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Introducing blockchain

Blockchain is no longer just about bitcoin or cryptocurrencies in general, but it can be seen as a disruptive and revolutionary technology which will have a major impact on multiple aspects of our lives. The revolutionary power of such technology can be compared with the revolution sparked by the World Wide Web and the Internet in general. As the Internet can be seen as a means for sharing information, so blockchain technologies can be seen as a way to introduce the next level: blockchain allows the possibility of sharing value.

The problem solved by a blockchain is “consensus”. It revolutionizes the concept of trust, introducing elements for

generating disruption in the financial sector. Currencies are therefore the first concept which can be implemented upon such technology, but this is only the premise. Satoshi Nakamoto conceived the Bitcoin electronic cash system in 2008 with the aim of producing digital coins whose control is distributed across the Internet rather than owned by a central issuing authority such as a government or a bank. It became fully operational on January 2009, when the first mining operation was completed, and since then it has continuously seen an increase in the number of users and miners. In the beginning, the interest in the bitcoin digital currency was purely academic, and the exchanges in bitcoins were limited to a restricted elite of people more interested in the cryptography properties than in the real bitcoin value. Nowadays bitcoins are exchanged to buy and sell real goods and services, as happens with traditional currencies.

Distributed infrastructure

The main distinctive feature introduced by the Bitcoin system is the distributed infrastructure where all the transfers are recorded. To send and receive bitcoins, a user needs an alphanumeric code called an address. An address can be seen as a bank account number and can be the recipient of funds. An address is public information derived from a public key. No personal information is recorded in a blockchain, and for this reason Bitcoin protocol offers pseudo-anonymity. The consensus mechanism allows agents to transfer "value" without having a third party involved in the process, which guarantees that the source actually owns that value which it wants

to transfer and which guarantees that the recipient receives (or not) the value being transferred. The elimination of this third trusted party is a major breakthrough. If we think about how banks work at the moment and what they actually do, it is immediately clear that banks match the definition of trusted third parties. The bitcoin blockchain allows the transfer of value without a third party. The disruptive potential of the bitcoin consensus algorithm is enormous. The fact that all the transactions are public and it is not possible to delete them is the key which lets the consensus algorithm work. The whole transaction history (from the first that occurred) is accessible by anyone (any agent which wants check what happened from the genesis), and it cannot be changed.

Consensus is linked with another two elements necessary to let this technology work: peer-to-peer networks and cryptography. The blockchain is built upon a peer-to-peer network, and anyone willing to join the network can do it without asking permission from anyone. Each node of the network exposes a constantly updated version of the blockchain, and this fact gives the possibility (to each node) to verify old and new transactions and to decide if they are valid or not. There is no possibility of "double spending", and by eliminating this possibility, distributed ledgers introduce the concept of digital scarcity.

Introducing scarcity in a digital world has been extremely complex. Scarcity and digital are almost opposite concepts, if we think, for instance, how easy is to duplicate a file (a music file, a document, a film). Speaking about money, it is easy to understand the concept of

scarcity: if we have a banknote, we are sure that that banknote is unique, no one else can have the same one, and if someone tries to "make a copy" we are aware of the fact that the action is classified as illegal. Governments, banks, laws and agreements protect a fiat currency from the double-spending problem.

From Web 1.0 to Web 3.0

The advent of blockchain technology brings a new era in the web, what here we define as the Web 3.0. The first era of the Internet was mainly characterized by information carried by static websites without any possibility of interaction. It was primarily made by information portals with flat data where users could "only" read and were not allowed to add any comments, reviews or feedback. A paradigmatic example of this first era of the Internet is the British Encyclopedia (or any other traditional encyclopedia) that "simply" digitalized the content, moving the information from offline to online but without giving the possibilities to users to interact and generate new content. The Web 2.0, or second stage of the World Wide Web's evolution, is characterized by the possibilities to interact, share information, add content and exchange data. This era, also known as participative, gives the possibility to all users to participate, generate content online (Users Generators Content and easily interact with other users (usability). One of the paradigms of this new era is Wikipedia, which, differently than the British Encyclopedia, can be written (and not only read) by users. The shift is from the "readable" phase to the "writable" phase, from passive users (simply consuming contents) to active users (becoming active

creators of content), from the static to the dynamic web. In this vein, another paradigmatic example of this new phase is given by the advent of social media, which encourages participation (Jenkins, 2006), information sharing and collaboration.

The advent of blockchain technologies brings the third era of the web, the so-called Web 3.0. This new era allows the transfer of value.

The Web 3.0 is based on decentralization, without points of control and unique profit centres. The blockchain enables the transfer of value without a centre of profit or monopolistic service providers. While the advent of social media allowed the exchange of information among users but kept the control among a few private actors (generating digital oligarchy with social media companies, peer-to-peer ridesharing, peer-to-peer hospitality networks), blockchain technologies allow the possibility of creating decentralized networks without centralized points of control. Here it comes one of the disruptive aspects of this technology that will enable to operate on a decentralized system without any central centre of profit in charge of coordinating (and taking advantage of) the network. Blockchain technology allows the secure transfer of information, assets and money without a third-party intermediary, such as banks or other financial institutions (Swan, 2015: 15). These third-party intermediaries are not limited to banks, but it also includes the economic platforms of the shared economy and Web 2.0, which make a profit from each transaction, and popular social media platforms, which make profits using users' data.

A blockchain can be used also as a backbone infrastructure for running smart contracts, particular decentralized applications which can be seen as computer programs executed by participants in a blockchain. Smart contracts are an additional disruptive factor and have gained tremendous popularity in the past few years, to the point that billions of US dollars are currently exchanged every day through such technology. However, since the release of the Frontier network of Ethereum in 2015, there have been many cases in which the execution of smart contracts managing Ether coins lead to problems or conflicts. Smart contracts rely on a non-standard software life cycle, according to which, for instance, delivered applications can hardly be updated or bugs resolved by releasing a new version of the software. Furthermore, their code must satisfy constraints typical of the domain, like the following: they must be light; the deployment on the blockchain must take into account the cost in terms of some criptovalue; their operational cost must be limited; and they are immutable, since the bytecode is inserted into a blockchain block once and forever.

The idea of a smart contract was originally described by cryptographer Nick Szabo in 1997 as a kind of digital vending machine. In his paper (Szabo, 1997), he imagined how users could input data or value and receive a finite item from a machine.

More in general, smart contracts are self-enforcing agreements, i.e., contracts, implemented through a computer program whose execution enforces the terms of the contract. The idea is to get rid of a central control authority, entity or organization which both parties

must trust and delegate such a role to the correct execution of a computer program. Such a scheme can thus rely on a decentralized system automatically managed by machines. The blockchain technology is the instrument for delivering the trust model envisaged by smart contracts.

Since smart contracts are stored on a blockchain, they are public and transparent, immutable and decentralized, and since blockchain resources are costly, their code size cannot exceed domain-specific constraints. Immutability means that when a smart contract is created, it cannot be changed again.

Smart contracts can be applied to many different scenarios: banks could use them to issue loans or to offer automatic payments; insurance companies could use them to automatically process claims according to agreed terms, postal companies for payments on delivery.

No border

The power of such a structure is also given by the fact that there are no borders, and it is possible to transfer value everywhere with low transaction fees. Or at least everywhere we have access to the network. Blockchain technologies will be used for financial products and have opportunities in all those fields, which requires transparency, immutability, certainty and certification. However, one of the main challenges that blockchain technologies are facing is related to the so-called digital divide, often intended as the gap in accessing and using new technologies. According to recent research, it seems that the digital divide in terms of access is narrowing

quickly, “driven by the expansion of broadband access in developing countries” (Nye, 2013**).** However, this assumption is only partly true. Indeed, it depends on what we intend when we say “digital divide”. If we consider the digital divide only a matter of accessibility, then this assumption might appear true. Indeed, thanks to the rapid growth of the new mobile and networking technologies and the expansion of broadband availability the digital divide in terms of the availability of the technology is narrowing at both at the national and international level. This definition is reductive and does not explain in detail the different levels of digital inequalities and how these could affect, in different ways, the diffusion, the uses and the benefits users can get from using new technologies. Indeed, there are major divisions in the type, quality, reliability and affordability of access both within and between nations across the globe. Furthermore, available and accessible information and communications technology ICT is not the only gap among users and citizens, and it is not the only divide that creates inequalities. For those with access we have moved from simple issues of an access divide (to have the material or physical access) to the capability divide (the ability to use, quality of provision and use of) and then to the outcome divide (to the effects of utilizing digital media). These three elements – access, uses, and benefits – are what we define as the three levels of the digital divide (Ragnedda, 2017) and provide a more sophisticated and complete picture of the multidimensionality of digital inequalities. The digital divide is therefore the actual social and personal consequences of the divide

or discrepancy in the levels of connectivity, in the level of capabilities, in the outcomes, in the digital and social skills, in the motivation and in a diversity of combinations of these measures.

These features influence the way in which we access, use and gain benefits from blockchain technologies. In other words, not everybody will benefit from the advent of these new technologies, since inequalities in accessing (the first level of the digital divide), in using (the second level of the digital divide) and in getting tangible outcomes (the third level of the digital divide) are persistent. For this reason and to extend to all users the benefits of blockchain, it would not be enough to implement access to the technologies to offer the possibility of gaining advantage from their uses. Without the necessary (digital) skills, the confidence to use blockchain technologies and the digital capital (Ragnedda, 2018) to "convert" the uses of technologies into concrete and tangible outcomes, the diffusion of blockchain will reinforce previous social inequalities, giving to the most advantageous groups more possibilities compared to their disadvantaged counterparts. In other terms, the full potential of this revolutionary technology is not fully displayed and exploited if the digital divide is not opposed and tackled.

Blockchain technologies: risks and opportunities

This book underlines the risks and opportunities offered by the advent of blockchain technologies and the rise of the Web 3.0. This book, adopting an interdisciplinary perspective, outlines the conceptual development of these technologies in different

disciplines, inter alia legal, sociological, media and engineering studies. The core analysis in the book explains how such technologies are disruptive and further discusses the concrete consequences of these disruptions in terms of social, economic, technological and legal consequences.

Such a comparative perspective has also been underemphasized in the debate about blockchain, and this underemphasis leads to weaknesses in our understanding of decentralized technologies. We anticipate that the comparative examination of these features will be helpful in clarifying the dynamics and consequences of the blockchain technologies in a variety of settings. This book aims at filling this gap by hosting an interdisciplinary and comparative discussion of blockchain technologies in a variety of disciplines.

From this unified perspective, the book proceeds with three discipline-focused sections, each one including five chapters. The first includes case studies examining the socio-economic consequences of the advent of blockchain technologies, while the last section focuses on the technological innovations and how this emerging technology has gone beyond cryptocurrencies to include health care, voting systems, energy, transport and so forth.

More specifically, the first section opens with a chapter (Chapter 2) written by Sune Sandbeck, A.. Kingsmith and Julian von Bargen that considers the disruptive potential of highly reliable, versatile forms of collective action in open networks that are now possible with blockchains. Sandbeck, Kingsmith and von Bargen argue that blockchain technology is compatible with what they refer to as a

commons-based framework for socio-economic interchange, which, in turn, holds the potential to disrupt neoliberal logics of governmentality, production and value that are only reinforced by standard blockchain architectures. Their analysis comprises an evaluation of the development and deployment of blockchains along each of these three parameters. Next, in Chapter 3, Guido Noto La Diega and James Stacey, after a brief introduction on general regulatory issues in the blockchain, explore the impact of the blockchain on copyright. They argue that the more the blockchain becomes widespread, the more lawmakers develop an interest in regulating it. Most existing regulations, policies and case law take a top-down approach and focus on Bitcoin and, therefore, on fraud and anti-money laundering. A more participatory and holistic approach would be more suitable. Indeed, it is important to involve all the stakeholders and keep in mind all the potential socio-legal issues if one wants to ensure that the blockchain unleashes its full potential and benefits all the players involved.

In Chapter 4, Philippa R. Adams, Julie Frizzo-Barker, Betty B. Ackah and Peter A. Chow-White explore the discourses and activities around women in blockchain meetups through a technofeminist lens. This reflexive "social shaping of technology" perspective highlights how gender and technology co-evolve in a seamless web of technical artifacts, social relations and cultural meanings (Wajcman, 2004). This position challenges the prevailing notion of technology as neutral and value free. In the 1990s, feminist scholars celebrated the emancipatory potential of the Internet to

close the gap of gender inequalities (Haraway, 1991; Plant, 1997; Turkle, 1995). Yet these claims in many ways fell short, leaving the corporeal realm behind. Technofeminism builds on Haraway's vision, conceiving of technology as both a source and a consequence of gender relations (Wajcman, 2004). Within this framework, both gender and blockchain are viewed as part of the texture that constitutes contemporary life rather than as separate from society. In Chapter 5, Scott Freeman, Ivana Beveridge and Jannis Angelis investigate the enablers and limitations of digital trust, which is enabling the mass mobilization of people across geographical and social boundaries at and to a historically unparalleled speed and extent, bringing them into a circle of trust. Blockchain technology is able to fundamentally transform the boundaries of organizations, thus challenging traditional assumptions about organizations being an ideal entity to manage market transactions. Moreover, it threatens to disrupt existing power structures by questioning their future role and reason for existence. Consequently, traditional notions of trust have to be updated. Drawing on market data, industry cases, anecdotes and academic frameworks, the authors analyze the drivers of digital trust in the crypto industry from historic, institutional, market and sociological perspectives. Ivana suggest that the ability to endorse distrust as a crucial aspect of digital trust may be essential for the long-term success of the industry. They support the conclusions drawn with empirical findings from first-hand managerial experience with a leading crypto exchange in Asia. Finally, in the last chapter of this section (Chapter 6), Bronwin

Patrickson explores the potential implications posed by blockchain technologies for Scotland's digital design industries, particularly in terms of creative IP formation, development and expansion. Patrickson worked with three case study partners of variable sizes (small, medium and large) across Dundee, Edinburgh and Glasgow, conducting a participatory action research study involving three active tests of the networked blockchain beta application Colony. During the beta test, Patrickson conducted tests with each industry partner, recording their experience with and evaluation of these applications. Combined with business profiles/histories and before and after participatory interviews, the test is a vehicle to actively explore the influence of blockchain technologies.

The second section of this book focuses on the implications of blockchain on the media development. More specifically, in Chapter 7, Walid Al-Saqaf and Malin Picha Edwardsson focus on how the peer-to-peer, decentralized and highly disruptive blockchain technology may impact or be used by news media and journalists. In this study, we explore blockchain's potential to make journalism a more sustainable business. By reflecting on the *relative advantage* attribute of the diffusion of innovations theory by Rogers, this study assesses whether a blockchain-based newsroom model can compete against the traditional centralized model. As a case study, the authors explore Civil, a blockchain-based protocol that aims to use cryptoeconomics to incentivize the production of quality journalistic content. They conclude that the main relative advantage of a Civil newsroom model is the ability to enhance news credibility. The

protocol achieves this by allowing a greater degree of decentralization, equality, transparency and accountability, which collectively reduce the influence of intermediaries such as advertisers, gatekeepers and media owners. Since Civil and blockchain technology in general are in early stages of development and face many challenges, they argue that it is too early to predict the success of this model and find it useful to track the progress of Civil and similar platforms over time. In the following chapter (Chapter 8), Balazs Bodo and Alexandra Giannopoulou critically examine whether the communities that develop and maintain blockchain technology infrastructures (such as bitcoin or Ethereum) are able to solve the governance issues of their respective, planetary scale technologies; how the governance logics they develop for themselves get reflected in the technology itself; and how the success or failure of the governance of the blockchain technology infrastructure affects blockchain technologies' promise to address the currently unresolved governance challenges of other, planetary scale resources. In this chapter, Bodo and Giannopoulou argue that the genesis of blockchain should not be seen merely as a response to the global financial crisis of 2008 (Nakamoto, 2008**)** but that the crisis of Web 2.0 modes of governance also played a role in the mainstreaming of blockchain technologies.

Lowett analyses the way in which two blockchain-based platforms – Mycelia's Creative Passport and Steemit – are emerging as examples of a particular paradigm of blockchain-based digital media commerce. Each demonstrates how such networks can generate

revenue directly, through enhanced production and distribution systems, and indirectly, via an exponential series of connections. Much has been said about how blockchain systems will increasingly do away with intermediaries – in other words banks, royalty collection agencies, even lawyers and other third parties, etc. – thereby rewarding content creators with higher earnings for their endeavours through frictionless payment systems and smart contracting. However, what is clearly emerging is another form of the "Internet of Value" (Tapscott, 2016), one that does not simply create more revenue by merely simplifying exchange protocols. Steemit co-founder Ned Scott suggests that "It's as though all the [Steemit] users are playing a social media game, and they're earning points based on how well they participate". As network effects are increasingly leveraged as a means to create income, blockchain-based innovations such as Creative Passport and Steemit are emerging as an opportunity to rethink wealth distribution beyond the narrow frameworks that have hitherto dominated the Internet.

Luke Heemsbergen, Alexia Maddox and Robbie Fordyce, in Chapter 10, argue against the ideological tide washing in on peer-to-peer, distributed ledgers based upon cryptography, or phrasing that adds "blockchain enabled" to various forms of digital communication practice. Through a media studies lens we theorize blockchain as "Web 3.0" technology, signalling the emergence of "human programming", where people become the conscious linkages between disparate machineries while serving their underlying vulnerabilities. The authors also draw upon historical

analysis of community access television (CATV) and the Internet and World Wide Web to argue that radical ideologies have intertwined with "new media" and specifically networked media since the 1960s (Hu, 2015**)** and follow an innovation and adoption trajectory of expansion and contraction. Through the case study of Bitcoin, a cryptocurrency based upon the blockchain protocol, they examine its initial innovative frames of expansion through decentralization and disruption of the centralized banking system. They conclude this critique by considering how smart contracts are ledgers of built personal data that are inescapable for their subjects. Guillermina Yensen, in the last chapter of this section (Chapter 11), characterizes an extended way of using blockchain technology in the field of circulation and commercialization of user-generated data through the case of Wibson. Launched in 2017, Wibson is a blockchain-based app that aims to decentralize the data market by "empowering individuals to profit from their data" (Wibson, 2017). This case is relevant for two reasons. First, it represents a clear example of one of the current and most extended modes of blockchain usage in the context of informational capitalism (Castells, 1997; Zukerfeld, 2010). Second, it operates within one of the most profitable branches of the information sector, potentially challenging giant companies like Facebook and Google. This branch has been subject to all kinds of debates about privacy boundaries and abuses and lack of transparency by corporations. Yensen advances the study of Wibson by pointing out some criticisms, underlining how this is a witness case to observe the way in which

the potentials of blockchain technology are being subsumed to the logic of the commercialization of the Internet and, thus, leaving aside the discussions about the meaning of the public.

Finally, the last section opens with Chapter 12 by Janet Hui Xue and Ralph Holz, in which the feasibility of using smart contract technology to handle online dispute resolution on a large scale is analyzed. Online dispute resolution is "referred to as the use of technology to carry out the dispute resolution process". Online dispute resolution combines alternative dispute resolution and information and communications technology; it can be used for disputes arising from both online e-commerce transactions and offline transactions such as purchases. The chapter identifies the feasible regulatory space to help understand how smart contracts for ODR platforms can possibly be regulated and embedded within current law systems.

In Chapter 13, Stéphane Ducasse, Henrique Rocha, Santiago Bragagnolo, Marcus Denker and Clement Francomme present SmartAnvil, an open platform to build software analysis tools around smart contracts. The authors illustrate the general components and focus on three important aspects: support for static analysis of Solidity smart contracts, deployed smart contract binary analysis through inspection, and blockchain navigation and querying. SmartAnvil is open source and supports a bridge to the Moose data and software analysis platform.

In the third chapter of this section (Chapter 14), Dario Puligheddu, Roberto Tonelli and Michele Marchesi describe a blockchain

technology application able to solve many of the drawbacks and inconveniences presently occurring in standard customer relationship management (CRM) using a completely new approach which exploits the blockchain features offered by Hyperledger. The authors implement this scheme with a permissioned blockchain, which requires a precautionary verification of network participants and use “Fabric” by Hyperledger, a project finalized to the creation of Blockchain for Enterprise. The permission structure of Hyperledger reduces the risk of security problems allowing transactions only between authorized parts.

Chapter 15, written by Duarte Teles and Isabel Azevedo, presents the core aspects of the General Data Protection Regulation (GDPR), and then three scenarios are discussed regarding the right to erasure, complemented with a generic GDPR compliance guideline for Ethereum DApps. The authors present also a case study: DFiles, a decentralized application (DApp) built mainly with decentralized technologies, which additionally adheres to blockchain software engineering (BOSE) principles.

In the last chapter (Chapter 16), Felix Hartmann, Xiaofeng Wang and Maria Ilaria Lunesu investigate what the success factors are for blockchain-based crowdfunding campaigns and how they are related to each other. They applied a mixed-method approach, including an analysis of three key evaluation websites of blockchain-based crowdfunding campaigns and construction of an interpretive structural model based on experts’ knowledge. As the results of the study, a list of success factors from both literature and practice is

presented, along with a hierarchical model of the relationships among these factors. The chapter provides a more extensive and structured understanding of what can lead to the success of (blockchain-based) crowdfunding campaigns.

In conclusion, by looking at these three main areas, this book sheds light on the potential impact of blockchain technology on the economic, media, social and technological fields. Thus, the volume integrates a number of chapters examining disparate areas, all unified around their focus on the phenomenon of blockchain in a comparative and interdisciplinary perspective. The book presents new theoretical approaches and empirical evidence to help guide the reader through some of the most critical debates of the digital era. Ultimately, this volume fills a gap in the emerging literature about blockchain technologies by proposing an interdisciplinary approach to understand the social, technological and economic consequences of decentralized technologies.

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