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Disintermediation Economics: An Introduction

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Trust Engineered!

In the early 1990s, Francis Fukuyama published a book with the provocative title "The End of History and the Last Man". The book was based on an article published a few years earlier and the main argument was that the battle of political ideas ended with the victory of Liberal Democracy as the sole version of social arrangement after the collapse of Socialisms around the world. We remember this, now famous, book from the first part of its title, "the End of History," and we usually neglect the second part, "the Last Man," which advances an equally powerful statement: that we, people, have reached a point in our social evolution that the level of individual trust to the institutions around us cannot be improved further with more "social engineering" (Fukuyama 1992).

The idea of the "last man" is not new, though. Its origins are as old as the theoretical explorations of Hegel and Marx who worked with these research questions first and introduced systems of polity that disrupted the conservative and liberal ideas of their time. We now know that the Hegelian and Marxian assumptions of the institutional evolution of the people were

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static and myopic because they neglected the factor of technology as accelerator of economic and social change. They replicated the ideas of Malthus who considered that change is statistically negligible, if not impossible, and saw every aspect of social interaction as a zero-sum game. Fukuyama, just like Hegel and Marx before him, was victim of the same "Malthusian fallacy". Trust can be further improved, or engineered, with the evolution of technology, or so it is the assumption of the enthusiasts of Blockchain.

Blockchain, as a technological narrative, brings to Economics a very powerful promise. It claims that it can improve economic efficiency by removing the impact of information asymmetries and disincentives of collaboration. Blockchain goes in the heart of the transactions, of any kind, and promises to remove the negative effects of the inherent lack of trust between the transacting parties by *eradicating* the risk of ex post misbehaviour of those involved in an economic relationship or interaction, whenever this relationship or interaction requires a minimum level of coordination and commitment.

In one sentence, blockchain, it is said, neutralizes the negative effects of the lack of trust and enables people to act economically without the need of being confident about each other, by providing an infrastructure that guarantees the integrity of any transaction and any database in a network of ledgers. This can be accomplished without any need for a trusted third party acting as an authority to validate the transaction or the integrity of data (Swan 2015). Blockchain is claimed to be a *truth machine* (Casey and Vigna 2018) that will revolutionize our understanding of money, the markets, the governments, even our identities, and the social cooperation in general (Tapscott 2016).

This collective volume brings together economists, lawyers, market participants, and regulators from all over the world to explore what this technology can do (and cannot do) and explore its impact in the disciplines of Microeconomics, Macroeconomics, Finance, and Political Economy.

Why Disintermediation—And Not Decentralization Economics? The Problem of Dealing with Randomness

We use the term "Blockchain" but it would be more accurate to speak about distributed ledger technologies (DLTs). Blockchain is one possible engineering option in a family of options, however for simplicity we call here blockchain every DLT. The very design of the blockchain, including its consensus protocol and the rules of participation and engagement,

usually categorized as permissioned and permissionless blockchains, can vary. Options entail the use of distribution, encryption, immutability, tokenization, and decentralization (Furlonger and Uzerau 2019). But these are just options. The engineer selects the design that works best for her business model.

However, there is a clear-cut governance distinction we cannot ignore. A fully decentralized blockchain, decentralizes also the role of the authority who enforces the "property rights" in the ledger. A fully decentralized blockchain is a very democratic blockchain because it allocates one ballot to every node. It is obvious that hierarchical institutional systems (both in the market and the government) do not value a fully decentralized option very high. This does not prevent them though from experimenting with less strict options that enable disintermediation, or options of designing systems that reduce transaction and verification costs that accrue from the use of a trusted third party, the intermediary.

Possibly, as blockchain technology matures (or as the market matures), as well as the interaction of humans with machines or machines with machines (in an IoT dense environment) proliferates, we will move with more confidence to fully decentralized solutions. We believe though that this move towards decentralization cannot happen in a social vacuum. Social forces, at least for the time being, predispose people to feel more comfortable with disintermediation-oriented blockchain solutions.

How fast can we move from a predominantly disintermediation-oriented blockchain environment to a predominantly decentralization-oriented one? We can assume that, just like in the case of disintermediation, decentralization will follow the same track of adoption. The diffusion of innovations model is helpful for us to understand the process (Rogers 2003), but as it happens to any diffusion model in general, there is a set of behavioural requirements that we cannot ignore (Page 2018). I believe that at the core of these behavioural barriers lies the (dis-)comfort of the individuals with the notion of *randomness*. How much randomness an individual can accept in its economic interactions?

To make this point more precise let's review a truly decentralized blockchain system, the Bitcoin blockchain. What makes the Bitcoin blockchain methodologically significant is its way of removing the need to link a particular person with its signature and at the same time it allows this person to have as many signatures as it likes. In a decentralized blockchain environment, an economic agent is as good as her digital signature. Delinking the personal identity from that person's signature is counterintuitive

in the economic system as we know it and it is already a significant deviation from the common practice.

What makes a person's signature so unique? It is something that brings a sense of authenticity because a signature is unforgeable and verifiable. What gives these properties to a person's signature? It is a fact that a signature is always similar but never identical. Humans generate *true randomness* in the way they write a signature that prevents replications and forgery from third parties. Our society accepts human-generated randomness as a source of authenticity, as this randomness is considered to be *true*. A decentralized blockchain system, on the other hand, generates digital signatures as a source of authenticity, but these signatures are *artificially random*. This can have significant implications.

A decentralized blockchain system, in order to be successful and reliable, must generate the properties of the physical signature, namely verifiability, and unforgeability, in a digital equivalent, the digital signature. The digital signature in the case of the Bitcoin blockchain is a 256-bits hexadecimal number generated by an algorithm, the blockchain protocol, automatically. This number is *almost* random and generated in a way that makes the reverse-engineering statistically *almost* impossible. This "almost" is what distinguishes artificial randomness from true randomness.

But the blockchain protocol goes a step further. It is designed in such a way that "honesty" is not required by the economic agents. Non-required honesty in a decentralized blockchain is another deviation from the common understanding of economic interaction that our society is hard to digest. In the case of the Bitcoin blockchain, honesty is not required because the appointment of a node in the blockchain to verify a transaction is also random. The randomness is necessary for the success of the decentralized blockchain because this prevents biases in favor of one transaction over another, prevents the prolongation of malevolent transactions that may endorse double-spending attacks, and prevents collisions that can compromise the validity of the ledgers by verifying *forking*. Randomness here is a tool strengthened by the requirement of a policy norm among the ledger participants (accept the leg of blocks that is bigger than the rest).

The first core question to ask here is: how can we trust that an algorithm, which by nature is a deterministic process, can generate randomness good enough to produce a probabilistic scenario that humans and their institutions can trust? This is a high behavioural barrier that becomes even higher when the stakes are higher and when the alternatives to this option are cost-efficient and deeply embedded in the minds and habits of legacy economic agents. The problem can become even more acute when other technologies,

like a possibly very efficient hyper-performance computer, or even a quantum computer, can compromise the encryption adequacy of those random streams of numbers. Of course, there is nothing to prevent us from thinking that a quantum computer threat will be impossible to be addressed by an adequate quantum-resistant encryption mechanism, but still, this does not leave us in a better position when considering the problem of attractiveness of artificial randomness by humans and their institutions.

The second core question to ask is: how can humans blend artificial randomness with policy norms to sustain a blockchain when they know that a minority can violate these norms by creating forks? A decentralized blockchain protocol is very efficient in creating incentives for not tampering with the ledger but, effectively, blockchains are not really tamper-proof. This means that artificial randomness is a necessary requirement for sustaining the validation of decentralized blockchains but not a sufficient requirement in keeping the integrity of the architecture if a group of people wants to redefine the prevailing norms. Moreover, people are not used to solve institutional disagreements with forking.

These two problems, (1) the trustworthiness of artificial randomness and (2) the coupling of artificial randomness with the need for solid norms for sustaining the integrity of a decentralized blockchain system are both significant impediments that prevent people and institutions from accepting decentralized arrangements, especially when the stakes of failure are high and the available legacy systems are still considered as trustworthy solutions. This generates incentives for economic agents to advance disintermediation rather than decentralization-oriented blockchain solutions.

A third limitation imposed by randomness is not about the protocol itself but about the limitations of the blockchain architects to predict all the possible contingencies and emergencies in complex situations. It is impossible to foresee all the possible scenarios in advance and design ex ante an omniscient algorithm agile enough to prevent any malevolent attempt against the ledger. Humans make the code and codes usually have glitches. There is always a "smarter" or "luckier" fellow who can detect and exploit algorithmic inconsistencies. This is the case of Ethereum DAO that forced people to implement a painful forking to restore the integrity of the ledger. People are smart, but not smart enough to design algorithmic contracts that grasp every aspect of the complexity in advance. This makes decentralized constructions exposed to random events, black swans if you will, that compromise the strength of the protocol in its entirety. A decentralized blockchain is as strong as the least perspicacious smart contract design.

Decentralized blockchain solutions are already with us in numerous cases; in the case of Bitcoin, in the design (successful or not) of Decentralized Autonomous Organizations (DAOs), in significant attempts to build Decentralized Finance service providers (DeFi). Market participants experiment already and tech-savvy agents experiment with it but the limits of DAOs and decentralized ledgers are as good as the capacity of the designers to predict what can go wrong. Bitcoin is a very illuminative case: it performs a very well-defined simple task repetitively. Contrary to the failed attempt of the Ethereum DAO a few years ago, it has limited aspirations. But even Bitcoin, the most successful case of decentralized ledger, could not escape from the limitations of its own architecture. It paid for its resilience with significant limitations to its scalability and an endless number of forks (to date 105 forks have happened to the original Bitcoin blockchain of which 74 are active projects).

Regulators and market participants cannot ignore these restrictions and feel much more comfortable to work with risks they can control and probability distributions that rely more on solid design architectures than unreliable levels of randomness. A purely decentralized blockchain, the Bitcoin, forced us early enough to think seriously about how far these innovative institutional arrangements that blockchain brings to Economics can go. This was the dawn of Blockchain. When the sun raised higher in the sky, we saw that the society is not ready to allocate much of its trust to artificial randomness. It was ready, instead to experiment with more controlled solutions that advance disintermediation (the removal of the third-party verification authority from peer-to-peer transactions between interested parties).

What do we mean by *Disintermediation Economics*? We mean the impact of blockchain in Economics when economic agents (including corporations, medium and small enterprises, and the public sector) use blockchain solution architectures that advance *distribution*, *encryption*, and *immutability* in a wide range of cases with the purpose to remove intermediaries from the value chain with significant results in their organizational setting and their vertical or horizontal integration. We also explore how *tokenization* transforms finance and financial market structures as well as how central banks and corporations introduce *programmable money*. We explore how blockchain advances social inclusion, transforms the citizen-state relationships, and improves democracy. We explore how blockchain accelerates growth in the developing world, accelerates the efficiency of innovation ecosystems, redefines our sense of ownership and distribution of data, and forces regulators to be more open-minded and alert for significant changes in the future.

This volume reflects those market and regulatory realities. The authors of this volume do not rule out the possibility of another book, possibly with the title *Decentralization Economics*, but we are not there yet. We hope, though, to be there soon as blockchain improves rapidly along with the change in the taste and preferences of the markets.

The Structure of the Book

The book is structured in three parts. First, we explore how blockchain fits in the curriculum of Microeconomic studies. Here we place emphasis on four topics: industrial organization economics, corporate strategy, economics of smart contracts, and economics of distributed data.

Dimitris Psarrakis opens the Microeconomics part of the volume. In his chapter, he explores how blockchain changes economic organizations. Dimitris claims that the technological change that blockchain brings to the economy is not Hicks-neutral. Different choices in the architecture design of a DLT generate different organizational settings and market structures. He underlines that there is a blockchain *organizational continuum* that includes blockchain-enabled, blockchain-complete, and decentralized-complete organizational settings. How far a firm will go in this continuum is a function of transaction and coordination costs. Though he does not make any prediction on the blockchain adoption over time, he shows that any approximation to a decentralized-complete organization is constrained by four empirical findings: first, ownership behaviour persists in blockchains, second, incomplete contracts persist in blockchains, third, blockchains cannot sustain consensus in perpetuity, and fourth, short-term behaviours in a blockchain are not necessarily aligned with long-term targets. He concludes his chapter with an exploration of techno-social factors that can affect the rapidity of adoption of blockchain in the context of variegated capitalisms.

Then ***Guenther Dobrauz-Saldapenna*** and ***Mark Schackmann*** introduce us to the topic of the economics of smart contracts. The authors support that smart contract is a significant innovation for the performance of industrial, commercial, and administrative tasks. They note that the concept of smart contracts is well developed in the field of Computer Science but its uses in the market and the legal services are not as mature yet. Smart contracts bring challenges in both economic and legal terms. Then they explain what a smart contract is and describe some possible use cases. They explore the role of smart contracts in the economic theory focusing particularly on the topics of contract completeness and dynamic contracting. Guenther and

Mark underline that functional inefficiencies and limitations in contract and algorithmic design are persistent in both the analogue and the smart contracts and prohibit contract completeness in both the versions. On the other hand, they note, the static nature of smart contracts prohibits dynamic contracting between the economic agents. This can be remedied, they claim, with deviations from purely decentralized designs with the inclusion into the smart contracts of physical intermediaries (curators) and programmable intermediaries (oracles). Finally, they explore how the property of self-executability can be improved with Ricardian contracts that can add discretion and flexibility.

Then, follows the chapter of ***Hans Verheggen***. Hans links corporate strategies and blockchain solutions. He explores what blockchain means for corporates today and how they approach digital transformation leveraging blockchain concepts and technology. After a brief outlook on the blockchain market for business, he presents a picture of how enterprise blockchain and digital assets are becoming part of the corporate business model (how they create and deliver value) and the corporate operational model (how they capture their value). Next, he looks into how companies can build successful consortia, design enterprise blockchain solutions, and engage with the innovation ecosystem. Finally, he considers how corporations and markets can create business and operating models that become blockchain complete.

The first part of the volume closes with the contribution of ***David Shrier*** on the topic of decentralized data economics. David states that distributed ledgers offer new horizons of opportunity for the monetization of data, and new models whereby individual consumers gain more control over and benefit from their personal data, versus the predominant model of today that awards the greatest economic gains to the oligopoly platform companies. He notes that understanding distributed data economics requires reviewing the lineage of data aggregation, the characteristics of legacy data economics, the rise of a new generation of data ecologies, and finally exploration of the potential of distributed data economics in the context of technology architecture, governance, societal implications, and distributed data policy. David underscores that data ethics, and a framework for the related area of ethical artificial intelligence (and how it interacts with data) have not only moral implications, but real-world business impacts, as governments strengthen their responses to private sector activities in data monetization. Furthermore, as distributed data economies move from theory into practice, government policy interventions can smooth this transition.

Then we move on to explore Macroeconomic and Financial Implications of the blockchain innovation. Here we explore how blockchain applications

and solutions can support major growth projects, including the Sustainable Development Goals of the UN. However, the impact of blockchain in monetary policy and payments infrastructures with crypto-currencies and stablecoins is a major topic to be explored. Then we turn our attention to the financial applications of blockchain, and we see how crypto-assets can improve the channeling of capital to risky projects, market structure concerns, and regulatory challenges.

Jane Thomason opens the second part of the book with her chapter on blockchain for growth. Jane claims that it is incumbent upon governments and the international community to explore how to marshal its benefits for the SDGs. Blockchain, Jane stresses, offers potential benefits for poverty, hunger, health, gender inequality, clean water, affordable clean energy, climate, and partnerships for the global commons. 2019 saw the stabilizing and maturing of the Blockchain industry, becoming more about what the technology enables. She believes that 2020 will be the year that blockchain goes enterprise—research and development projects will bear results. She underscores that the areas where major blockchain progress is taking place are as diverse as the applications they are creating. The global nature of Blockchain's development can help distribute opportunities for wealth creation and economic development more widely than before. It is important for governments to develop the right policies to harness the potential benefits of this technology while mitigating its risks and potential for misuse. To do so, it is essential for countries to cooperate in order to share best practices and ensure interoperability. Jane summarizes the many applications of Blockchain in contributing to widespread social transformation and enabling traction against the SDGs, focusing on emerging economies. It also discusses barriers and enabling factors to achieve such a transformation.

Then we move to the opportunities and challenges that cryptocurrencies bring to the monetary policy. ***David Lee*** and ***Enrie Teo*** introduce us to the concept of the "new money". The authors stress that since their inception in 2008, cryptocurrencies are gaining adoption globally. Even though its utility may vary, the primary purpose of cryptocurrencies is to provide some form of payment (or medium of exchange) in the digital world. Lee and Teo underline that as more use cases arise from the industry, cryptocurrencies and blockchain are no longer a niche topic. Educational institutions are introducing it into their curriculum, and governments are talking about it in parliament. In particular, governments are keen to determine if the underlying technologies can form the fundamentals to issue a Central Bank issued Digital Currency (CBDC). Will these forms of currency become the "New Money"? This paper sets out to explore the utility of cryptocurrencies and

CBDC, their implications on the economy and the government's ability to use monetary policy. In their chapter, the authors examine and compare the approaches to CBDCs suggested by various governments.

Stablecoins become a major topic in the monetary policy and blockchain community after the announcement of Libra to issue its own programmable money. ***Dante Disparte***, VP of Libra, shares his views about privately issued digital currencies. Dante notes that the progress and maturation of digital currencies should be welcomed by a wide range of stakeholders. Over a maiden decade, the world observed the wave of cryptocurrencies, greed-fueled or shoddy initial coin offerings (ICOs) and basic risk management failures, give way to credible opportunities to add optionality and competition in payments and banking through sound privately issued digital currencies. Dante underscores in his chapter that privately issued digital currencies or so-called stablecoins can play an important role in improving financial services. From enhancing consumer choice to spurring responsible financial services innovation and operating within the realm of regulatory and prudential oversight, rather than undermining or circumventing it, an industry is coming of age. After all, he claims, the vast amount of money in circulation in the global economy is privately issued via the two-tier banking system, credit card issuers and payment services firms, which are now turning to cryptocurrencies as a part of their own digital transformation efforts. This much holds true for the advent and likelihood of widespread public sector issuance of digital versions of fiat money in the form of central bank digital currencies (CBDCs).

Then we move into the space of crypto-asset. ***Elisabeth Noble*** from the European Banking Authority, gives us the view from the EU on this very critical topic, in the light of the recently introduced "Markets in Cryptoassets Regulation" and the "DLT Pilot Regime" for the crypto-asset secondary markets. Elizabeth provides some context for those regulatory proposals and reflects on some of the issues industry, regulators, and supervisors have encountered in seeking to reconcile innovative DLT applications with EU and national financial services law. Her chapter goes on to outline the key elements of the legislative proposals, which are intended to mitigate risks effectively and facilitate the scaling-up of DLT and crypto-asset applications in the EU.

Having explored the view of the EU on this topic we turn our attention to the view from Asia. ***Syren Johnstone***, regulator in Hong Kong, stresses that the response in Asia to the emergence of crypto-assets has varied enormously intra-regionally. Developments in the larger capital markets have ranged from actively permissive industry-regulator partnering that has led to more granular regulation (Japan), to cautious approaches openly permitting industry

development while applying existing laws where possible (Hong Kong), to banning specific activities while also promoting blockchain technology (Mainland China). After a review of the Asian narrative, he summarizes the current status of regulation in Asia. Then he addresses the hurdles to ecosystem development and questions whether regulatory incrementalism is sustainable. At the end of his chapter Synen reviews suggestions for policy development.

We conclude the Disintermediation Economics book addressing the impact of blockchain in the political economy, the regulation, the government sector, and the concept of disposable identities.

Peteris Zilgalvis, head of the Blockchain unit of the European Commission, opens the final part of the volume. Peteris stresses that the law and political economy of decentralized digital ecosystems is the policy, economic, and legal framework surrounding the convergence of Blockchain/Distributed Ledger Technologies, the Internet of Things, decentralized Artificial Intelligence, and other emerging technologies. He claims that the key unifiers are the enablement of multilevel governance, the decentralized management of data and the distributed nature of the technologies. These new realities, Peteris underscores, will challenge the existing more centralized economic and data management model of today's Internet and will provide self-determination to citizens in the management of their data and transactions. He believes that a major challenge for the implementation of these technologies is linked to their very essence, their decentralized nature. Much existing legislation was adopted in a time when more centralized models dominated. Finally, he analyzes the legal challenges of applying such legislation to decentralized digital technologies, and reflects on the use of regulatory sandboxes as well as novel legislation in order to enable innovation in the economy and society based on the application of these technologies.

Then, we turn to the fundamental question, how to create a global regulatory competitive advantage for the blockchain applications and solutions. ***Eva Kaili***, the rapporteur of the Blockchain Resolution of the European Parliament and Chair of the Committee for the Future of Science (STOA) gives us her view on the topic. Eva stresses that the current efforts to provide institutional and legal certainty around blockchain-based innovative solutions reflect the status of the technology as it appears in the market today, which emphasizes more the "disintermediation" properties of the DLTs and less the "decentralization" properties. She believes that with the improvement of the design architectures, the algorithmic efficiency of the smart contracts, and the blending of DLTs with machine learning we can expect "decentralized autonomous organizations" to become more efficient over time and reach

more strategic industries. This, she expects, will transform market structures, business and operational models and it is expected to have strong macroeconomic effects. These developments will pose significant challenges to the regulator. A principles-based approach is a sine qua non for creating a sustainable competitive advantage in order for an economy to leverage the benefits of blockchain. European Union is a pioneer regulator in the space of distributed ledgers. It adopts a technologically neutral approach. She believes that this is an appropriate approach, however technological neutrality should be coupled with business model neutrality. This is a requirement for making sure that the regulator will not be directed by short-term considerations and constraints. The European Parliament's Blockchain Resolution is a text that reflected the views of how to approach, from a regulatory point of view, a technology, which is still evolving. The Blockchain Resolution text provided the basis for the regulatory initiatives of the EU in blockchain-related topics and became the reference point for many other jurisdictions around the world.

European Union is very active in exploring cutting-edge innovative blockchain solutions to improve the functioning of the public sector. ***Emanuele Baldacci*** and ***Joao Rodrigues Frade*** from DG Digit of the European Commission work in the frontline of the digital transformation of the Public Sector. In their chapter, Emanuele and Joao discuss blockchain from a public sector perspective in Europe where interest in its adoption is accelerating. Having this goal in mind, the European Commission is currently deploying a common European Blockchain Services Infrastructure (EBSI) in close collaboration with the Member States, in addition to specific funding provided by EU Programmes. Emanuele and Joao note that despite being a recent technology, blockchain builds on classical trust enabling technologies to offer novel functionalities that open new possibilities for creating value for society. In the public sector, this happens via improved processes (internal focus) and services provided (external focus). Blockchain-based solutions, the authors believe, have the potential to increase significantly the rate of automation and modernization within the public sector in compliance with Europe's specific legal constraints, in particular when it comes to ensuring the authenticity of information in digital format.

The final chapter of this volume addresses the pioneering topic of disposable identities, accelerated by blockchain technology. ***Loretta Anania, Gaëlle Le Gars***, and ***Rob van Kranenburg*** deal with this critical topic. The authors believe that many smart contract applications—or more precisely blockchain-based digital ledger technologies (DLTs) proliferate. And yet, without accounting for the identity dimension and the different authentication regimes, there is little chance that these technologies will gain widespread

use, and their disruptive innovation potential will not be realized. A growing number of digital interactions in which we engage online require more trust and more security; choosing the right identity technologies and data policy safeguards is an important policy choice. Digital wallets are part of their proposed solution: based on disposable identities tied to events and timelines. They explain why identity technologies matter. They describe the communication network architectures and functionalities and then show how EU Treaty legislation safeguards the important elements of this identity framework. They give examples of self-sovereign identity, and other solutions adopted by the EU Member States. The authors conclude that successful deployment requires an EU legislative and regulatory framework fit for the digital society. The digital identity problem starts from the perspective of serving half a billion individual citizens, and inclusion requires public policy that strongly supports it.

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