020. Company law during the blockchain revolution. The rise of "CorpTech". *Open Review of Management, Banking and Finance* 6(2): 33–52.
23. Lu, Zhihui, XiaoLi Wan, Jian Yang, Jie Wu, Cheng Zhang, Patrick C.K. Hung, and Shih-Chia Huang. 2019. "Bis: A Novel Blockchain Based Bank-Tax Interaction System in Smart City" *IEEE Intl Conf on Dependable, Autonomic and Secure Computing, Intl Conf on Pervasive Intelligence and Computing, Intl Conf on Cloud and Big Data Computing, Intl Conf on Cyber Science and Technology Congress (DASC/PiCom/CBDCom/CyberSciTech)*: 1008–1014.
24. Lund, Eirik Harald, Maria Letizia Jaccheri, Jingyue Li, Orges Cico and Xiaoying Bai. 2019. "Blockchain and Sustainability: A Systematic Mapping Study." *IEEE/ACM 2nd International Workshop on Emerging Trends in Software Engineering for Blockchain (WETSEB) (2019)*: 16–23.
25. Macchiavello, Eugenia, and Michele Siri. 2020. Sustainable Finance and Fintech: Can Technology Contribute to Achieving Environmental Goals? A Preliminary Assessment of 'Green FinTech' (August 13, 2020). *European Banking Institute Working Paper Series 2020* 71. http://dx.doi.org/10.2139/ssrn.3672989
26. McMaster, Andrew. 2017. "Bitcoin Is Massively Polluting the Earth – And We Should All Be Scared." https://www.globalcitizen.org/fr/content/bitcoin-pollution-environment-electricity-robots/?template=next
27. Medhi, Pankaj Kumar. 2019. Role of Blockchain Enabled Transparency in Risk Management and Sustainability of the Complex Global Supply Chains. http://dx.doi.org/10.2139/ssrn
28. Mohan, Vijay. 2020. *Automated Market Makers and Decentralized Exchanges: a DeFi Primer*. http://dx.doi.org/10.2139/ssrn.3722714
29. Capponi, Agostino, and Ruizhe Jia. 2021. *The Adoption of Blockchain-based Decentralized Exchanges* http://dx.doi.org/10.2139/ssrn.3805095
30. Moore, Julia E., Alekhya Mascarenhas, Julie Bain, and Sharon E. Straus. 2017. Developing a comprehensive definition of sustainability. *Implementation Science* 12: 110.
31. Peters, Gareth, and Efstathios Panayi. 2015. Understanding Modern Banking Ledgers Through Blockchain Technologies: Future of Transaction Processing and Smart Contracts on the Internet of Money. http://dx.doi.org/10.2139/ssrn.2692487
32. Popova, Natalia, and Natalia G. Butakova. 2019. "Research of a Possibility of Using Blockchain Technology without Tokens to Protect Banking Transactions." *IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus)*: 1764–1768.
33. Rowlatt, Justin. 2021. "How Bitcoin's vast energy use could burst its bubble." https://www.bbc.com/news/science-environment-56215787
34. Saleh, Fahad. 2021. Blockchain Without Waste: Proof-of-Stake. *Review of Financial Studies* 34: 1156–1190.
35. Stoll, Christian, Lena Klaaßen, and Ulrich Gallersdörfer. 2019. The Carbon Footprint of Bitcoin. *Joule* 3(7): 1647–1661 https://doi.org/10.1016/j.joule.2019.05.012
36. Sulkowski, Adam J. 2018. Blockchain, Business Supply Chains, Sustainability, and Law: The Future of Governance, Legal Frameworks, and Lawyers? Delaware Journal of Corporate Law 43: 303–345.
37. Thapa, Sarita, Papri Ghosh, and Bijoy Chhetri. 2019. "Security Issues on Blockchain Network (BcN): A Review". *2nd International Conference on Advances in Science & Technology (ICAST) 2019 on 8th, 9th April 2019 by K J Somaiya Institute of Engineering & Information Technology, Mumbai, India*. http://dx.doi.org/10.2139/ssrn
38. Wang, Rui, Zhangxi Lin and Hang Luo. 2019. Blockchain, bank credit and SME financing. *Quality & Quantity: International Journal of Methodology* 53(3): 1127–1140.
39. Wu, Tong, and Xiubo Liang. 2017. "Exploration and practice of inter-bank application based on blockchain." *12th International Conference on Computer Science and Education (ICCSE)*: 219–224.