Preface

Everything changed after users' data were made public on the Internet and privately traded by Big Tech companies, and nothing will be the same once such data are made private on the Internet and publicly transacted by their rightful owners.

Blockchain Technology (BT) leverages the disruptive capacity of the Internet in what is thought to be an inflection point for humanity. The dawn of the *Blockchain Era* coincides with a *post-Covid-19 new normal* that mixes health and economic problems, unleashing an even faster transition to digital society. Knowing that money and health are crucial factors in peoples' lives and the two greatest human aspirations besides love, Business and Healthcare are natural choices to envision BT's impact on society.

In the first phase of the Internet, information sharing, and social media economics led to decentralization that stood well below expectations. Instead of Internet democratization made by the people and for the people, the disintermediation envisioned by some has resulted in the fastest reintermediation and personal enrichment processes in business history. Such a successful business reengineering sacrificed traditional editors and old media publishers while, paradoxically, despite Internet's potential to democratize accessing information, new digital business models rather centralized users' data without any further consideration.

Again, disintermediating and re-intermediating processes will be inexorable. Moreover, this time it will not be just about sharing and monetizing users' data. Now, it will be about users' transactions. Indeed, opting for democratizing (public blockchains) or segregate (private blockchains) transaction procedures will have further implications on privacy, free initiative, and even democracy. In the Blockchain Era, not only the users' profiles but also their money will be processed digitally on the Internet. The blockchain's digital functionalities are proven, and it is necessary to choose who will be allowed to use them and whether transparently. Hence, as both economic media went digital (social media and digital money), a redoubled Internet impact on people's lives is expected. This book looks into the political-economic consequences of such impact in the new digital paradigm triggered by blockchain protocols.

It is known that money talks, but it is challenging to realize that digital money is multilingual. Contrary to what one would think possible, money's universal language is changing because the universe of money is now a multiverse—the multiverse of digital tokens. Cryptocurrencies and other crypto-assets can express a wide range of innovative value propositions made possible by blockchain cryptographic techniques.

Digital tokens should not be understood as amounts kept in virtual wallets but as keys that allow exercising ownership by transferring assets and rights. The so-called wallets are, in fact, keychains, which keep private cryptographic keys safe. These keys allow acknowledging tokens' ownership and ciphering the rights to record specific immutable transactions in tamper-proof global digital ledgers

or *hyperledgers*. Transferable rights may be related to an increasingly vast array of fungible and non-fungible assets such as money, votes, bonds, collectibles, and many other goods and services. Hence, personal rights on the Internet can be guaranteed by using private cryptographic keys to access public blockchains, while transactions carried out on private blockchains stay dependent on third parties who have their master keys. In other words, some blockchains decentralize power, and others do the opposite.

Central Bank Digital Currencies (CBDC) can be politicized using particular types of blockchains. For instance, when created by authoritarian governments or totalitarian political regimes, such currencies can even be transformed into globalized rationing tickets tailored to each citizen's political profile, with no private cryptographic keys available whatsoever. Thus, as seen in Chapters 1 and 4, only some blockchains guarantee privacy and freedom of choice in transacting, making it possible to defend private initiative and democracy in a challenging Blockchain Era.

The purpose of this book is to contribute to a discussion of BT's political and economic implications. It is not aimed at discussing buzzwords nor the ups and downs of cryptocurrency prices. While such volatility can impress some and attract the attention of others on the still universal scale of traditional money, this book has more to do with the opportunities and threats raised in the new multiverse of money. It is believed that traditional uni-dimensional money is being replaced by multidimensional programmable money that will enter the financial mainstream perhaps soon than expected. The non-programmable traditional money reduces all the tradable value to just one dimension and limits the spectrum of financial incentives for humanity. However, to freedom advocates, even such uni-dimensional money may be remembered as bearable if digital money becomes a monopoly of the state and corporatocracy. Thus, in this book, it is argued that BT should remain open to free initiative and permeable to human ingenuity so that cryptocurrencies and other digital tokens can be designed and programmed transparently both by governments and companies and by civil society and communities as well. This evolution will extend to many areas besides finance and politics. One of these areas is Healthcare.

Governments are regarding the digitalization of the Healthcare sector as a topic of the utmost importance, especially in developing countries. Although developed countries are driving the digitalization of health, many emerging countries are also implementing digital health programs. Due to its efficiency, these programs enable such limited national economies to make better healthcare investments.

Usually, people only relate Blockchain to digital currency and the investment sector. However, not considering the importance of Blockchain in the Healthcare sector can be misleading because this is one of the areas that may benefit the most. Digital Health is enabling a more patient-centric approach to healthcare. The limited ability of traditional information systems architectures to manage big data quickly, open, secure, and reliable makes BT critical. The privileged use of Blockchain in Healthcare starts at the clinical trial level, moves through the exchange of data between healthcare professionals and healthcare industries, and finally gets to the exchange of information between patients and the other healthcare stakeholders. No other existing technology can manage the very complex inter-relations in healthcare as Blockchain does.

The book's third section covers how vital Blockchain is in different healthcare issues. When considering national and multi-country projects that require a massive amount of sensitive data to be shared, like the COVID-19 vaccination passport, transparency, decentralization, immutability, and auditability, it turns out that Blockchain can be the most reliable and safe approach. This global convenience is no surprise as Blockchain can be crucial to connect communities, countries, healthcare providers, and patients in a decentralized, safe, and tamper-proof manner.

The following lines present a panoramic view of how the book contents are organized.

The book's first section presents the new ethical framework in the light of BT, which is explained throughout this section in relation to Business and Healthcare.

The first chapter, entitled "Blockchanging Trust: Ethical Metamorphosis in Business and Healthcare," opens the book because BT is neither good nor bad, nor by no means neutral. A systematization of the ethical dilemmas in cyberspace, proposed in 2012 by the same author, is now used as a starting explanatory model of the new *distributed trust* ethical consequences. BT changed the trust paradigm for humanity, which requires, above all, a thoughtful, ethical approach. Hence, in this first chapter, it will be seen why BT modifies the technical specifications of the trade-off between privacy and convenience, also changing the compromise between ownership and public rights. In Chapters 1, 3, and 4, it will be argued that the financial incentives and many kinds of transactions can now enjoy transparency and privacy simultaneously, two concepts brought together for the first time in history. BT also seems to allow catalyzing access to information and facilitating digital inclusion, benefiting citizenship and financial literacy. Several new ethical possibilities will be observed as BT offers tamper-proof solutions to certify data accuracy and content precision, which can be a crucial civilizational advantage in a time of *fake news* and political distrust. Throughout the chapter, it is highlighted why BT is a double-edged sword, which can either inaugurate a trustworthy openness era or, on the contrary, reinforce data centralization and feed a lust for power, perhaps pushing society into a worrisome non-democratic path.

The second section of this book (chapters 2 to 6) focuses on the impact of BT on society in general and on business in particular, analyzing the respective political and economic implications.

Chapter 2 is entitled "The Evolution of Trust in Money: A Historical Approach from Clay Tablets to Blockchain." This chapter makes a thoughtful review of the trust evolution underlying the history of money. For many centuries or even millennia, the reckless monetary policies of kings and emperors, often to finance wars (both in east and west), contributed to high inflation periods. Distrust in the economic and financial soundness of currency value foundations boosted money metallization, with emphasis on silver and gold standards, as a way to reinforce currency credibility. However, human greed resulted in seigniorage costs and speculation leading to successive cycles of devaluation in which the bad currency tends to expel the good currency from the market, as stated in Gresham's law. This pragmatic monetary course is justified because people save the most reliable money, withdrawing it from the market, preferentially using the one offering more devaluation perspectives. For decades, the world witnessed the widespread use of the so-called *fiat* currencies, which are not backed by anything else than confidence in the states' ability to finance themselves by collecting taxes. Nevertheless, as explained in this chapter, when the nominal value of currencies is essentially determined by authorities and is not related to its intrinsic value, money's value has been historically interrupted whenever the lack of confidence in money's issuers is so blatant that fiduciary trust ceases its effect. Over the centuries, a vicious circle of measures and countermeasures motivated by inflation and greed formed a spiral that persisted in the last century (*e.g.*, World War I and II) and reached this century with a financial crisis (2008-2009) that was not a good omen. Right at the beginning of the second decade of the 21st century, a severe pandemic further eroded confidence reminding that the specter of inflation or even hyperinflation always lurks. Chapter 2 also shows that, at least for the past 500 years, there have been financial instruments, such as the Bill-Of-Exchange and the Scriptural-Money issued by banks, that have provided economic agents, like merchants, companies, and banks with valuable networking information on the financial position and commitments of the parties involved in commercial transactions. For centuries, these documents were *paper tokens* registering financial movements in ledgers shared on the economic agents' networks, making international trade much more dynamic. Such *paper tokens* can be considered somehow *equiva-*

lent to the current digital tokens, inscribing precisely the same type of valuable information in a global digital ledger (hyperledger) to ensure safe transactions carried out on blockchain networks. The chapter's journey through money's underlying trust finally reaches the 21st century with the advent of cryptocurrencies, which are viewed with some skepticism, although tempered by recognizing their important role in the evolution of trust.

Chapter 3 is entitled "Blockchanging Money: Reengineering the Free World Incentive System." It begins by discussing money's essence, arguing that cryptocurrencies can be genuinely considered, from a market perspective, as being real money despite having no intrinsic value. Hence, it is explained why, for centuries, the so-called *stone money* of the Yap Islands in Micronesia was perfectly handled even though each one of such coins could weigh several tons. This *stone money* is a weighty argument against the assumption that intrinsic value is an indispensable currency's attribute because a stone's value is practically null. Instead, the value of *stone money* was due to its costly production (which was responsible for their scarcity) and to the fact that such stones were tokens playing an essential role in double-entry bookkeeping thanks to the oral ledger of Yap's natives' collective memory. According to several authors, this oral ledger can be considered a precursor of BT's *hyperledger*, and *stone money* can be compared to Bitcoin. This case serves both to illustrate the nature of money and to show how erroneous intrinsic value can be when one is assessing the economic potential of cryptocurrencies. This chapter acknowledges programmable money's political-economic potential, emphasizing how crucial its governance will be keeping freedom and democracy safe (the political question is further detailed in chapter 4). As seen throughout the chapter, digital tokens bring together all the characteristics and technical attributes of money (most of them with comparative advantages). However, the story does not end just like that. Unlike traditional currencies, cryptocurrencies and other digital tokens can be programmed to incorporate *labor* and *capital*, integrating both productive factors in the same unit of account for the first time in history. This financial chimera puts humankind on the verge of a multidimensional monetary system where cryptocurrencies can integrate social and individual incentives. A new architecture of financial incentives, which will be discussed throughout the chapter, may induce socially desired behaviors in producers and consumers. The author thinks that the new *crypto economy* will make it possible to use digital tokens to foster collective action in a decentralized way (without resemblances with collectivism). By endowing the free market's invisible hand with blockchain cryptographic credentials, it will be possible to shake that hand, making it visible to society, promoting the alignment between human ingenuity, ambition, and merit on the one hand, and ethical entrepreneurship socially endorsed by human values on the other. As seen in this chapter, private cryptographic keys will code free initiative in a liberal political scenario, protecting privacy to openly catalyze innovation, unleashing a myriad of cryptocurrencies integrating private financial incentives with the public interest, not only creatively incentivizing and rewarding individuals but nurturing social synergies in sustainable community ecosystems.

Chapter 4 is political, and one should acknowledge that it is framed by a liberal reformist political perspective and written in co-authorship with a Former Prime-Minister of Portugal and Former Mayor of Lisbon whose political positions are also well known. Entitled "Blockchanging Politics: Opening a Trustworthy but Hazardous Reforming Era," this chapter argues that digital centralization should not be a political option for free societies in the Blockchain Era. It presents political solutions and recommendations that figuratively can be equivalent to a vaccine against the ideological virus of single-thought because BT can also be used in a particularly virulent way. In the authors' opinion, for the worst scenario to materialize, it is enough that law-abiding citizens be prohibited from using private cryptographic keys to protect data's property and defend their privacy. As discussed throughout the chapter, such personal

secret keys are digital passports to free initiative, privacy, and democracy. They are like *digital masks* that will protect citizens against contagions digitally spread in economic media vectors (social media and digital currencies) by authoritarian governments, especially when the centralized digital currencies enter the global financial mainstream. Probably, this will be the case of Digital Yuan, which is already booming in China. In this chapter, Digital Yuan and Bitcoin are comparatively watched, anticipating the clash between *surveillance money* and *money that sets people free*. It is thought that this confrontation will be much more than a financial dispute, introducing what probably will be the most crucial political dichotomy in the following decades: open/decentralized vs. closed/centralized. Blockchain cryptographic technologies are paving the way for establishing decentralized and transparent governance models based on community consensus. As seen in this chapter, transparency allows more auditable and granular governance models that will provide secure information through *public blockchains*. On the other hand, thanks to *smart contracts*, digital tokens can make citizens' will more actionable and be used as votes scrutinizing the government often, if there is the freedom to do so. However, unfortunately, instead of giving people a voice, BT can be used to do just the opposite, which should be a matter of great political concern. Indeed, digital money protocols can be used to serve society in good and evil ways, and this chapter discusses how to take political advantage of BT possibilities to increase governance transparency, which is anticipated as something truly essential in the Blockchain Era.

Chapter 5 is entitled "The Real Blockchain Game Changer: Protocols and DAOs for Coordinating Work to Provide Goods and Services." After the hierarchical organizations that drove institutions for thousands of years, followed by digital platforms that increasingly streamlined the creation of value in many areas in the last three decades, it is now time for *protocols* creating value in a new decentralized way. BT protocols make it possible to develop ecosystems and synergies between people by integrating the productive factors *labor* and *capital* in a way only possible thanks to advanced cryptographic techniques. Thus, creating new decentralized forms of governance is viable either in politics or other areas of social and economic interest through Autonomous Decentralized Organizations (DAO). This chapter explains DAOs straightforwardly and compellingly, presenting use cases that include decentralized finance projects (Defi). Although pioneer DAOs like Yearn (yearn.finance) presents competitive financial solutions, one should understand that money is just the beginning, and probably many other DAOs and decentralized apps (*dApps*) will thrive, delivering a vast array of products and services. DAOs protocols ensure growth by promoting a synergistic alignment between consumers who are also producers (*prosumers*) that add value, primarily through their intellect, and the required capital to start the projects, integrating it with the necessary *labor* to provide products and services. Four concrete DAO cases are presented: (i) censorship-resistant money; (ii) trustless operating system; (iii) permissionless hedge fund; (iv) trustworthy data feeds to decentralized applications.

Section 2 ends studying how BT can leverage e-commerce. As is well known, commerce has been a fundamental wealth generator for humanity, which justifies relating BT and e-commerce. The *pre-blockchain* Internet was endowed with significantly simplified information sharing protocols, and the business models have adapted accordingly: given the impossibility of charging for the consumption of content copied at practically zero cost, business models reengineering sought indirect and sophisticated profitable approaches extracting value from the very human tendency to share information to satisfy affiliation, self-esteem, and self-fulfilling needs, especially if there are no payments involved. Thus, "freemium" business models and tactics that artificially exacerbated market segmentation (deceptive marketing) have emerged using controversial biased algorithms to monetize users' data (see Chapter 1). However, direct commercial exchanges between people, *i.e.*, the simple purchase and sale of products

and services, have always been the mainstay of human progress and economic development. Today, as BT's cryptographic protocols make it possible to preserve the originality of data transmitted on the Internet, it is possible to simplify and speed up digital transactions, which can now be carried out in decentralized markets, between individuals, and without intermediaries (see Chapter 3). It is thought that such democratization can take e-commerce to a higher level, justifying Chapter 6.

Chapter 6 is entitled "Combining E-Commerce and Blockchain Technologies to Solve Problems and Improve Business Results: A Literature Review." It presents a comprehensive and in-depth assessment on how BT can leverage *e-commerce*, identifying the advantages of combining blockchain and e-commerce, and raising foundation grounds for future research in this regard. Through thoughtful thematic analysis, this chapter points the spotlight to scientifically illuminate a way of leveraging e-commerce that is expected can be taken by humanity in favor of progress and wealth creation.

The third section of the book (Chapters 7 to 13) discusses BT's political and economic implications in *Healthcare*, covering how vital Blockchain is in different health issues, enabling a more *patient-centric* approach to Healthcare.

Chapter 7 is entitled "Application of Technology in Healthcare: Tackling COVID-19 Challenge: The Integration of Blockchain and Internet of Things." This chapter discusses the importance of blockchain and IoT technologies in the healthcare system. The number of medical devices that allow data collection and remotely interconnection increases exponentially every year, and the security problems due to the IoT architecture must be handled to ensure better privacy and security. A synergy between BT and IoT will help overcome these issues. The three cases explored in this article show the potential of integrating these two technologies in the healthcare sector, focusing on possible applications to face the COVID-19 crisis and its aftermath, making industries more resilient and help the public health systems cut costs improving healthcare.

Chapter 8 is entitled "Electronic Health Record Patient Portals and the BT." *Electronic Health Record Patient Portals* play a significant role in promoting *patient-centric* digital Health. Thanks to digital Health, patients can access their medical records, book appointments, and ask for prescription refills. *EHR Patient Portals* manage complex and sensitive patient data and should be able to support the transfer of data between different systems. Interoperability, confidentiality, and data consistency are critical features that should be embedded in the logic of *EHR Patient Portals*. BT comprises all these characteristics and should be used to support *EHR Patient Portals*.

Chapter 9 is entitled "A Concrete Way to Develop Clinical Research in a Fair Way to the Users/Patients Using BT." Combining the incorruptibility of BT with clinical research might be a powerful tool to re-establish trust in clinical data. Moreover, the introduction of this technology may allow patients to possess their clinical data and decide to share it in exchange for tokens representing financial gains and other benefits. Hence, this chapter describes how to develop clinical research fairly using BT, discussing the main advantages of blockchain-based technologies in this particular, focusing on some examples and the challenges of their implementation. On the other hand, it explores *patient-centric data monetization* using *smart contracts*.

Chapter 10 is entitled "Data Security in Clinical Trials Using BT." Clinical Trials are technically very complex studies that have to manage pharmaceutical drugs and patient data. Another challenge is connected with the fact that clinical trials often use multiple clinical sites and multi-country approaches. Concerns with security and data integrity in clinical trials encourage the use of BT, which comprises characteristics that include traceability, decentralization, immutability, and auditability critical to the success of clinical trial data management. This chapter maps the current use of blockchain systems in

clinical trials, particularly data security managing systems, and their characteristics. It concludes that BT can produce a more transparent and tamper-proofing clinical trial by providing accurate, validated data, producing more reliable and credible outcomes in clinical trial research.

Chapter 11 is entitled "Blockchain and Clinical Data Economics: The Tokenization of Clinical Research in the EU." In this chapter, next-generation technologies in clinical research are presented, and innovative solutions are identified given their potential to accelerate biomedical research and give patients new tools to take control and monetize their data. Specifically, the current status of BT in the EU is presented, observing how it can impact the development of clinical research going forward. Several examples to put personal health data in the hands of the patient also be shown. This chapter enlightens the primary goal of using BT, which is to facilitate the interaction between organizations and individual data-owners, although blockchain integration in healthcare systems creates some technical challenges. Not less important are the misperceptions of different players (researchers, patients, funders) about BT, making it difficult to embrace this technology.

Chapter 12 is entitled "Dentacoin: A Blockchain-Based Concept for Dental Healthcare." Dentacoin is an excellent example of a community-based ecosystem (in the dentistry area) whose existence is only possible due to BT. After discussing BT and the new token economy, the chapter follows observing the case of Dentacoin, both a customer-centric and an industry-centric solution whose primary purpose is to improve dental care worldwide and make it affordable by reducing the costs and increasing the benefits for all participants. As more and more people earn Dentacoin (DCN) and use them in various ways, the value of the cryptocurrency can rise, which would give more freedom and trust to the Dentacoin Community. Indeed, the idea behind Dentacoin is a revolutionary technology, and it is thought that it will only be a matter of time before it reaches other areas of the healthcare industry once that Dentacoin numbers of users and partners are growing each day.

The book's third section ends with Chapter 13, entitled "Blockchain Pharma: A Prospective Overview." BT is at the epicenter of a progressive digital revolution which includes the pharmaceutical industry, where BT is changing the supply chain, clinical trials, and research, offering more transparency, traceability, and security. As it is highlighted in this last chapter, BT aggravates the dilemma between data centralization and the original vision of a decentralized Internet, namely because it provides the necessary confidence to transact value on the Internet even in the absence of intermediaries, and this disintermediation can be used predominantly in favor of patients or be focused on increasing other stakeholders' privileges. Throughout this chapter, the aim is to examine the eventual shift towards a health system where the patients are the legitimate owners of their medical records. As it will be seen, Estonia, perhaps the most digital country worldwide, stands out as an example of health systems modernization. This chapter discusses blockchain's structural characteristics and competitive advantages (immutability, transparency, and security) that it is thought will justify its wide use by the pharmaceutical industry. In the pursuit of greater process rationality and simplification, blockchain is applied in diverse areas as supply chain, clinical trials, and R&D. The author will present existing solutions that allow the end consumer to verify provenance and authenticity using a simple smartphone *app*. Finally, it will be observed how BT plays a crucial role in R&D, notably protecting intellectual property rights.

As of last remarks, the editor emphasizes that this book intends to convey that humanity is experiencing one of the most important, if not the most, inflection points in its social, political, and economic history.

If freedom prevails, which is not guaranteed, especially when times are tough, BT will allow taking advantage of the most remarkable reduction in transaction costs of human history, a value created

by the new *distributed trust*. This historic landmark constitutes a unique opportunity to foster ethical entrepreneurship and sustainable human development.

As digital tokens are tradable without intermediaries and may carry specific workloads by integrating *labor* and *capital* valences (and not just capital like traditional money), money becomes a means of expressing other types of value in addition to the financial value in the restricted sense, and one must start reasoning upon monetary value in a broader sense. The new *multiverse of money* can now serve to express political, economic, and social wishes. Digital tokens are programmable and can be used to vote for achieving specific outcomes through self-executable contracts (*smart contracts*) that articulate resources in a decentralized, although structured way, allowing people to take options, make deals, and trigger deeds in many different areas, as explained throughout this book.

Dario de Oliveira Rodrigues
Instituto Politécnico de Santarém, Portugal