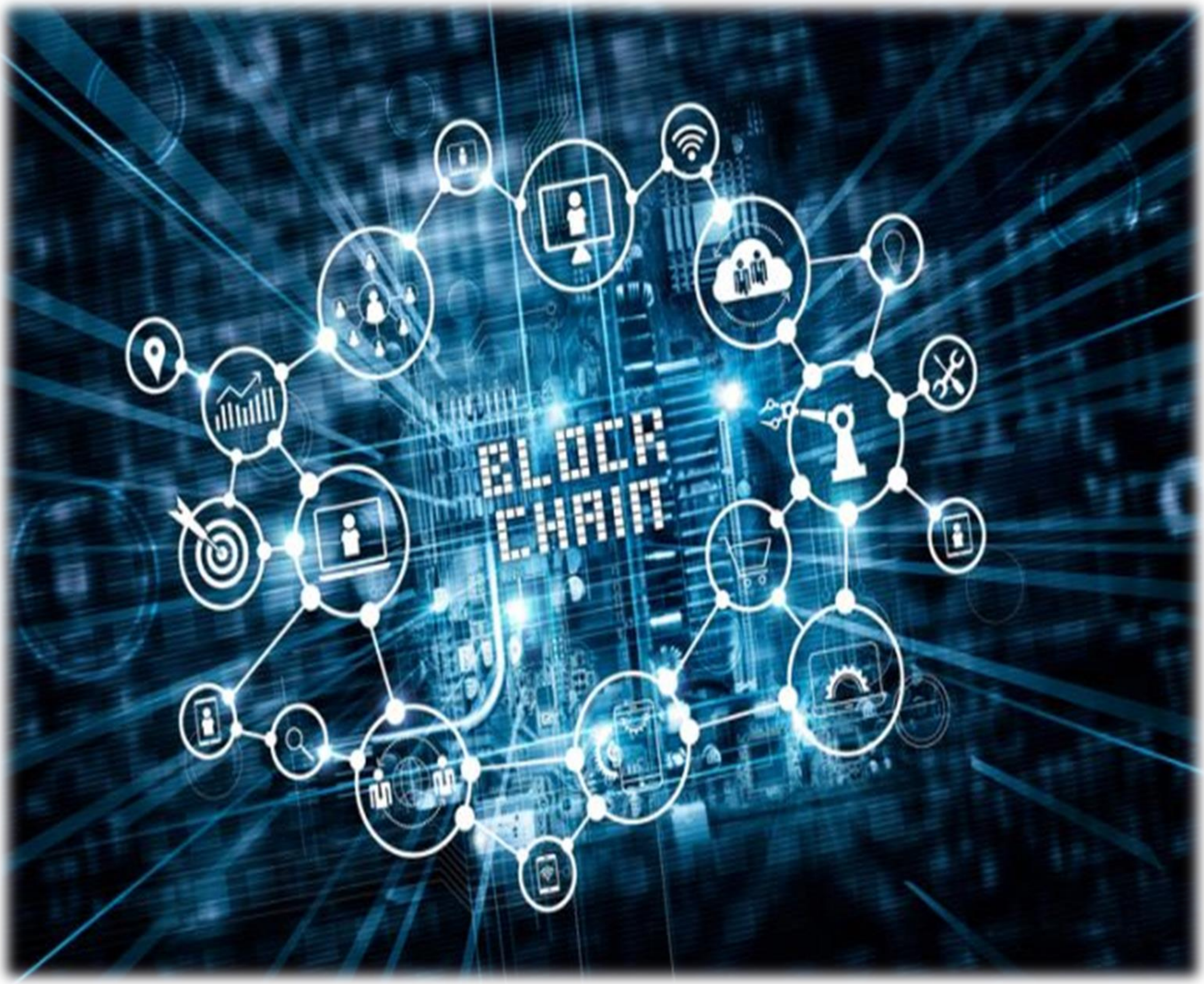
UCL FACULTY OF LAWS

Centre for Law, Economics and Society

Research Paper Series: 8/2018



Blockchain Competition

Gaining Competitive Advantage in the Digital Economy: Competition Law Implications

Ioannis Lianos

Centre for Law, Economics and Society

CLES
Faculty of Laws, UCL

Director: Professor Ioannis Lianos

CLES Research Paper Series
4/2018

Blockchain Competition

Gaining Competitive Advantage in the Digital Economy: Competition Law Implications

Ioannis Lianos

September 2018

Centre for Law, Economics and Society (CLES)
Faculty of Laws, UCL London,
WC1H 0EG
The CLES Research Paper Series can be found at
www.ucl.ac.uk/cles/research-papers

Pre-published version of I. Lianos, Blockchain Competition – Gaining Competitive Advantage in the Digital Economy: Competition Law Implications,
in Ph. Hacker, I. Lianos, G. Dimitropoulos & S. Eich, *Regulating Blockchain: Political and Legal Challenges* (forth. OUP, 2019)

Also published as BRICS Competition Law & Policy Centre Research Paper 1/2018

ISBN 978-1-910801-22-2

Centre for Law, Economics and Society
Faculty of Laws, UCL
London, WC1H 0EG
United Kingdom

Blockchain Competition
Gaining Competitive Advantage in the Digital Economy: Competition Law Implications

Ioannis Lianos[*]

Abstract:

Taking a dynamic and reflexive perspective on the interaction between technology, law and economics, the study focuses on the role of competition in shaping the economic, but also regulatory, eco-system in which blockchain technology becomes embedded. There is the promise that the technology and the social space it will foster will give rise to more competitive structures in the organisation of economic activity in the digital economy, in comparison to the current paradigm of digital platforms, which is highly centralised. The narrative of disruption has indeed been quite important in promoting the greater use of blockchain technology and has also framed the socio-technical 'agencements' that have so far guided regulatory action in this area. However, this narrative of disruption has also led to some hasty conclusions made in the literature as to the impotence of competition law to deal with an emergent digital space dominated by blockchain technology, predicting its eventual demise...

The study critically engages with this rhetoric and explains why it does not stand serious scrutiny and relies on a superficial analysis of Blockchain competition, as it does not consider the various ways in which the competitive strategies of economic actors shape the rules of the competitive game, the broader "industry architectures" that structure competitive interactions. The study then unveils how blockchain can contribute to competitive advantage, and can thus shape the distribution of surplus value in various industries. It then draws lessons for the work of regulators, in particular competition law enforcers. The last part of the study provides a detailed analysis of the competition law implications of blockchain technology for all aspects of competition law enforcement.

Keywords*: Blockchain, Distributed Ledger Technology, Competition Law, Mining, Digital Wallets, DApps, Proof of Work, Proof of Stake, Competitive Advantage, Architectural Advantage, Platforms, Eco-systems, Co-opetition, Disruptive Innovation, ICOs,*

JEL Codes: *K21, L1, L2, L4, L50, M20, O32*

[*] Professor of Global Competition Law and Policy and Director of the Centre for law, Economics and Society, Faculty of laws, UCL; Academic Director, BRICS Competition Law and Policy Centre, HSE, National Research University. The author would like to thank Dr. Yannis Stamelakos for useful discussions and some research work and drafting undertaken that was very helpful for completing parts II.B and III.A of this study, Igor Nikolic for helpful research assistance on the IP law issues discussed in this study, and Meg Cochrane for outstanding editing.

Blockchain Competition
Gaining Competitive Advantage in the Digital Economy: Competition Law Implications

Ioannis Lianos

I. Introduction

Far from its depiction as a well-defined and linear techno-social phenomenon that developed incrementally the last three decades following a consistent masterplan, the Internet of today has been transformed beyond recognition from its original version. The initial conditions under which the Internet developed were characterised by its distributed technological structure, which relied on an interconnected system of thousands of individual networks enabling people to connect directly with each other through desktop computers[1]. In this system, people were able to create and use new peer-to-peer services without needing to seek permission from any third party[2]. The Internet dream was depicted as 'decentralised', 'democratic', and profoundly inspired by the 'hacker ethic' of freedom[3]. This anarchic or libertarian, depending on whom you ask, vision of the Internet welcomed the lack of a centre and underpinned a preference for this being a space of atomistic competition where no private or public actor would be able to own or control the medium and its content.

In reality, its technological foundations favoured a distributed, and not decentralised as such, structure of control[4]. Despite the emphasis put on decentralisation, a few tens of networks providing international connectivity spanning countries and continents occupy central positions in the global internet topology; these constituting, from a technical perspective, distributed points of control[5]. However, even if technology was not exactly decentralised, the ethos of this first-generation Internet was profoundly marked by the decentralisation narrative. Benkler, one of the leading legal commentators on Internet-related issues, notes how the basic end-to-end design principle characterising the web and the generality of the protocol made it quite difficult to identify the nature of parties to a communication; it offered "no control points through which an entity could exclude or constrain another discrete entity attempting to use it"[6].

This portrayal of the Internet, however, soon became antiquated, as the shift to proprietary, controlled devices, software and networks in the early 2000s led to the emergence

---

[1] Note, however, that ARPANET, the first network to implement the protocol suite TCP/IP, which became the technical foundation of the Internet was administered by a single organisation through centralised control.

[2] Yochai Benkler, "Degrees of Freedom, Dimensions of Power", (2016) 145(1) *Daedalus*, 19 writes that during this first period "the Internet was not only a technical system but also an innovative organizational system; an institutional system pervaded by commons; a competitive market with low barriers to entry; and, finally, a zeitgeist, cultural habit of mind, or ideology, perhaps best captured by the saying from computer scientist and early architect of the Internet, David Clark: 'We reject: kings, presidents and voting. We believe in: rough consensus and running code".

[3] Jennifer Grannick, "The End of the Internet Dream?", (*Wired*.com, 17 August 2015), <https://www.wired.com/2015/08/the-end-of-the-internet-dream/>.

[4] Ashwin Mathew, "The Myth of the Decentralised Internet", (2016) 5(3) *Internet Policy Review*, noting that the Border Gateway Protocol ('BGP'), the technology that enables the interconnection of separate networks to form the global internet relies on three elements: (i) the packet switched networks that break up communications into individual packets of data, (ii) the routing protocols: each of these packets traverses multiple independently administered networks, each of them taking different paths to their eventual destination, at which point they are reassembled, the route being determined by a number of routing protocols which are variations of the BGP, which forms the common routing protocol, and (iii) the topology of these interconnected networks, which is a complex graph 'consisting of over 55,000 individual networks'.

[5] *Ibid*.

[6] Benkler, (2), 20.

of a number of intermediaries and additional points of control, in both technical and economic senses. This led to the accumulation of power by a limited set of influential players that re-shaped Internet's architecture thereby countering the initial decentralisation dynamic. Of course, this re-shaping was not the inevitable consequence of the techno-social structures of the Internet, which as mentioned were biased towards decentralisation, but was entirely due to the strategies (and, thus, the agency) of a few players that soon came to control the vast amounts of information generated by Internet use[7]. App store centres constitute the first type of these new points of control, as Internet access through smartphones, rather than browsers, gained traction enabling "the majority of Internet-mediated practice" to be undertaken "with devices that are either narrowly customizable appliances or controlled on the app store model"[8]. The move to wireless cellular networks and cable broadband offered further possibilities of identification of Internet users and usage and the development of strategies of monetisation of Internet access, now controlled by a limited number of players, in comparison to the old copper network[9]. The rise of Cloud computing, which emerged in order to provide co-location services for data storage and computation, is controlled by a few firms. Resources (including control over data) move away from end-users, towards centralized systems that possess huge processing power and storage capacities[10]. The shift towards the Internet of Things ('IoT') will further revolutionise the medium as it makes possible, for the first time, an 'unconscious' use of the Internet and offers a new point of control, to the extent that most of the Internet use will occur through smart devices taking action on their own without direct human intervention. Indeed, those that control these devices will control the majority of Internet *use*, not just Internet access.

Of course, "centralization and decentralization, in and of themselves, are neither good nor bad"[11]. It all depends on the governance system that the various entities put in place and the possibility of all 'stakeholders', particularly Internet users, for them to participate in it and for their interests to be considered. There is no guarantee that a decentralised system will be better than a centralised one but it is likely that a decentralised system will be more inclusive of all those whose interests are affected by Internet use. The developments of the last decade and the more recent rise of the cloud computing model indicate a growing trend towards centralisation, which, in conjunction with the development of Big Data, behavioural profiling and online manipulation, let us contemplate a future where a small number of digital platforms

[7] This process and strategies are well described in Tim Wu, *The Master Switch: The Rise and Fall of Information Empires* (First Vintage Book, 2011) and in Tim Wu, T*he Attention Merchants: The Epic Scramble to Get Inside Our Heads* (Penguin, 2016).

[8] Benkler, (2), 21.

[9] *Ibid*.

[10] Primavera de Filippi and Smari McCarthy, "Cloud Computing: Centralization and Data Sovereignty", (2012) 3(2) *European Journal for Law and Technology*, observe that "(c)loud services, whether they're infrastructural, platform-based, or software as a service, present a fiction of decentralization to the user in the form of network effects, while the service is increasingly operated by large companies that leverage their position to limit interoperability. Because of their dominant position, large service providers can exert a degree of subjugation never conceived of by smaller and more local services, and a degree of control that would be impossible in a peer-to-peer network."

[11] Benkler, (2), 19, "to imagine either that all centralized power is good and all decentralized power is criminal and mob-like, or that all decentralized power is participatory and expressive and all centralized power is extractive and authoritarian is wildly ahistorical."

will hold immense power that is expanding both in all sectors of the digital economy, but also beyond, in politics and culture. This has led some legal scholars to plead for specific regulation and law for the platform economy, in order to introduce some form of democratic control and accountability[12].

This rather gloomy prediction for our shared Internet future may be avoided if blockchain or distributed ledger technology ('DLT') were to deliver on its promises. Blockchain is set to become the 'Internet of value'[13] that will complement the current Internet architecture, albeit on very different principles. Blockchain is a technology that facilitates the value exchanges in a secure and decentralized manner, without the need for an intermediary. Its main components are a distributed ledger recording all transactions or assets that are part of its domain, an encryption protecting this ledger from tampering and the distributed storage of all data through the sharing of excess drive and network capacity on PCs and in data centers. The essence of the 'blockchain dream' is that the decentralisation and disintermediation it enables will challenge the current centralised architecture of the Internet and will accomplish the expectations of the original Internet dream for a borderless and radically democratic space. As Lana Swartz writes, "the blockchain is meaningful as an inventory of desire…(i)t is an engine of alterity: an opportunity to imagine a different world and imagine the mechanics of how that different world might be run"[14].

Blockchain is often opposed to the centralised paradigm of digital platforms that dominate different segments of the digital economy, often reducing consumer choice and privacy. The entities controlling these digital platforms now constitute the largest companies in the world[15]. An essential component of the blockchain dream is that it would finally fulfil the aspiration of a competitive space for the Internet, where peer-to-peer exchange without intermediaries would provide immense opportunities to establish alternative communities of economic, social and political exchange whilst also resolving the difficulty of combining this with the respect of privacy and digital autonomy.

Protecting consumers' privacy and promoting a competitive market are certainly important ingredients of the blockchain narrative. However, that which really stands out is the perception that DLT may profoundly alter the economic and social structures of our societies, bringing 'disruptive innovation' to all the economic areas in which it would be implemented[16]. DLT has the potential to apply in different economic (and non-economic) digital sectors. It

---

[12] See Julie Cohen, "Law for the Platform Economy", (2017) 51 *U.C. Davis School of Law Review*, 133.

[13] See, McKinsey&Company, "Getting Serious About Blockchain", (*mckinsey.com*, May 2017) <https://www.mckinsey.com/industries/high-tech/our-insights/getting-serious-about-blockchain>.

[14] Lana Swartz, "Blockchain Dreams: Imagining Techno-Economic Alternatives After Bitcoin" in *Another Economy is Possible: Culture and Economy in a Time of Crisis* (edited by Manel Castells, Polity Press, 2017), 83.

[15] The five largest companies in the world are tech platforms: see Alex Wilhelm, "Big Tech Goes Five for Five" (*techcrunch.com*, October 2017) <https://techcrunch.com/2017/11/06/big-tech-goes-five-for-five/>.

[16] There are countless articles in the popular press and in legal and other specialised academic journals referring to the 'disruptive' potential of the blockchain. A search engine search with the words "blockchain" and "disruptive innovation" may provide an illustration of this point.

could also be considered as a general purpose technology ('GPT')[17], to the extent that it satisfies the three conditions usually required for such qualification[18]:

- *Pervasiveness* – DLT should be capable of infiltrating most economic sectors, to the extent that "they can be used as inputs in a wide range of downstream sectors"[19]. This is certainly the case for blockchain, which although it was first used in cryptocurrencies and Fintech, its implementation has recently expanded to a variety of sectors of the digital economy;
- *Improvement* – the GPT should improve over time and, hence, should keep lowering the costs of its users, leading to increased economies of scale. Blockchain also satisfies this criterion as the blockchain functionalities have improved so as to not only store information of all kinds protected by a cryptographic token but also to serve as a decentralised platform allowing programmable transactions of assets between a decentralised peer-to-peer network that allows the implementation of any computable function effectuated through smart contracts, that is, in-built executable code[20].
- *Innovation spawning* (or 'innovation complementarities') – the GPT should make it easier to invent and produce new products or processes. In particular, the development of the IoT, smart property and artificial intelligence provides the possibility to automate, through blockchains (and smart contracts), a number of activities that were previously undertaken by humans acting as intermediaries. This may give rise to the unbundling of various economic activities as the focus shifts to micro-transactions, which may be executed automatically, not only through some decentralised application, but also, in future, through some form of decentralised autonomous organisation and algorithmic entities[21]. This could eventually reduce the labor costs involved in the organisation of economic activity, in view of the great degree of scalability enabled by artificial intelligence, thus, enabling the development of blockchains for various activities currently organised through centralised platforms.

The explosion of public attention and academic commentary on blockchain that followed the rise of the value of cryptocurrencies in 2016 and 2017, has so far largely focused on the way financial regulation has grappled with this technology and how it engaged with the risks and opportunities its implementation may bring. Financial regulation was one of the first fields of law to collide with the new social reality, to be more precise, the frenzy of crypto-currencies, initial coin offerings ('ICOs') and other crypto-assets that took hold of a global public opinion witnessing the meteoric rise of the value of Bitcoin during the same period. What is particularly significant is that regulatory action strived to respond to the exciting narrative of 'disruptive

[17] For a similar characterization, see Sinclair Davidson, Primavera De Filippi and Jason Potts, "Blockchains and The Economic Institutions of Capitalism", (2018) 14(4) *Journal of Institutional Economics*, 639; Ethan Kane, "Is Blockchain a General Purpose Technology?", (2017) <https://ssrn.com/abstract=2932585>.

[18] Timothy Bresnahan and Manuel Trajtenberg, "General Purpose Technologies: Engines of Growth?" (1995) 65(1) *Journal of Econometrics,* 83-108; Boyan Jovanovic and Peter Rousseau, "General Purpose Technologies" in *Handbook of Economic Growth* (edited by Philippe Aghion and Steven Durlauf, Volume 1, Elsevier, 2005), 1181.

[19] Ibid.

[20] Roman Alyoshkin, "Blockchain 2.0. The Purpose of Blockchain", (2017) <https://medium.com/polys-blog/blockchain-2-0-the-purpose-of-blockchain-e84e5a95cdd9>.

[21] The possibility of legal entities without human controllers is examined in detail by Lynn Lopucki, "Algorithmic Entities", (2018) 95 *Washington University Law Review,* 887.

innovation' put forward by blockchain evangelists, in all possible forms, while still trying to cope with the 'parochial' concerns of consumer and investment protection, and the natural cynicism of the lawyer who sees control, accountability and governance as the crucial elements to think about when regulating a new technology. Although some more recent work has engaged with the more general theme of the interaction between blockchain and the law[22], that which has been less explored are the implications of DLT, from both a competition policy and law perspective.

This is a crucial issue. More than the technological innovation brought by DLT, the return to a more competitive and decentralised Internet that will break the hold on it by few digital platforms and the organisational innovations that will consequently emerge constitute the principal elements underlying the appeal of the 'blockchain dream' to policymakers and the public opinion. The relatively few works that have engaged so far with blockchain from a competition law and policy perspective provide useful insights on some of the economics of DLT and lessons for competition law enforcement[23]. However, a comprehensive study that will not only reflect on the welfare economics of DLT or the implementation of competition law to some blockchain-related conduct, but will attempt to understand the new competition dynamics unleashed by the blockchain revolution is still lacking. Furthermore, understanding how DLT may impact upon competitive advantage is crucial if one is to design a competition law enforcement that will not only be reactive but also proactive and will fully engage with both the protection of consumers (and other stakeholders) as well as the promotion of innovation.

This study aims to fill this gap. Part II engages initially with the broader perception of blockchain as an antagonistic narrative to that of platforms for the digital economy. The study provides a critical analysis of the decentralisation and disintermediation potential of the blockchain and how this perception of DLT may ignore the emergence of blockchain intermediaries and some potential points of control. Part III engages with a discussion of the fundamentals of blockchain competition by exploring the various strategies for acquiring competitive advantage and how these determine the incentives of the various blockchain actors. Two broad categories of competitive advantage are discussed: conventional strategic competitive advantage and 'architectural advantage', the latter of which is less explored in competition law and policy literature. Various economic actors use DLT and the different dimensions of competitive advantage it confers on them in order to enhance their power, i.e. their ability to shape the actions of other actors forming part of their environment. Hence, the discussion over the various forms of competitive advantage is directly linked in Part IV with the social and economic implications of a more expansive use of this new GPT in other areas

[22] See, Primavera De Filippi and Aaron Wright, *Blockchain and the Law* (Harvard University Press, 2018).
[23] See, *inter alia*, the work of Christian Catalini and Joshua Gans, "Some Simple Economics of the Blockchain", (2017), Rotman School of Management Working Paper No. 2874598, MIT Sloan Research Paper No. 5191-16; Christian Catalini and Catherine Tucker, "Antitrust and Costless Verification: An Optimistic and a Pessimistic View of the Implications of Blockchain Technology" (2018), MIT Sloan Research Paper; Peder Østbye, "The Adequacy of Competition Policy for Cryptocurrency Markets", (2017) <https://ssrn.com/abstract=3025732>; Jesús Fernández-Villaverde and Daniel Sanches, "Can Currency Competition Work?", National Bureau of Economic Research No. w22157; Thibault Schrepel, "Is Blockchain the Death of Antitrust Law? The Blockchain Antitrust Paradox" (2018), <https://ssrn.com/abstract=3193576>; Brad Finney, "Blockchain and Antitrust: New Tech Meets Old Regs", (2018) 19 *Transactions: The Tennessee Journal of Business Law*, 709; Rory Van Loo, "Making Innovation More Competitive: The Case of Fintech", (2018) 65 *UCLA Law Review*, 232.

of economic activity. Science and Technology Studies literature instructs us that the direction of technological change is profoundly shaped by the interests and positioning of the social forces that promote the use of the new technology, of those who, in the disruptive potential of a new technological paradigm, see the opportunity to re-position themselves more centrally by being able to shape competition[24]. It is no different with blockchain. Following the analysis of the various forms of blockchain competition on product and financial markets, Part V of this study reaches some preliminary conclusions as to how DLT transforms the competitive game in the digital economy, from one that centres on a 'winner-takes-all' dynamic with the development of digital platforms to one that focuses on 'co-opetition' in ecosystems. Part VI draws lessons from this broader competition analysis for competition law enforcement. It provides an in-depth discussion of the various forms of DLT-related conduct that may raise competition concerns as well as reflecting on the broader implications of blockchain competition for existing competition law doctrines, methodologies and tools.

II. Blockchain and Digital Platforms as Alternative Organisational Narratives in the Digital Economy

Decentralisation and disintermediation constitute the two most cited benefits of blockchain technology and to a large extent they explain the reason for which DLT is often considered as an important challenge to the power of digital platforms and intermediaries dominating the digital economy. However, the question emerges as to whether this narrative is factually justified. Section A focuses on the basic components of the decentralisation and disintermediation story whilst Section B presents an alternative account.

A. The Promise of Decentralization and Disintermediation

The Internet era gave rise to online intermediaries and digital platforms controlling and orchestrating value-generating ecosystems that not only offered products and online services but also provided the infrastructure and tools on which other platform businesses can be built. In contrast, blockchain technology has been widely perceived as promising a decentralised and largely disintermediated model of organisation of the digital economy that would dispense with intermediaries and, consequently, the risk of monopolistic bottlenecks. While in the digital platform model only the centralised online platform collects information about past transactions, blockchain offers a distributed decentralised ledger, which keeps a complete record of all past transactions on the network. This enables all participants to have access to information about past transactions and, thus, ensures that no participant to the network enjoys a position of superior bargaining power due to informational asymmetries. This equality is

[24] On this fundamental insight see Giovanni Dosi, "Technological Paradigms and Technological Trajectories", (1982) 11 *Research Policy*, 147, noting how the development of a technology is contextual to the history of the industrial structures associated with that technology, where the emergence of a new paradigm is often related to new 'Schumpeterian' companies, while its establishment denotes a process of 'oligopolistic stabilization'.; Brian Arthur, "Competing Technologies, Increasing Returns, and Lock-In by Historical Events", (1989) 99(394) *The Economic Journal*, 116, examining competition between two increasing returns technologies and what determines equilibrium selection.

furthered by the transparency of the process: each new transaction is broadcast to the entire network and each participant has the power to determine its authenticity. This breaks with the centralised data silos model of the platform economy, where only some actors have access to this information, as all interactions between the network participants happen through them, thus, enabling them to accumulate data, which, in turn, can help them to increase their bargaining power and to erect barriers to entry.

Of course, blockchain is not a monolith. There exist various types of blockchain, some of which are closer to the centralised ledger model of digital platforms. It is customary to distinguish 'private' or 'federated' blockchains from 'public' blockchains.

A private blockchain is controlled by a centralised entity, like an Intranet. Only the entity controlling the blockchain has the possibility to approve participants, to read and/or write new blocks and to validate the transactions. The entity also benefits from information concerning the identity of the participants. As with digital platforms, users are free to leave a platform in the case that competitive alternatives exist. However, it should be noted that contrary to digital platforms, each participant maintains a replica in sync of the ledger of digitally signed transactions, thus, guaranteeing the immutability of the blockchain. Private blockchains are transparent and can be read in real-time by a regulator.

Federated blockchains are private blockchains managed by a consortium of multiple organisations. As with private blockchains the participants are identified and pre-approved by the entity that manages the blockchain. The consensus process is controlled by a pre-selected set of nodes. R3 constitutes an example of an open-source and federated distributed ledger controlled by a consortium of more than forty financial companies and an ecosystem of more than 200 companies. R3 was put in place in 2015. Its aim was to develop apps for finance and commerce capable of running on its blockchain platform, Corda. The objective was to replace complex legacy systems that could not handle complex transactions and suffered from interoperating difficulties. Private or federated blockchains are usually permissioned, although one cannot exclude the possibility of a 'permission-less', private or federated blockchain (e.g. a Byzantine agreement)[25].

Public blockchains are closer to the decentralised model and are characterised by free entry: anyone may contribute to it by adding a block, execute the consensus protocol and/or maintain the shared ledger. Public blockchain protocols are open source. In principle, anyone can download the protocol and validate transactions. In this context, the blockchain is considered to be 'permission-less' (e.g. Bitcoin). There is also the possibility that, although in principle open to any participant, the participant should satisfy some conditions. The imposition of such would qualify the public blockchain as 'permissioned'. For instance, anyone can develop a decentralised application ('DApp') on Ethereum *so long as* they purchase some Ether (the native token of this blockchain). The network provides an incentive system in order to encourage more participants to join. This is done with either the release of native tokens or the payment of commission fees to miners and other developers for each transaction added to

[25] A 'Byzantine agreement' or 'Byzantine fault tolerance' exists where participants to the blockchain, which are known and who possess a public key agree on a concerted strategy to sign with their public key, validating a block as it passes through their node. Once a predefined number of participants sign the block, this is deemed valid and added to the chain.

the chain. Due to its openness and the risk of double spending, public blockchains need an identity management system. This system enables the participants to the blockchain to achieve consensus. Each node in the network must solve a complex, resource-intensive cryptographic problem ('proof of work') or other mechanisms of pre-approval (e.g. 'proof of stake' etc.) for a new block to be added to the blockchain.

The use of blockchain technology offers numerous advantages, in comparison to interacting across different networks. First, it facilitates the organisation of micro-transactions. There is no need for a centralised network intermediating all transactions nor for administration costs to be incurred for each additional transaction. Blockchain may enable direct transactions to take place between the various nodes of a network, without being necessary for these to be administered from the centre of the network. This greatly reduces transaction costs. Consequently, micro-transactions that were too expensive to organise in the context of a centralised network because their value was lower than the administration costs are now, due to the much lower administrative costs of DLT, economically rational. Blockchain can thus charge lower fees than that which platforms usually charge.

Second, all transactions that run through blockchain benefit from in-built network neutrality, to the extent that the only criterion for processing a transaction is whether the appropriate fee has been paid. Contrary to platforms, it is not technically possible for an entity to either control the traffic in the blockchain network and/or differentiate the way in which various transactions will be executed in terms of speed, quality etc. In comparison to neutrality arising from the structure of a blockchain network, for digital platforms neutrality obligations are usually mandated by law[26].

Third, once a transaction is 'mined' into a block, after a certain period of time it is nearly impossible to reverse it because it would mean that you would have to re-mine the block and all the other blocks added on top of that; this computationally intensive operation would incur high costs that would likely be disproportionate to the value of reversing the original transaction. Transactions in blockchain thus become irreversible, and this reduces the risk of manipulation of the data by an operator, a risk that is very much present with regard to digital platforms.

Fourth, everybody can check the public ledger and verify whether the transaction took place or not, the identity of the sender and the locations between which the value was transferred. The transparency of the blockchain offers significant advantages to platforms when organizing a network of transactions, as transparency generates institutions-based trust, without that being based on the power of control exercised by an intermediary, as it is the case in platform-based networks. This has also profound implications as to the ability of each participant to this network to feel as though they are in control. One of the main features of blockchain-based applications is that users have absolute ownership of their assets (e.g. money, data etc.) without the need for any kind of custodian (e.g. banks, online intermediaries etc.).

[26] See, for instance, the 2017, Google Search (Shopping)competition law Case AT.39740 in the EU, regarding search neutrality, or the Proposal for a Regulation of the European Parliament and of the Council on Promoting Fairness and Transparency for Business Users of Online Intermediation Services, 2018/0112 (COD), imposing neutrality requirements in the way digital platforms treat other websites and other businesses with regard to ranking etc.

Thus, once someone generates a private key, no other person can claim the assets, confiscate them or deny access to them.

Fifth, blockchain leads to a reduction of economies of scale and network effects. These well-known features of digital platforms, to a large extent, explain the higher levels of economic concentration in the platform economy. New technologies require important investments and fixed costs for their development, which often lead to network effects (i.e. the use of a product or service by any user increases the product's value for other, potentially all, users). Indeed, the value of the product to one user is positively affected when another user joins and enlarges the network (i.e. 'positive network externalities'). For instance, an additional user of a search engine may increase the quality of search provided by this search engine because the search engine with its increased stock of queries can, through the data stemming user's expressed preferences, seek to better tailor the results displayed to the user. In turn, this process has the capacity to benefit all users. This 'positive feedback loop' mechanism explains the reason for these markets being so tippy and being characterized as 'winner-takes-most' competition. For instance, there might be fierce competition to conquer a market share advantage over rivals, with regard to the specific technology or standard applying in the industry, as the market may switch almost completely to the winner ('competition for the market').[27] Quite often, these products or services constitute a package of complementary products and technologies, which form a system competing with other systems ('systems competition').[28] The value of the product does not always depend directly on the number of adopters but on the adoption of some complementary products that are bundled or packaged with the first product (think about a book reader and the content of the book).

Network effects lead to collective switching costs and lock-in effects, which reduce competition and may entrench the dominant position of the winner for a significant period of time. Firms are quite imaginative in their business models, sometimes distributing the product for free on one side of the market, thereby inducing more users to join the network and, thus, increasing the value of the product for other users situated on the other, paying side of the market with this (multi or two-sided market) platform facilitating the interaction between these two different customer groups . Firm may also use various business practices, such as penetration pricing, where they charge low prices (even below their costs) to gain market share, or strategic bundling of their products in order to gain a foothold in another market prior to expanding its market share in this latter market. In these latter markets, it is possible that firms may incur losses for a significant period of time in order to invest in acquiring market share (either through natural growth or by buying out actual or potential competitors) or in order to constitute one-stop-shop solutions or essential platforms for various groups of customers. Competition between firms takes on unexpected forms, such as competing for consumers'

[27] Usual examples include the videotape format war between VHS and Sony's BETAMAX, or the competition between Windows and Intel from one side and Apple from the other for the microcomputer market. For an analysis of competition in open and closed systems see Competition and Markets Authority (UK) and Autorité de la Concurrence (France), "The Economics of Open and Closed Systems", (2014) Report.
[28] Michael Katz and Carl Shapiro, "Systems Competition and Network Effects" (1994) 8(2) *Journal of Economic Perspectives*, 93.

attention (or eyeballs), eventually profiling them and using algorithms in order to predict and possibly manipulate their behavior.[29]

Blockchain leads to lower network costs "both in the phase of bootstrapping a new platform and in the phase of operating it"[30]. With regard to the advancing of a new platform, it is unclear if the development of a blockchain requires lower fixed costs than setting up a traditional centralised platform. Blockchains rely on a number of miners running a cryptographic program in order to verify the authenticity of the transactions in the decentralised ledger. The first generation of blockchains ('blockchain 1.0') relied on the proof of work ('PoW') concept. It required the use of the highest number of CPUs to validate a block. Miners had to go through more computational work in order to prove that a transaction hash is legitimate: the more computers used, the stronger the authenticity of the ledger becomes ('one CPU, one vote')[31]. Miners running the cryptographic program start from the final hash of the current block hashed with the previous block searching for the answer to this mathematical puzzle (the 'proof string'). Once a miner discovers the correct proof string, this is broadcast to the rest of the network of other miners active on the system who will verify if all the transactions are valid and that the proof string broadcasted has, in fact, solved the puzzle. The number of verifications a string receives counts as votes leading the block with the highest number of verifications to win and, thus, to be officially added to the chain. The reward is released as soon as a new block is added to the chain. This can either consist on a coinbase reward (a native token that compensates the miners) or, in view of the diminishing returns of the coinbase reward, a fee (e.g. a percentage of the transaction). PoW thus relies on competition between network participants (i.e. 'miners') on who will be the first one to validate the transaction.

PoW enables trustless consensus to develop by deterring attacks to the blockchain. This is done by raising the costs of an attack, as a successful attack requires a lot of computational power and a lot of time to do the necessary calculations. Miners perform a lot of calculations in order to generate blocks and maintain the security of the chain. Their role is to ensure the legitimacy of a transaction by avoiding any double-spending. The asymmetry of computational power required by those requesting the addition of a new block in the blockchain, in comparison to the rest of the network, means that, on average, a higher number of calculations needs to be performed each time in order to create a new block. Hence, the more the blockchain grows, the more hash and computational power algorithms are needed in order to generate consensus. The difficulty of the hash depends on the number of users, the network load and the current computational power used. The algorithm rewards the first miner that has completed this extra computational work and has solved this increasingly difficult mathematical problem thereby enabling the creation of this additional block or the release of the commission fee.

---

[29] Frank Pasquale, *The Black Box Society - The Secret Algorithms that Control Money and Information* (Harvard University Press, 2015).

[30] Catalini and Gans, (22), 12.

[31] Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System" (2008), <https://bitcoin.org/bitcoin.pdf>, 3, explains that "(i)f the majority were based on one-IP-address-one-vote, it could be subverted by anyone able to allocate many IPs. Proof-of-work is essentially one-CPU-one-vote. The majority decision is represented by the longest chain, which has the greatest proof-of-work effort invested in it:.

This computational work involves the consumption of a lot of electricity power and the use of computer hardware only focused on maintaining the operation and security of the blockchain. In addition to these variable costs, blockchain involves high fixed costs concerning storage. Contrary to platforms that may store information on the cloud, by paying a monthly fee for cloud storage, blockchain 1.0 projects require the storage of data indefinitely and, hence, must opt for paying upfront the storage costs. This, in turn, increases fixed costs, which could be considered as a barrier to entry for newcomers. The shift from centralised to decentralised cloud computing with data being maintained on both public and private clouds, may, nevertheless, reduce the costs of storage and the significance of this entry barrier. The PoW model is also risky as it may be subject to the '51% attack'. This may occur if a miner or pool of miners have attained 51% of the computing power thereby providing them the ability to re-write the entire blockchain. Although this could easily be observed by other participants of the network and could result in the value of the native token of the blockchain collapsing, the attackers may have more to win than to lose, as they many not own any of these native tokens. The risk of centralisation is particularly high when the mining activity is concentrated among a limited number of entities or pools, as is the case for Bitcoin mining, because of the costs engendered by the PoW approach.

The high costs of the PoW concept led the second-generation ('blockchain 2.0') projects (based on Ethereum) to switch to the proof-of-stake ('PoS') approach which requires far less computational power and, thus, far less electricity for the creation of cryptographic proof. In contrast to PoW system, which takes into account the amount of CPU devoted to the system, in a PoS system it is not the amount of computational power one is willing to spend in order to confirm the legitimacy of the block that counts for the payment of the reward. Rather the creators of a new block are chosen in a deterministic way that depends on the 'stakes' they hold. The weight to their vote is proportional to the ownership stake they hold. For instance, a miner holding 2% of the total Bitcoins may have the possibility to mine 1% of the blocks. In PoS, miners are mostly rewarded with transaction fees. The system is preserved from double spending and attacks by the fact that a cyber-attack, for instance, by someone holding 51% of the computational power of the network may affect the value of the specific digital asset held with the result that it would make it disadvantageous to attack the network. The majority stake owner is therefore incentivized to maintain a secure network. This system drastically reduces the costs linked to the use of computational power (e.g. energy costs).However, such system may risk being exposed to the potential for a miner, or a group of miners, to monopolise it, to impose conditions on the rest of the network, which could involve the adoption of exploitative practices or leveraging practices in related markets. Hence, although the PoS approach is more secure than the PoW approach with regard to the risk of a 51% attack, given the importance of the stakes of the miners in preserving the value of the blockchain's assets, one cannot categorically exclude the possibility of abuse.

The incentives of the developers also differ between digital platforms and blockchain. Platforms rely on the indirect network effects they generate to incentivise developers to write applications for their (dominant) platform, as higher consumer use of a platform makes the platform more valuable for producers (this is called 'cross-side network effects'). Blockchain relies on an incentive system based on the venture capital model whereby early contributors earn tokens for providing the resources (capital and time) needed for the operations of the platform[32]. Developers are attracted by the prospect of potential future profits generated by the appreciation in value of the native token, once the ICO is completed. Following the initial process of development of the blockchain, miners are initially compensated with native tokens; later they are compensated with the payment of transaction fees.

An important difference between the traditional centralised platform model and blockchain is that users of the latter are less anchored to the specific platform because of the risk of losing the data it contains. This may harm the users to the extent that the harvesting of data contributes to higher performance, as, for instance, search results become more personalised and irrelevant advertising is excluded. An important feature of blockchain is that information is distributed in a decentralised ledger and it is possible for anyone (in the case of public blockchain), or for a number of participants (in the case of a permissioned blockchain) to have access to it, particularly if they decide to switch to a different platform or blockchain 'fork'. Contrary to centralised platforms, where users are averse to switching, the replicability of data makes it easier for blockchain to switch to competing forks and abandon the older version of the blockchain[33]. This has also important implications for indirect network effects, as blockchain developers (writing apps) and blockchain operators (e.g. miners) also have less reasons to be anchored to a specific platform. It is in their interest to be among the first to contribute to a fork because if such were to attract a considerable number of existing users, in particular at the initial stages of its development, rewards (for mining) may be very high. Hence, contrary to centralised platforms which, due to indirect network effects have the capacity to dissuade competing platforms from entering into the market, by denying them access to an efficient scale (of developers and contributors etc.), or to maintain a competitive advantage over their competitors, in the case that there is entry, thereby leading to a gap between the fee charged by the incumbent and the fee charged by the entrant, these indirect network externalities are much lower for blockchain[34].

Sixth, the form that competition may take is different for blockchains than for centralised platforms. As indicated above, competition among platforms mostly takes the form of 'competition for the market', as network effects often lead to 'winner takes most' competition, with only one platform controlling, or being the significant player, for a relevant market or, more broadly, a value chain. Thus, markets marked by platform competition are concentrated, sometimes to such an extent that the second or third player in the market may not offer a viable competitive alternative to the established platform with the result that inter-platform competition remains weak and that there is significant inequality in the distribution of market shares among (horizontal) competitors. At the same time, the centralised platform forms a 'bottleneck' with the power to determine the allocation of the surplus generated by the value chain between the various contributors, and, in particular, to keep the overwhelming part of this surplus thereby accumulating significant profits for itself. In view of the (reported) low levels of users switching to competing platforms, platform operators can be confident that the

---

32 Catalini and Gans, (22), 12.

33 Joseph Abadi and Markus Brunnermeier, "Blockchain Economics", (2018) <https://scholar.princeton.edu/sites/default/files/markus/files/blockchain_paper_v2c.pdf>.

34 *Ibid*, 3.

reduction of vertical competition between the different segments of the value chain, with regard to the allocation of the total surplus value generated by the value chain, will not lead to a significant number of applications-developers deserting their platform . Hence, value chains dominated by digital platforms are also marked by a very unequal distribution of profits between the relevant established platform and other participants in the ecosystem. Users are also unable to identify how much value they add to the platform's operations as the history of transactions is not public and this information is only collected and stored by the platform or online intermediary.

In contrast, blockchain enables various forms of competition to intensify. First, due to the reduced significance of direct and indirect network effects, inter-platform competition is more intense. Both users and app developers may switch more easily to competing platforms. If a platform economy is characterised by 'winner-takes-most' competition or 'competition for the market', blockchain reverts the focus to 'competition in the market', as lower entry costs and the reduced significance of network effects have the potential to lead to less concentrated, more contestable markets. Quite significantly, horizontal competition is not only limited between the blockchain and other competing platforms but may also consist in competition from a 'fork' blockchain (i.e. the blockchain with a different set of rules), should the developers and users of a blockchain decide to migrate to the new one because of their dislike of the former system's existing rules or blockchain governance. In this case, the information in the blockchain will be replicated thereby levelling the playing field between the 'old' and the 'fork' blockchain. At the same time, through their private key, users maintain information about their contribution to the value of the blockchain. The fact that this information is not controlled by a centralised ledger makes it possible to devise ways to compensate users for the value they add. Thus, vertical competition is more intensive and the surplus generated by the value chain more fairly distributed among the various contributors.

B. The New Blockchain Intermediaries and Centralization Dynamics

Despite the various advantages of blockchain in comparison to centralised platforms and the dominant decentralisation narrative, the choice of a decentralised distributed ledger does not dispense of any risk of intermediation and centralisation.

I will first focus on intermediaries. As it is rightly noted by Arruñada, "[…] blockchain applications require the intervention of between parties' intermediaries to write the code, run the system, and store data"[35]. There are different types of intermediaries[36].

Oracles serve as links between the blockchain and external 'off blockchain' events that may trigger the enforcement of smart contracts when these external conditions reach the level specified in the contract. *Oracles* bring data from an outside source onto the blockchain. There is a number of companies specialising in connecting web applications programming interfaces ('APIs), which allow software to interact with another piece of software), or any other data sources, thus, enabling the implementation of smart contracts and the interaction of the

[35] Benito Arruñada, "Blockchain's Struggle to Deliver Impersonal Exchange", (2018) 19 *Minnesota Journal of Law, Science and Technology*, 65.
[36] *Ibid*.

blockchain with the context external to it. In view of the relative failure of a decentralised and distributed Oracles network, such as Orisi for cryptocurrency contracts in which a large number of players operated as blockchain oracles reporting data from the outside[37], more centralized oracles solutions were developed, either by trusting the companies controlling the data sources or by involving third parties that developed authentication and verification procedures for external data sources – a distributed but not a decentralized oracle system). Oracles may even be algorithmic entities operating on the basis of sensors or other trusted data-feeds generated by devices (in the IoT environment), Big Data harvested from the Internet, or other trusted web application programming interfaces ('APIs'), thus, establishing a reliable connection between these APIs and the DApps. Therefore, their main function is to connect the blockchain to the real world. They may also serve as reliable sources of information about the external world when engaged in online dispute resolution systems[38].

Curators perform a variety of technical functions, such as contributing to the selection of proposals coming from the contractors and/or preventing 51% attacks that could undermine the integrity of the blockchain[39]. This form of architecture was selected for the decentralised autonomous organisation ('DAO') launched in 2016, with twelve curators, most of them respected and trusted Ethereum programmers, who were able to whitelist proposals (i.e. add contractor addresses to the DAO whitelist), by checking the identity of people submitting them (making sure that the code of the proposal actually originates from the contractor, thus, confirming that the proposal comes from an identified entity or person). These curators were also able to freeze the DAO activities in case of attack[40]. The nature of this intermediary role involves curators being appointed by the token holders (most likely in the form of a 'multisig' contract) but potentially being fired by them at will. This control structure avoids the risk of centralisation.

For its operation, blockchain also requires the presence of a number of intermediaries, whose function is to either keep the blockchain operational, in principle by validating the transactions/blocs, or to enable transactions between different blockchains, thus, ensuring that the native tokens of one blockchain may be exchanged with those of another.

The first operation is performed by *miners*. 'Mining', in blockchain terminology, is the procedure that aggregates pending transactions in a block and by making a vast amount of cryptographic calculations ('hash functions') produces a valid outcome that satisfies a list of strict, predefined conditions encoded in software. The block is appended to the head of the blockchain and the procedure starts all over again. The miner is rewarded for the processing power spent to produce the block with either a newly generated coin or by a transaction fee. The Bitcoin architecture is a deflationary policy designed and implemented on a protocol level, with the quantity of bitcoins minted per block being reduced by 50% every 4 years ('halving period'). Initially, the block reward was 50 BTC, then 25 and in July 2016, it was reduced to

[37] See GitHub, Orisi White Paper (2014) <https://github.com/orisi/wiki/wiki/Orisi-White-Paper>.

[38] For instance, Jurico is a decentralized blockchain-based dispute resolution platform designed to help resolve smart contract-related disputes by allowing users to open disputes and then oracles to vote on whom won the dispute with the most votes making the decision, see Oliver Dale, "JUR ICO: Decentralised Dispute Resolution Platform", (*Blockonomi.com*, 11 July 2018) <https://blockonomi.com/jur-ico/>,.

[39] *Ibid*.

[40] See Stephen Tual, "On DAO Contractors and Curators", (*blog.slock.it*, 9 April 2016) <https://blog.slock.it/on-contractors-and-curators-2fb9238b2553>.

12.5. The aim is to ensure that the number of bitcoins in existence will not exceed 21 million and the last satoshis (i.e. the smallest denomination, one hundred millionth of a bitcoin) will have been mined by the year 2140.

During the first years of the network, a simple desktop computer could be used to mine bitcoins, which is compatible with Satoshi's vision of 'one CPU, one vote'. However, as it became more popular and its price appreciated, the attention bitcoins received led to the development of more efficient hashing hardware, thereby excluding from the market normal miners who were previously mining Bitcoin using their consumer grade hardware, such as computer processing units ('CPUs') and graphic processing units ('GPUs'). GPUs, and then field programmable gate array ('FPGA') devices, were used by sophisticated users for mining. Nowadays this can only be done by powerful specialized hardware that performs several billions of hash operations per second: application specific integrated circuits ('ASICs'). These ASIC devices, with chips developed for the purpose of mining specific algorithm, were developed by a small number of top Chinese companies. This has made bitcoin mining unprofitable for individuals and has led to the creation of big mining facilities, the so-called *mining farms*. Usually, these farms are built in places that provide cheap electricity, preferably combined with a cold environment for facilitating the dissipation of the excessive heat produced by the mining equipment. Most of them are located in China (60% of the total hashpower) due to the cheap coal-based electricity as well as the abundance of hydro-electric facilities, while most of other locations are based on far north countries such as Canada, Sweden and Iceland. These facilities earn important revenues but they need to sell a big portion of the bitcoins produced in order to pay the bills and re-invest in hardware equipment since this becomes obsolete rather quickly. Mining pools enable the aggregation of various miners that want to invest in mining equipment but do not have a high enough hash-rate. The miners involved form big groups. They combine their computational power and share the resulting profits between between them according to each individual's contribution. At the moment, there are many pools with different economic models but most of them take a portion of the profits as a fee. Other cryptocurrencies, such as Bitcoin Gold ('BTG') have adopted ASIC resistant algorithms to avoid the problem of mining centralization by big players and to instill trust in normal miners that they can use their average hardware for mining. This has led to a huge demand in GPUs. The stock of big manufacturers, like NVIDIA, have been emptied whilst the prices of GPUs have rapidly increased. This may, in itself, lead to some degree of centralization as fewer miners will be able to afford them and reach the minimum efficient scale.

Digital wallets and *digital exchanges* enable the exchange of native tokens of different blockchains, which, in turn, enables the development of blockchain-based digital marketplaces.

Digital wallets can be both software and hardware. The *hardware* wallets provide strong, banking-grade security. The keys that manage the funds are generated by the hardware whilst the transactions are signed internally and then broadcasted. Hence, there is no online exposure of the keys. This provides a lot more safety and reduces the potential for hacking as no connection to the Internet is required. There are three main hardware wallet providers: Ledger, which provides wallets for the average user ('Ledger Nano S/Blue') as well as security solutions ('Ledger Vault') for customers that demand higher guarantees, e.g. banks and hedge funds, Trezor and KeepKey.

Software wallets, on the contrary, do not require the purchase of any specialized device. They can run on a smartphone or desktop. They are less secure than the hardware ones because the attack vector is larger mostly because these devices require access to the internet and in order to be fully secure the underlying software platform needs to be secure, which is never the case e.g. a vulnerability in the Android OS can give full access to the wallet app and a potential hacker can steal the relevant funds. Most software wallets are open source projects, the development of which was initially dependent on user donations. Consequently, many of the wallets that were very popular in previous years have stopped being used due to halts in development. Since all of them are free to download and install, the common business model and, hence, the main source of revenue is based on fees charged for additional services and support. Recently, driven by the ICO explosion, most of them found another way to profit. They advertise and promote thieir service and support efforts, usually through the so called 'airdrops' (free token delivery to the wallet users). Some of the most popular wallets are Electrum, Green Address, Coinomi, Bitcoin.info, Jaxx, BitGo and Mycellium. An interesting development in this area is the idea of a hybrid approach that integrates a fully operational exchange into the wallet. Wallet providers could take advantage of their user base and provide a user-friendly way for their users to buy and trade cryptocurrencies at the same time whilst they, as the providers, receive the fees charged for the services offered. One of the first attempts of this is Eidoo, a multicurrency wallet that aims to provide the service of a decentralized exchange. It is of great interest to note here that companies from the traditional fintech world are starting to consider this route as well. Revolut, a digital banking solution offering peer-to-peer payment options, pre-paid cards and multi-currency accounts and exchange, a few months ago announced the launch of a crypto-exchange offering their users the possibility of buying, storing and trading certain cryptocurrencies.

Exchanges that act as intermediaries between the people that want to trade blockchain-based cryptocurrencies have thusfar constituted the most profitable business model that has emerged in the blockchain space. The market, in contrast to regulated ones (e.g. stock exchanges) operates 24/7 and the volatility of the prices is huge. The exchanges offer a variety of trading products such as margin trading with up to 100x leverage on occasions. At this moment, since mining cryptocurrencies is either too expensive, due to investment in specialized hardware and power consumption, or can only be done by tech-savvy individuals, the exchanges are the only way for regular people to obtain cryptocurrencies. In order to do so, they have to go through know your customer ('KYC') and anti-money laundering ('AML') procedures, thus, the anonymity that the blockchain offers is lost to a certain extent. However, the exchanges introduce a big risk in the whole ecosystem, because they represent a single point of failure in a system where everything is supposed to be decentralized and the need for third party custodians or intermediaries eliminated. When you buy or deposit cryptocurrencies in an exchange, you do not really own them (you do not possess the private keys) but you own IOUs instead. Additionally, exchanges are the target of constant attacks from hackers and if one gets hacked then all its users may lose their assets, something that would not have otherwise happened since the assets on the blockchain are secured by strong cryptographic guarantees.

Almost all existing exchanges have had a hacking incident with the biggest event being the final collapse of Mt. Gox in 2014, which was responsible for almost 70% of the whole bitcoin trading volume at this time and, thus, led to a 67% price crash. Finally, being an entity, the operations of an exchange can be easily regulated or even halted by governments, which represents a contradiction to the nature of bitcoin and blockchain technology. A recent example of such are the bans announced by China and South Korea which, once again, led to a price crash in all cryptocurrencies. This is something that is actually being addressed by using the same technology, i.e. blockchain, in order to build decentralized exchanges. In that way, the user can be sure that, if it is not impossible, it would be extremely hard for a single government or jurisdiction to control it or seize the funds.

Turning now to ddecentralization, this constitutes the '*raison d'être*' of the blockchain[41]. However, the exact meaning of the concept is debated. Vitalik Buterin, the creator of Ethereum, distinguishes between three types of decentralisation:

- "*Architectural (de)centralization*—how many physical computers is a system made up of? How many of those computers can it tolerate breaking down at any single time?
- *Political (de)centralization*—how many individuals or organizations ultimately control the computers that the system is made up of?
- *Logical (de)centralization*— does the interface and data structures that the system presents and maintains look more like a single monolithic object, or an amorphous swarm? One simple heuristic is: if you cut the system in half, including both providers and users, will both halves continue to fully operate as independent units?"[42].

He argues that "blockchains are politically decentralised (no one controls them) and architecturally decentralised (no infrastructural central point of failure) but they are logically centralised (there is one commonly agreed state and the system *behaves* like a single computer"[43]. The idea that the blockchain is logically centralised may seem like it is not considering the possibility of a fork (the fork constituting a separate blockchain that operates as an independent unit).

As previously explained, from a political perspective, there are various possibilities through which a blockchain ecosystem may become centralised if we follow Buterin's typology. Mining constitutes the first centralisation lever. Miners provide consensus for the blockchain. They enable it to function by verifying transactions, pool correct information into the transaction block, perform proof of work processes in order to authenticate the transaction and broadcast the results to the network of miners who accept it as the new end of the blockchain. Everything operates through a democratic consensus under the 'one CPU/GPU, one vote' mechanism. However, it is possible that some miners (mining farms or pools) end up controlling enough computational power to produce proof of work at a faster pace than all the other miners of the network, thereby lengthening the chain at a faster rate than all other users.

[41] Vitaliak Buterin, "The Meaning of Decentralisation", (*medium.com*, 6 February 2017) <https://medium.com/@VitalikButerin/the-meaning-of-decentralization-a0c92b76a274>.
[42] *Ibid*.
[43] *Ibid*.

If the computation power of these mining pools or firms exceeds that of the rest of the network, it is likely that some miners will be able to add new blocks to the chain and effectively act as a gatekeeper, picking the transactions they want to include in a new forked chain. This suppresses competition between miners to validate transactions, the competition between whom is supposed to make it impossible to predict which specific miner will solve the cryptographic puzzle. It may also generate a double spend problem, leading to a duplication of the blockchain. The possibility of a 51% attack that would enable some malevolent actors to re-write the blockchain's history is particularly high if mining becomes centralised among some large players. As explained above, because of the high costs of mining and the development of ASICs, industrial mining and mining pools that allow group of miners to collectively solve the proof of work and split the reward between them, with most of the mining activity being concentrated among a limited number of mining pools, the resulting market structure would be oligopolistic[44].

The shift from a PoW to a PoS approach limits the risk of the 51% attack. If the consensus is formed on the basis of votes representing the ownership stakes of a miner, the miner's incentive is to ensure that the transactions else the future performance of the native token may be affected, which could potentially undermine the system and lead to a loss of its value, thereby inflicting losses to the miner. Hence, in a PoS approach, the miners do not have incentives to cheat on the system. However, PoS has its own issues as PoS limits the possibility of 'competition on the merits' for the verification of transactions, to the extent that it is not the fastest miner to verify the transaction that is rewarded but the actor that has the highest stakes, with these actors being offered considerable leeway to shape the evolution of the blockchain in a way that is proportional to their stake in the platform (in terms of their control of assets, such as storage and computational power, labour or capital dedicated to it). This could lead to some form of plutocratic governance. However, in contrast to the world of digital platforms, lock-in effects in blockchain are quite limited as those that disagree with the strategy of the core developers may fork the chain and launch a separate, backwards-compatible platform, which responds more closely to their preferences.

Blockchain intermediaries and other suppliers of resources may also constitute another possible centralisation lever to the extent that they can use their control over key inputs to shape competition on the marketplace in their favour. This, for instance, may be the case of an oracle that controls access to essential external data sources for the operation of specific smart contracts, exchanges or digital wallets that have become indispensable, for instance because of network effects, or because they gain critical mass by leveraging their dominant position from another network, external to the blockchain. An example would be a blockchain teaming up, on an exclusive basis, with a digital platform whose consolidation of a digital sector has resulted in it controlling some indispensable asset, such as storage on the cloud[45].

[44] For an extensive discussion of the market structure of Bitcoin mining, see June Ma, Joshua Gans and Rabee Tourky, "Market Structure in Bitcoin Mining", (2018), Rotman School of Management Working Paper No. 3103104.

[45] See Andrew Bartels, Dave Bartoletti, John Rymer, Matthew Guarini and Robert Valdovinos, "The Coming Consolidation of Cloud", (2017) Forrester Report, noting that the three areas of greatest consolidation are currently in the base-level computing and storage known as infrastructure as a service ('IaaS'), desktop applications delivered via the cloud and customer relationship management. The report notes that the three largest providers in those markets already collectively hold 70 per cent or more of subscription revenues, with little

Although the crowdsourcing model for the funding of blockchain applications may preserve us from the problem of the same group of venture capitalists and institutional investors controlling or influencing it, one may not exclude the possibility that a core team of developers controls or influences competing blockchain applications. The small community of blockchain experts, some of whom have thousands of followers and exercise an undeniable influence over the actors' perceptions of the evolution of the industry, provide some stakeholders with the power to frame the ongoing conversation/agenda about the future of the blockchain. Due to the important weight of its futurity dimension, this power may be easily converted to economic rents. I will explore this potential, when examining the need to move beyond the strict confines of market power, as this is understood in competition law, in order to assess the power dynamics in a blockchain.

III. Blockchain Competition: Traditional Strategic Competitive Advantage

Blockchain technology has already been applied in various industries and will continue to do so in the near future. Although the technology is quite new and has not yet permeated the entire economy, in this Part the purpose is to understand the various ways firms implementing this technology have attempted to gain strategic competitive advantage both vis-a-vis competing technologies and within the blockchain competitive space. The underlying assumption is that, as with traditional industrial capitalism, economic actors operating in the digital or 'informational' capitalist system compete for rents ('capital') by using different resources at their disposal, including technology assets. They strive to direct their entrepreneurial activity and disposable capital to industries that provide them the highest rate of return. Usually, their strategy is to take advantage of the industry structure in a way that enables them to constitute 'bottlenecks', i.e. activities where scarcity and the potential for control offer superior opportunities for profit or, in other words, to gain strategic competitive advantage. Although this is not the only form of competitive advantage that may generate power, it is still the one on which competition law enforcement usually focuses. In view of the idiosyncratic method of funding of DLT projects through ICOs, this strategic competitive advantage may take different forms than that which is usually the case in traditional digital platform competition.

A. The Emergence of Blockchain-Powered Industries

Some authors distinguish between three categories of blockchain technology with increasing degrees of complexity[46]: The first applications of blockchain (Blockchain 1.0) concerned digital currencies which, for the first time, involved the use of a public ledger system to validate transactions. The next step (Blockchain 2.0) was to move the use of this technology from digital currencies to broader economic sectors. This step enabled the implementation of smart contracts and related applications. The final stage (Blockchain 3.0) will concern the

---

chance that their market share declines. Amazon Web Services ('AWS') dominates the public cloud market, followed by Microsoft Azure and Google Cloud Platform.

[46] Ethan Kane, "Is Blockchain a General Purpose Technology?", (2017) <https://ssrn.com/abstract=2932585>.

complete diffusion of blockchain technology throughout economy and society. Blockchain technology is already utilised in various areas of economic activity[47]. Starting with the remittance industry and then expanding in various sub-sectors of the financial industry (including insurance), this merger of technologies and financial capabilities, which has given rise to the term ‘Fintech’, has since expanded into diverse areas ranging from gambling, to content distribution, decentralised marketplaces, management and decentralised autonomous organizations, to the IoT or to the Internet of Services (‘IoS’).

The Remittance Industry: One of the first ambitions of cryptocurrencies and blockchain technology was to completely disrupt the remittance industry. Blockchain technology was considered the perfect candidate for substituting the traditional error-prone, costly system that took a few days to produce a settlement. A number of companies offer end-to-end blockchain-powered remittance services[48]. In 2004, Santander became one of the first banks to merge blockchain to a payments app thereby enabling customers to make international payments 24 hours a day whilst clearing would occur the next day. Additionally, there are quite a few services that offer to users the possibility to pay with cryptocurrencies while they absorb all the risk of price volatility. BitPay, for example, is a global bitcoin payment service provider, that entered into collaborations with many companies such as Microsoft, TigerDirect and Warner Bros. and processes more than $1 million per day. Other companies provide bitcoin debit cards, companies such as Cryptopay, Xapo and Wirex.

Fintech is certainly the acronym that most people are familiar with when they are asked to provide the example of an industry where blockchain technology has led to significant changes in the industry landscape. The term was coined to describe the intersection between finance and technology. It may refer to technical innovation being applied in a traditional financial services context or to innovative financial services offerings which disrupt the existing financial services market. It is one of the most exciting and dynamic segments of the financial services marketplace. Global investment in Fintech ventures has increased considerably in the last few years. There have also been a few global alternative finance entrants, digital platforms such as PayPal, Apple, Facebook, Amazon, which have changed the digital finance ecosystem beyond recognition. Some use data in a way that is customer facing. They use data to segment customer populations, identify opportunities for new products and services and to optimise pricing. Others use data to help manage risk. They use data to spot outlier transactions that may indicate fraud or cybersecurity breach, or to validate credit-worthiness decisions. It will be interesting to see how blockchain-based Fintech will interact with these digital platforms that are also entering into this industry.

Insurance: Blockchain technology can also be used to implement various insurance policies. This is done usually with the use of a smart contract. The assets can be kept in an escrow account until the triggering condition is satisfied and then the prearranged action takes place. This eliminates counter party risk, intermediaries and costly delays. For example, a flight

[47] For a complete survey, see Deloitte, “Global Survey: Breaking Blockchain Open”, (2018) <https://www2.deloitte.com/us/en/pages/consulting/articles/innovation-blockchain-survey.html>.
[48] For instance, Align Commerce and Bitspark.

delay insurance policy may be easily implemented using a smart contract and there are some pilot projects already[49].

Gambling: Another promising application is gambling on the blockchain and this was actually the first ‘killer app’ built on bitcoin (Shatoshi Dice). In this case, the blockchain solves the most important thing missing in online gambling today: *provable fairness*. The current status is that an auditing authority certifies the algorithms (mainly the random number generation algorithm, the ‘RNG’) being used by the gambling company but the client can never be sure about what is actually running at the time when they areplaying. However, this could be easily tackled by the blockchain. Its public ledger could be used to prove that the code running is the audited one[50].

Digital Content: Since the blockchain is a decentralized, permission-less system, everybody and anybody can release any kind of digital media content (music, video, blog) and be paid in its native token or any other cryptocurrency. With the new advances in payment channel technology such as the ‘lightning network’, which introduces the concept of micro-transactions, blockchain will be able to scale to thousands or even millions of transactions per second (‘TPS’). Anybody interested will have access to that content and pay per second, per word, per byte etc. (the concept of ‘micropayments’). This could be a revolutionary development in the digital media sector, creating a new on-demand, real-time context and eradicating the monopoly of the big players as well as the classic model of subscriptions and omnipresent advertisements[51].

Management and Decentralized Autonomous Organizations (DAOs): Decentralized applications is not a new concept introduced by blockchain technology but the recent advancements and the hype surrounding it has brought it back to prominence. Peer-to-peer systems existed in the past. Napster, an example of a peer-to-peer music file sharing system, was the start of the traditional music industry decline and the transition to the digital age. Decentralized protocols like ‘BitTorrent’ have always been used by people to exchange digital content but the infrastructure to build and develop truly decentralized apps emerged with the creation of the blockchain. However, a concept that is not widely spread despite it being considered by many the holy grail of blockchain technology is the decentralized autonomous organization (‘DAO’). Vitalik Buterin, the inventor and co-creator of Ethereum, defines it as follows: “an entity that lives on the internet and exists autonomously but also heavily relies on hiring individuals to perform certain tasks that the automaton itself cannot do”[52]. The main characteristic of a DAO is that it processes an internal capital or property that has some value and can use it as an incentive mechanism for motivating and putting in action certain activities. In a few words, a DAO aims at automating and setting in stone the rules that will manage and govern the organization through software. The rules that would run the organization are

---

[49] See, <https://fdd.etherisc.com/>.

[50] See, for instance, Funfair Technologies, “Blockchain Solutions for Gaming”, (*funfair.io*) <https://funfair.io/>; EtherFlip, (*etherflip.co*) <http://www.etherflip.co/>; Winsome, (*blog.winsome.io*) <https://blog.winsome.io>.

[51] For instance, Steemit, (*steemit.com*) <https://steemit.com/>, is a blogging and social networking platform where users are free to post, comment and generally interact with the platform and they get rewarded in STEEM tokens, which are pegged to the US-dollar.

[52] See Vitaliak Buterin, “DAOs, DACs, DAs and More: An Incomplete Terminology Guide”, (*blog.ethereum.org*, 6 May 2014) <https://blog.ethereum.org/2014/05/06/daos-dacs-das-and-more-an-incomplete-terminology-guide/>.

formalized in software code then the tokens that represent ownership are distributed through a token sale and finally people can vote on how to allocate resources or on whether a new project should be approved or rejected.

This could provide the foundation for the development of ambitious projects that could potentially threaten and disrupt the monopoly of big established players. There could be, for example, a truly decentralized transportation system, using a similar business model to the one of Uber, but running on the blockchain and controlled entirely by a DAO. People could register and participate as employees or clients, or in the extreme case it could use the available funds and allocate resources (cars, buses, helicopters etc.) in order to build its own. In a (not so) futuristic scenario, if this were to be combined with the self-driving vehicle technology currently being developed, it could create a truly automated corporation leaving humans completely out of the equation. Another example could be a decentralized version of the Airbnb hospitality service. The DAO, in a similar fashion as outlined in the previous case could allocate resources and operate autonomously. The potential benefits of that could be numerous and of great value. The costs of administration would be significantly reduced thereby making the service less expensive whilst providing more competitive prices for low-end management services. The lack of an intermediary taking an arbitrary commission would increase the profits of the people offering their properties and it would increase trust whilst reducing or completely eliminating the risk of human-run corporations, e.g. fund embezzlement, opaque processes and various other scandals usually taking place in such environments.

Internet of Things/Internet of Services: The transition from smartphones to the IoT where millions of devices will get direct Internet connectivity including thermostats, refrigerators, cars etc. will increase the means through which companies may get access to valuable consumer data. One of the possible uses of blockchain technology and associated cryptocurrencies is that it could be to become the backbone of the machine-payable web, i.e. machines communicating, sharing processing power and exchanging value with each other, and the base layer connecting the different industries. IOTA[53] is the first cryptocurrency designed to power the IoT revolution. It enables the secure sharing of resources between smart devices with zero transaction fees. IOTA has also been used as the underlying ledger for transferring information during the production process in Industry 4.0 projects, while also leading to a tamper-proof audit trail.

Decentralised Marketplaces: Elements of DLT have also been implemented in online decentralised marketplaces. For instance, OpenBazaar, a decentralized marketplace, much like eBay or Amazon, operates independently of any intermediary operator. The platform relies on blockchain technology to ensure that buyers and sellers can interact directly with each other without passing through any centralized middleman. All transactions are accomplished through Ricardian contracts, a form of smart contract that is readable by computers and humans and can be cryptographically signed, which enable the buyer, the seller and a potential third-party arbitrator to agree for the funds to be released in one of the most widely used cryptocurrencies, once a contractual condition is satisfied. Decentralised marketplaces, such as OpenBazaar may challenge the dominance of online retail platforms. ModulTrade aims to replace the letter of credit used quite often in global trade, in particular for small and medium-sized enterprises

[53] See Serguei Popov, "The Tangle" (2018) Report <https://iotatoken.com/IOTA_Whitepaper.pdf>.

(‘SMEs’) and, thus, provide important savings from the significant costs that banks charge for acting as an escrow between two companies[54]. The Origami network offers a decentralised peer-to-peer marketplace. Powered by the Ethereum smart contract technology, it is combined with a decentralised escrow and payment solution developed for both e-commerce and online marketplaces, without the need to provide any personal information nor for a third party to control the cash-flow, as the escrow payment management is automated, together with a decentralised customer review management, connected to the external data sources via Oracles[55]. Other decentralised marketplaces have been built on networks different to Ethereum[56]. The economic and social implications of the emergence of these global decentralised marketplaces for the organisation of global e-commerce and for the position of incumbent online intermediaries and online marketplaces cannot be overstated.

B. The Blockchain Profit and Growth Drivers: Seeking Strategic Competitive Advantage

There are two main sources of profits for the capital invested in the blockchain technologies and DApps. The first refers to the possibility of blockchain-based technologies being offered in distinct product markets as their use is expanding in various sectors of economic activity. The second refers to the possibility that the development of blockchain technology attracts funding on the expectation of future (sometimes immediate future), phenomenal returns on investment. We will explore both sources of potential value capture for blockchain technology projects. Competitive strategies seek to promote both but the two are not always interrelated to the degree that one might have expected[57].

1. Competitive Advantage in the Blockchain Era

To the extent that blockchain technology has not so far been implemented in a great number of product markets, one may conclude that a major driver in the profitability of the technology has not yet emerged. However, we will explore different ways in which blockchain technology may accelerate growth and lead to the establishment of strategic competitive advantage in an industry or in specific markets.

One has to conceive the blockchain as a new technology that becomes embedded in existing schema of acquiring and maintaining competitive advantage, before these schema being transformed when the full competitive potential of the technology becomes evident to economic actors, or at least a significant number of them, and there is a generalised shift to the new technology. Just being the most advanced technology in terms of technical characteristics is not sufficient to gain prominence in either a specific industry or the overall economy. The existence of significant sunk costs, path-dependencies and network effects are some of the

[54] See ModulTrade, (*modultrade.com*) <https://modultrade.com>.
[55] See Origami Network, (*ori.network*) <https://ori.network>.
[56] For a discussion, see Christine Comben, “Top Decentralised Marketplaces that Use Blockchain Technology” (*coincentral.com*, 9 July 2018) <https://coincentral.com/decentralized-marketplace-blockchain/>.
[57] The exuberance of some projects that still managed to have successful ICOs and attract funding may support this point.

factors that may influence the success of a technology even vis-à-vis inferior alternatives. This illustrates the endogenous character of technological change[58]. Hence, the competitive game and the strategies developed by the players change with each shift in the dominant GPT. Resources and assets that were considered valuable may lose importance whilst others become valuable overnight. For instance, many have referred to the significance of data in the digital economy emerging out of the third and fourth industrial revolution, these being referred to as equally, if not more, valuable and essential as oil and electricity have been following the second industrial revolution[59], a claim that, of course, needs to be qualified.[60]

Data will certainly constitute an essential feature of any application of blockchain technology. Blockchain puts in place an 'Internet of Value' that enables through a backbone service ensuring the security (via a distributed consensus ledger) and the immutable and uncensored history of transactions, the movement of digitised assets across the world in a few seconds. What is really transferred is not value as such but data on transactions that have value. To the extent that data is a public good, characterised by non-rivalrous consumption, that can be massively produced and/or harvested from an ever-increasing array of resources, in particular after the IoT adds billions of devices and sensors collecting data to the data production system, it may seem unlikely that it could reproduce the scarcity that makes oil being such as valuable resource[61]. It is possible that some actors control some key access points to data or indispensable storage facilities, which confers market power on them, or that these actors have managed to develop, on the basis of data that they have already harvested, efficient algorithms that, in tandem with network effects, may provide them with a sustainable head start and competitive advantage for a significant period of time[62].

In the context of blockchain, the crucial issue is not the data as such, but the transaction that has been digitised and incorporated in the blockchain. From this perspective, one may consider that any scarcity generating a valuable resource would emanate from some degree of control over the digitised transactions. However, the decentralised architecture of the blockchain enables each user to maintain the resource to be exchanged into a digital wallet to which only the user has access and to use for the transaction: a private key, to which only the holder of the key has access. The transaction requires the conversion of this private key to a public key through a cryptographic transformation pursuant to the digital signature by both parties. Hence, so far, only the parties to the transaction control the resource to be exchanged

---

[58] See Paul David, "Clio and the Economics of QWERTY", (1985) 75(2) *American Economic Review*, 332-337; Paul David, "The Hero and the Herd: Reflections on Thomas Edison and the 'Battle of the Systems'" in *Favorites of Fortune: Technology, Growth, and Economic Development Since the Industrial Revolution* (edited by Patrice Higonnet, David Landes and Henry Rosovsky, Harvard University Press, 1991); Paul David, "Heroes, Herds and Hysteresis in Technological History", (1992) 1(1) *Journal of Industrial and Corporate Change*, 129; Håkan Håkansson and Anders Lundgren, "Paths in Time and Space - Path Dependence in Industrial Networks" in *Evolutionary Economics and Path Dependence* (edited by Lars Magnusson and Jan Ottosson, Edward Elgar, 1997), 119-137.

[59] See, for instance, The Economist, "The World's Most Valuable Resource is No Longer Oil, But Data" (*economist.com*, 6 May 2017) <https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data>.

[60] Data was not that valuable before the digital revolution.

[61] See the discussion in Adam Schlosser, "You May Have Heard Data is the New Oil. It's Not", (*weforum.org*, 10 January 2018), <https://www.weforum.org/agenda/2018/01/data-is-not-the-new-oil/>.

[62] Autorité de la concurrence (France) and Bundeskartellamt (Germany), "Competition Law and Data" (2016) Report.

in the transaction, to the exclusion of any intermediary. However, for the blockchain to operate, this private transaction needs to be communicated or broadcasted to the network, and later verified and authenticated by the miners, who, following some consensus, the form of which is specified in the specific blockchain's design rules (*lex cryptographia*), will incorporate the transaction into the blockchain. This process of verification and authentication by the miners through consensus introduces some degree of scarcity as the assets of the blockchain value system need to be transformed from raw information about a transaction to a transaction block incorporated in a distributed and networked ledger about real valuable transactions. Scarcity may be artificially created in this case either by specifying the amount of blocks a blockchain may have with block space being a scarce commodity for technical reasons, or by regulating the number of native tokens that are distributed as incentive to miners to engage in their mining activity. This scarcity may be source of value but may also give rise to strategies of exclusion and exploitation that could be of interest for competition law (see our analysis in Part VI).

Competitive interactions in the digital economy are quite complex. What constitutes an established or a potential competitor becomes blurred as economic entities are actively pursuing strategies to alter the industry structure in order to alleviate competitive pressures. They seek to position the firm at the point where competition, both horizontal and vertical, is at its weakest[63]. In traditional strategy analysis, competing entities (often, corporations) seek a competitive advantage, either by imitating successful competitors while lowering their costs or by differentiating themselves from their competitors by developing idiosyncratic resources and capabilities and designing strategies to exploit these differences. The business environment in which competitive advantage strategies are integrated is formed by the relationship that the corporation has with three sets of players: customers, suppliers, and competitors[64]. Firms make profits but they must also provide value to their customers. "Value is created when the price the customer is willing to pay for a product exceeds the costs incurred by the firm"[65]. This surplus is distributed between the customers and the producers by the forces of competition. If competition is strong, consumers will receive the higher percentage of the surplus value (the so-called 'consumer surplus', which measures the difference between the price they paid and the price they were willing to pay). The rest of the surplus value will be received by producers (the so-called 'producer surplus', which measures the difference between the amount a producer receives and the minimum amount the producer is willing to accept for the product). The profitability of different industries varies, some earn high rates of profit whilst others can barely cover their cost of capital[66]. This largely depends on the degree of competition that prevails in each industry as intense price competition generally leads to weak margins. Profitability within a specific industry may also be quite different with some firms earning significant profits whilst others struggle to maintain themselves on the market[67].

[63] Grant Robert, *Contemporary Strategy Analysis* (Wiley, 2013), 74-76.
[64] *Ibid*, 61.
[65] *Ibid*, 62.
[66] *Ibid*.
[67] The advent of the digital economy has led to the development of what has been characterized as the rise of "superstar firms" which are able to take advantage of technology, including Big Data and artificial intelligence, in understanding better than "standard" firms the competitive game. See David Autor, David Dorn, Lawrence Katz, Christina Patterson and John Van Reenen, "The Fall of the Labor Share and the Rise of Superstar Firms", (2017) NBER Working Paper No. 23396.

The most widely used competition framework in business strategy is that put forward by Michael Porter, the "five forces of competition framework"[68]. According to this framework, the profitability of an industry is determined by five sources of competitive pressure: competition from substitutes, competition from new entrants in the industry, competition from established rivals, which can be characterised as sources of 'horizontal' competition, and competition from the bargaining power of suppliers and the power of buyers, which can be characterised as sources of 'vertical competition'[69].

[68] Michael Porter, "The Five Competitive Forces that Shape Strategy", (2008) 25 *Harvard Business Review*.
[69] Grant, (62), 65.

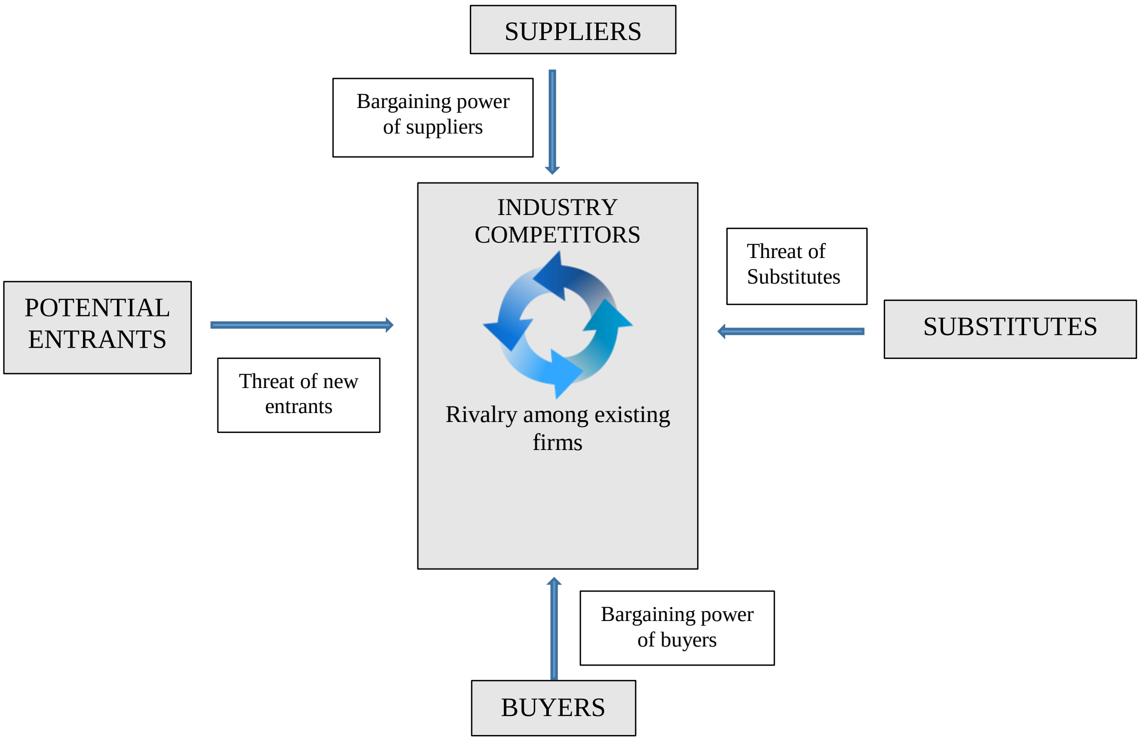


Figure 1: Porter's Five Forces[70]

Competition economics has largely focused on horizontal competition from established competitors producing substitute products or on the threat of entry of potential competitors. Rivalry between established competitors is often measured by reference to the level of market concentration, often measured by a concentration ratio, the market share of the largest producers in a specific market. However, it is still unclear how the level of market concentration impacts upon profitability and, consequently, the allocation of the surplus between consumers and producers. The likelihood of a new entry (i.e. potential competition) largely depends on barriers to entry, that is, an advantage that an established firm enjoys vis-à-vis its rivals, which may include economies of scale (to the extent that large, indivisible investments in production facilities, research & technology or marketing may be more easily amortized over a large volume of output), absolute cost advantages (which may come from an easy access to an indispensable input), capital requirements (because of the large fixed costs required in order to kick start economic activity in an industry), product differentiation (as it might be quite difficult to enter a market where consumers have strong loyalty ties to existing brands), access to channels of efficient distribution, strategic barriers to entry because of competitive strategies that aim to increase the potential rivals' costs if they enter the market, or legal and regulatory barriers etc. Competition law aims to limit the effectiveness of barriers to entry in order to increase the 'contestability' of the market[71].

[70] The graph reproduces Figure 3.2. in Grant, (62), 65.
[71] William Baumol, John Panzar and Robert Willig, *Contestable Markets and the Theory of Industry Structure* (Harcourt Brace Jovanovic, 1982).

In contrast, vertical competition has not been the primary focus of competition economists even if it may play a significant role in the allocation of the total surplus value generated by a value chain. The relative bargaining power of a supplier upstream or of a customer downstream has been considered as playing a less important role than 'horizontal competition' because it is assumed that, in most cases, they have a limited impact on the overall economic efficiency of the transactions. If public policy shifts its focus on to the productivity and ability of 'superstar' large digital platforms to pull away from competition and enjoy tremendous levels of profitability, without these accumulated profits being used for productive investments, vertical competition may become an important concern.

Interactions between economic actors may focus on either the horizontal or vertical competition dimension. They can be qualified as strategic to the extent that each actor considers how rivals will react. Simply put, there are two possibilities:[72]

- Economic actors' decisions may be *strategic complements* in that they tend to reinforce each other (i.e. they move in the same direction). For instance, setting prices among horizontal rivals is such that a decision to raise (reduce) prices will incentivise (or even, force) rivals to do likewise;
- Economic actors' decisions may be *strategic substitutes* in that they tend to offset each other (i.e. they move in opposite direction). In the horizontal competition scenario, setting capacity is such that a decision to expand capacity will force rivals to reduce theirs.

There is a difference, though, between the two strategic settings. Under strategic complements, economic actors' moves reinforce each other - i.e., there is a positive feedback loop, but this competitive mode tends to produce more extreme outcomes than under strategic substitutes. However, even in the context of strategic substitutes, the intensity of the strategic response may vary and be 'tough' or 'accommodating', depending on the economic actor's decision to create more room for rivals[73].

Although there is a plethora of blockchain-based projects with a number of hypothetical use cases (see for a discussion our analysis in Part III.A. of this paper), it is still unclear how DLT can contribute to create value within economic organisations[74]. It is clear that blockchain provides some intangible resources (to the extent that blockchain consists essentially in code and, occasionally, its combination with purpose-built hardware) to economic organisations that can be employed to gain sustainable competitive advantage in product markets. However, in view of the immaturity of the technology, it is still too early to venture specific predictions. It is only possible to refer broadly to some potential sources of strategic competitive advantage.

---

[72] This terminology is inspired by Jeremy Bulow, John Geanakoplos and Paul Klemperer, "Multimarket Oligopoly: Strategic Substitutes and Strategic Complements", (1985) 93 *Journal of Political Economy*, 488-511.

[73] Dean Fundeberg, and Jean Tirole, "The Fat-Cat Effect, the Puppy-Dog Ploy and the Lean and Hungry Look", (1984) 74 *American Economic Review*, 361-366

[74] There is however an ongoing discussion in the literature. See, for instance, Magnus Vitsø Bjørnstad, Joar Gunnarsjaa Harkestad and Simen Krogh, "A Study on Blockchain Technology as a Resource for Competitive Advantage", (2017) *Norwegian University of Science and Technology*; Brant Carson, Giulio Romanelli, Patricia Walsh and Askhat Zhumaev, "Blockchain Beyond the Hype: What is the Strategic Business Value" (*mckinsey.com*, June 2018) <https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value?cid=other-eml-nsl-mip-mck-oth-1807&hlkid=8ca56a40fe474c7497e74038a1f43fe7&hctky=9280917&hdpid=bb9f89f0-458b-4b4e-a1ee-ad99e602294e>.

The adoption of blockchain technology will certainly lead to an important reduction of verification costs that have typically been required for transactions in digital markets[75]. These are close to zero, in particular because the computation and energy costs may be reduced by a more systematic recourse to PoS protocols, blockchain is a technology allowing for costless verification, and because administrative costs for record keeping can be significantly reduced, to the extent that this is delegated to a distributed ledger. To the extent that blockchain technology may substitute trust in the code to trust in intermediaries, (DLT has been qualified by some as the 'trust machine')[76], it can also lead to a significant reduction of costs associated with the presence of intermediaries in the economy. A recent McKinsey report has looked to ninety use cases of blockchain technology in fourteen industries and found that 70% of the value at stake in the short-term brought in by the implementation of blockchain technology was in cost reduction[77]. Such significant reductions in costs may provide important cost advantages and operational efficiencies to economic entities employing blockchain technology. It could also shift the flow of value by creating new revenue streams for blockchain as a service ('BaaS') providers that offer integrated solutions of online distributed ledger technology to companies eager to develop blockchain-based solutions.

According to the same report, "(o)ver time, the value of blockchain will shift from driving cost reduction to enabling entirely new business models and revenue streams", one of the "most promising and transformative use cases being the establishment of a distributed, secure digital identity and the services associated with it"[78]. This is related to the know your customer ('KYC') process, in which firms seek to establish the identity of their customers both before and after entering in transactions with them. This is particularly important for implementing anti-corruption legislation and laws pertaining to terrorist financing and money laundering, and implementing economic sanctions regimes. This may lead to a more intensive use of blockchain technology in the banking and, more generally, financial industry. The application of blockchain technology on a larger scale will certainly lead to network effects, although not as pronounced as those for digital platforms, for reasons already explained in Part II, and could also be a source of competitive advantage.

However, blockchain technology has some inherent limitations that may interfere with the process of transforming the competitive advantage to dominance and higher profitability. First, blockchain largely consists in combining code that is open source and could be easily replicated by competitors with purpose-built hardware, which is also available, sometimes at a relatively low cost, to competitors. Furthermore, blockchain technology does not enable the development of mechanisms isolating the incumbent from actual or potential competition. As explained in Part II, the possibility of developing a blockchain fork, in the case that some blockchain actors disagree with the blockchain developers, diminishes any likelihood that direct and indirect network effects will set high barriers to entry.

In order to transform the competitive advantage provided by capabilities acquired in blockchain technology to *sustainable strategic* advantage, economic actors should adopt conduct in complementary spheres or markets that will be strategically linked with the

[75] Catalini and Gans, (22).

[76] The Economist, "The Trust Machine" (*economist.com*, 31 October 2015) <https://www.economist.com/leaders/2015/10/31/the-trust-machine>.

[77] Carson et al., (73).

[78] *Ibid*.

blockchain technology with the objectives of protecting the advantage provided by these blockchain capabilities and of limiting the possibility of their rivals to copy them. Thus, in order to protect their profits, economic actors will have to develop isolating mechanisms.

Acquiring a first mover advantage is certainly a successful strategy but for it to be maintained and eventually expanded on the firm should make considerable investments on innovation. It also makes sense for the firm to focus on difficult problems that no one else has previously explored, seeking technical solutions that could potentially be implemented in the whole industry.

Another mechanism to protect the competitive advantage in the long-term is technical complexity. By combining cryptographic techniques, unique computational power, cheap and extensive storage capabilities and powerful algorithms, firms can make it more difficult for their competitors to reproduce the firm's original competitive advantage. Attracting highly specialised staff (blockchain core developers), who have been specifically trained in this complex combination of assets, may also have significant effects on competition, in view of the relative scarcity of 'blockchain experts', at least at the initial stages of the development of this technology[79].

This may be combined with a strategy of patenting blockchain technologies, developing an IP portfolio protecting investments in these technologies, and/or proceeding with a simple protection as a trade secret. The last option may not be that attractive as currently blockchain applications are open source (i.e. the source code is accessible and editable by everyone). This is essential in order to attract the user community. Although the original blockchain codes used for Bitcoin and Ethereum (smart contracts) are open source, patent applications may be made for algorithms improving the blockchain processing operations and/or for algorithms or hardware enabling new uses of blockchain. Patenting software is a distinct possibility in the US, as the Patent Act (35 U.S.C. § 101) enables the grant of patents for decentralized data structure management technology software and some aspects of internet-implemented applications of blockchain technology[80]. As Singh explains, one may apply for patent protection for several internet-implemented applications of blockchain:

- "Applications that use the blockchain technology over the internet, such as applications for financial data, such as cryptocurrencies, public records, identification."
- "Improvements in the architecture of one or more of the following individual technologies that collectively form the blockchain technology implemented over the internet, such as: asymmetric encryption, hash functions, Merkle trees, key-value database, peer-to-peer ('P2P') communication protocol and proof of work".
- "Improvements in methods executed […] such as: (a) a method of sharing transactions and blocks as executed using the P2P communication protocol, (b) a process of validating transactions and achieving distributed consensus, which use the blockchain concepts of proof of work, proof of stake, and decentralised consensus, (c) a method of efficiently packaging transactions into blocks, using the concept of Merkle trees, (d) a

[79] See Marcin Zduniak, "6 Ways to Stay Ahead of Blockchain Competition" (*espeoblockchain.com*, 23 May 2018) <https://espeoblockchain.com/blog/blockchain-competition-example/>.
[80] Gumeet Singh, "Are Internet-Implemented Applications of Blockchain Technology Patent-Eligible in the United States?", (2018) 17(2) *Chicago Kent Journal of Intellectual Property*, 357.

method of performing hashing of at least one of the blocks and transactions, and a method of obfuscating public keys, (e) a method of searching previous transactions to prevent double-spends, which uses the concept of key-value database, and (f) a method of signing transactions, which can use the technologies of digital signatures based on public and private keys, asymmetric encryption, and elliptic curve cryptography"; and

- "Computing systems or devices, computer program products and articles of manufacture that are used by the end customer to execute the internet-implemented applications that implement the block-chain technology"[81].

The issue of patentability of blockchain-based technologies can be set in different terms in the US and in the EU, due to some specific limitations to the patentability of software that exist in Europe. Section 101 of the US Patent Act, in defining the subject matter eligible for patent protection, contains an implicit exception for "[l]aws of nature, natural phenomena, and abstract ideas". In applying this exception, the Supreme Court distinguishes between patents that claim the "buildin[g] block[s]" of human ingenuity, which are ineligible for patent protection, from those that integrate the building blocks into something more, thereby "transform[ing]' them into a patent-eligible invention"[82]. In *Alice v. CLS Bank International,* the Supreme Court implemented these principles to patent claims directed to a computer-implemented technique of intermediating settlements in the context of financial transactions[83]. The Court first found that the concept of intermediated settlement was an abstract idea and constituted a fundamental and long-prevalent economic practice in the system of commerce. It then held that claims that "require generic computer implementation, fail to transform that abstract idea into a patent-eligible invention"[84]. Hence, the fact that the well-established concept of intermediation is performed by a generic computer was not sufficient for making the claims eligible for patentability. It should also have been necessary to provide evidence that the technology improved the functioning of the computer or any other technology or technical field.

Under the joint *Mayo/Alice* test, courts should first assess if, on the whole, the claims are "directed to" patenting an abstract idea, before, in the second step, considering whether the claims contain "an inventive concept" that would transform the nature of the claim into a patent-eligible application. According to the Court, the claim should contain "an element or combination of elements that is sufficient to ensure that the patent, in practice, amounts to *significantly more* than a patent upon the [ineligible concept] itself". Such would be the case, if the claim limitations "involve more than performance of well-understood, routine, [and] conventional activities previously known to the industry". This requirement of 'significantly more' contribution than the use of a generic computer implementation is assessed on a case by case basis by the courts. To the extent that blockchain technology significantly improves the functionality of a computer because it enables immutability, a decentralised architecture and cryptographic security of data, or the way the system stores, tracks and processes data, and the fact that it puts forward 'unconventional' solutions to technological problems, going beyond

[81] *Ibid*, 358-359.
[82] *Mayo Collaborative Services* v. *Prometheus Laboratories, Inc.*, 142 S.Ct. 1289 (2012).
[83] *Alice* v. *CLES Bank International*, 134 S. Ct. 2347 (2014).
[84] *Ibid*.

performance of "well-understood, routine, and conventional activities previously known to the industry", makes it possible to patent some implementations of blockchain technology and, thus, exclude rivals from using the technology.

In the EU, although computer programs 'as such' are, in principle, excluded from patentability in view of Article 52(d)(2) of the European Patent Convention which creates an exception to their patentability, by virtue of the interpretation of Articles 52(d)(2) and 52(d)(3), software–based patents may be eligible to patentability if the claimed subject-matter has a technical character. The European Patent Office ('EPO') has already granted thousands of patents related to software-based technologies and a quite complex, and not necessarily clear, jurisprudence of the Technical Boards of Appeal of the EPO has attempted to interpret the limits of patentability in this area[85]. Traditionally, improvements in CPU processing speed, a decrease in energy consumption or memory usage for a particular device, and/or progress in information encryption have been considered as providing a technical solution to a technical problem having technical effects and, thus, eligible for patentability. This could also be the case for some aspects of blockchain technology. It was reported that from the 27 European patent procedures related to blockchain published in 2017 and 2018, only two patents were granted, which proves that blockchain is patentable in Europe[86].

In recent years there has been some significant patent activity related to blockchain technology. It has been reported that patent applications towards blockchain technology started as early as 2007/2008 and have grown substantially, in particular, since 2015[87]. From less than two dozen applications per year, during 2007-2013, the number of applications has increased to 1237 filed worldwide in 2017, up from 594 in 2016 and 258 in 2015 (see Box 1)[88].

Box 1: Blockchain Patent Applications

USPTO: the search was conducted using the US patent application search and using the keyword "blockchain" in the title and/or abstract of the patent application. This resulted in the finding of 226 patent applications.

EPO: the search was conducted using the European Patent Register and using the keyword "blockchain" in the title of the patent application. This resulted in finding of 187 patent applications.

---

[85] See European Patent Office, "Programs for Computers", Guidelines for Examination <https://www.epo.org/law-practice/legal-texts/html/guidelines/e/g_ii_3_6.htm>.

[86] These are patents EP3125489 and EP3257191. See the discussion in João Cabral, "The Patentability of Blockchain Technology in Europe" (*inventa.com*, 24 April 2018) <https://inventa.com/en/news/article/300/the-patenteability-of-blockchain-technology-in-europe>.

[87] Johan Ståhlberg and Isabel Fiol, "Analysing Blockchain Patent Trends", (*managingip.com*, 24 April 2018), <http://www.managingip.com/Article/3802483/Analysing-blockchain-patent-trends.html>.

[88] See Bruce Berman, "Blockchain Patent Applications Doubled in 2017 to More than 1,200" (*ipcloseup.com*, 27 March 2018) <https://ipcloseup.com/2018/03/27/blockchain-patent-applications-doubled-in-2017-to-over-1200/>.

CNIPA: the search was conducted using Chinese National Intellectual Property Administration's database and using the keyword "blockchain" in the title of patent application. This resulted in the finding of 236 patent applications.

Espacenet: EPO contains a special database of worldwide patent applications. We searched for the keyword "blockchain" in title and abstract sections which resulted in 1,237 patent applications.

US PTO	**EPO**	**China**	**Worldwide (Espacenet)**
226	187	236	1,237

Most of these filings take place in China, South Korea, Australia, the US and the EU (including the UK)[89], with China recently overtaking the US for the number of patents filed. European patents have been sparsely granted to blockchain technology with only a handful of patents (no more than 10) granted between 2011 and 2016[90]. With regard to the number of patents granted, US patents are the most prevalent, followed by those granted in China, Korea and Australia[91] (see Box 2).

Box 2: Blockchain Granted Patents

USPTO: the search was conducted using the search of granted patents and using the keyword "blockchain" in the title or abstract of the patent.

EPO: the search was conducted using European Patent Register and using the keyword "blockchain" in the title of the patent/patent application and for searching only for issued patents.

China: There was no option in the CNIPA database to search for granted patents so we could not conclusively find how many patents have been granted from these'236 patent applications.

US PTO	**EPO**
37	2

It was reported that "(o)f the top nine filings for blockchain patents between 2012 and 2017, six were Chinese, led by Beijing Technology Development"[92]. Mastercard, Digital Asset Holdings, Bank of America, Intel, Coinbase, Security First Corp, Microsoft, IBM, Qualcomm,

89 Ståhlberg and Fiol, (86).

90 See PatentlyGerman, "Blockchain Patent Activity Increases – but Granted Patents are Still Rare in the Field" (*patentlygerman.com*, 14 February 2018) <https://patentlygerman.com/2018/02/14/blockchain-patent-activity-increases-but-granted-patents-are-still-rare-in-this-field/>.

91 Ståhlberg and Fiol, (86).

92 See Financial Times, (*ft.com*) <https://www.ft.com/content/197db4c8-2e92-11e8-9b4b-bc4b9f08f381>.

Medici are among the leading US patent applications, while NChain, Accenture and British Telecom the top EU-based assignees[93]. These patents cover different areas and include both business methods and software patents (see Box 3).

Box 3: Blockchain Patenting Technological Areas (USPTO)

The most common classification of blockchain patents are in the following categories:

G06F – Electric Digital Data Processing
G06Q – Data Processing Systems or Methods
G06N – Computer Systems Based on Specific Computational Models
H04L – Transmission of Digital Information

Blockchain patents include both business method and software patents.

Can blockchain be protected by copyright (database right)? Due to the specific decentralised nature of blockchain technology, a blockchain, in and of itself, is unlikely to be considered as a 'database' and enjoy copyright protection under the EU Directive on the Legal Protection of Databases (EU Database Directive).[94] Blockchain is a distributed ledger on which transactions are anonymously recoded and blocks are maintained simultaneously across a network of unrelated computers or servers. A new block of data will be appended to the end of the blockchain only after the computers on the network reach consensus as to the validity of the transaction.[95] After a block has been added to the blockchain, it can no longer be deleted. The transactions it contains can be accessed and verified by everyone on the network. It becomes a permanent record that all of the computers on the network can use to coordinate an action or verify an event.[96] Consequently, the principles of decentralization and participation by all users characterise blockchain technology.[97] In contrast, the EU Database Directive protects, with a copyright-like right, those databases that are centralized and created by a specific natural or legal person. Article 3 of the EU Database Directive emphasises that the database should constitute the author's own intellectual creation. Article 4 provides that there must be an known author of the database, in particular a "natural person or group of natural persons who created the base or, where the legislation of the Member States so permits, the legal person designated as the rightsholder by that legislation". Blockchain does not have a sole or defined group of authors who 'created the database'. Hence, it does not seem to fit within the traditional legal boundaries of the right protecting 'databases'.

---

[93] Compilation of data reported in Henry Chiu, "An Overview of the Blockchain Patent Landscape", (*clarivate.com*, 8 November 2017) <https://clarivate.com/blog/overview-blockchain-patent-landscape/>; PatentlyGerman, (89).
[94] Directive 96/9/EC of 11 March 1996 on the Legal Protection of Databases [1996] L 77/20.
[95] de Filippi Primavera and Wright Aaron, "Decentralized Blockchain Technology and the Rise of Lex Cryptographia" (2015) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664>, 7.
[96] *Ibid*, 8.
[97] Nolan Bauerle, "What is the Difference Between a Blockchain and a Database?" (coindesk.com) <https://www.coindesk.com/information/what-is-the-difference-blockchain-and-database/>.

As already explained, acquiring a sustainable strategic competitive advantage may require the tailoring of strategies that leverage the market position of the economic entity, in particular strategies concerning essential infrastructure and services for maintaining the operation of the blockchain in order to acquire the ability to shape the ecosystem, for instance by establishing industry standards or by influencing regulation[98]. We will explore the second strategy in a subsequent Section. With regard to the effort to develop industry standards, in the absence of a dominant position which may impose *de facto* standardization, a voluntary standardization process requires some degree of cooperation between multiple industry players, including between horizontal competitors. This may give rise to situations of 'co-opetition', a concept put forward by Brandeburger and Nalebuff to describe the "future of competitive interactions in the economy, whereby businesses become more competitive by cooperating with each other and develop unique capabilities that add value and complement those of their competitors".[99] Competitors could, thus, cooperate in setting the standards of the industry.

The presence of multiple players renders the effort of standardization more complex and may, thus, affect the possibilities of cooperation. In most cases, the industry players form consortia. For instance, a number of financial institutions collaborated in the R3 consortium with the aim of developing the financial-grade, open-source Corda blockchain platform. The establishment of common standards for the operation of the blockchain is particularly important in the context of the IoT. These standards may relate to a number of design choices, for instance the size of the blocks, the consensus protocol employed for the governance of the blockchain, the type for storage, interoperability between different blockchains[100] and technologies connecting the blockchain with the outside world (such as IoT and biometrics) in a way that can maintain the security of the blockchain ledger, even if the physical sensors or APIs of existing systems and databases are interrupted[101]. The important costs for building the blockchain infrastructure, and the presence of network effects, has led some commentators to observe that "few start-ups have sufficient credibility and technology stability" for deploying the optimal scale of these technologies. A number of large corporations are instead pursuing a BaaS approach, using a model similar to that employed for cloud-based storage in order to assist more rapid diffusion of the technology among small and medium undertakings and the deployment of new applications[102].

2. Competitive Advantage and Financial Markets

ICOs emerged as the main source of funding blockchain projects, in particular, outperforming venture capital ('VC') for the financing of cryptocurrency and blockchain startups since 2017[103]. Despite their similarities to initial public offerings ('IPOs') and crowdfunding campaigns, ICOs can be distinguished from the former, as they involve the pre-sale of native software-based tokens, not through regulated exchange platforms, but through a

[98] Carson et al., (73).
[99] Adam Brandenburger and Barry Nalebuff, *Co-opetition* (Currency Doubleday, 1997).
[100] On this issue, see Paolo Tasca & Riccardo Piselli, The Blockchain Paradox, Chapter 1 in this volume.
[101] Carson et al., (73).
[102] *Ibid*.
[103] See TechCrunch, (*techcrunch.com*) <https://techcrunch.com/2018/03/04/icos-delivered-at-least-3-5x-more-capital-to-blockchain-startups-than-vc-since-2017/?guccounter=1>.

distributed ledger. These tokens are purchased through fiat or digital currency thereby creating the capital inflow needed for the financing of the specific blockchain project. ICOs can be distinguished from the latter because they provide a financial stake in the company, carry self-enforcing rights on a code-is-law basis and cannot be qualified as a 'donation'[104]. Investors are usually driven by the high returns that may follow if the token's evaluation increases, by the specific product or service they can have access to, and/or by the cause followed by the specific blockchain project.

Blockchain 2.0, especially with the creation of platforms like Ethereum, has introduced a new paradigm in fundraising that threatens to disrupt the existing one of VC. Smart contracts make it easy for any entity (company or individual) to release its own tokens and distribute them to potential investors around the globe. These tokens are divided into two main categories: utility tokens and security tokens. Utility tokens give future access to a company's product or service. Security tokens can be any kind of tradable asset (usually they represent equity) and they promise to deliver dividends from future company profits. The procedure is as follows: there is a certain period in which the potential investors can send cryptocurrencies to certain addresses and get back tokens according to a fixed predetermined ratio. This is a similar tactic to crowdfunding and companies in the space have managed to raise cryptocurrencies worth of millions of dollars in a matter of a few days, often driven by the speculation frenzy and the huge, recent appreciation in the value of cryptocurrencies.

Ethereum itself, the platform that has actually facilitated and driven the adoption of ICOs, was one of the first to take place raising 3700 BTC (worth around 18 million USD at that moment) in the first 12 hours of the crowdfunding, back in 2014. The 'pre-mined' coins, i.e. pre-generated coins for the crowd sale were 11.9 million, which corresponds to 13% of the current supply, which indicated the intense futurity dimension of these projects. One of the most ambitious projects that proved to be a great failure was the DAO. The DAO was launched in April 2016, raising over $150 million, and setting the record for the largest crowd sale at that time. However, a 'bug' in the code implementation led to a major vulnerability that allowed a hacker to steal $^1/_3$ of the funds. This led to a price crash in both the DAO token and 'Ether' (the native currency of Ethereum). This generated discussion about whether action should be pursued against the theft or not. Advocates of the latter option contended that pursuing reversion would go against the decentralized, irreversible nature of the blockchain, ruin the reputation of and trust held in the technology and would violate the 'code is law' attribute of smart contracts. Finally, the Ethereum developers decided to revert the hack but the whole incident drew the attention of the Securities Exchange Commission ('SEC'), which after a long investigation announced that the DAO crowd sale was a securities sale. It raised community awareness of the risks involved in such cases.

After the DAO, many other ICOs have raised capital, paid upfront, often in a few hours or days, something that would be otherwise impossible with a traditional fundraising model. At the time of writing the cumulative all-time ICO funding exceeds $20 billion. The most important of those are EOS, attracting $ 4.2 billion, and TaTaTu $575 million in 2018, Filecoin

---

[104] Marco Dell'Erba, "Initial Coin Offerings. A Primer. The First Response of Regulatory Authorities" (2017) 14 *NYU Journal of Law and Business*.

attracting $262 million and Tezos $232 million in 2017[105]. Recently, non-blockchain related companies were also attracted by the ICO hype and moved toward that direction. Kodak announced that they are developing their own crypto token (KODAKCoin) and Telegram, a popular messaging service and Whatsapp competitor, attracted $1.7 billion from private investors (before the public sale was cancelled) with the project aiming to leverage their important customer base of 200 million active users and their expertise in 'encrypted data storage' in order to build a decentralized supercomputer and value transfer system that may become an alternative to VISA/Mastercard.[106]

The quite considerable valuation of some of these tokens cannot be explained by the expectation of future revenues on the basis of market sales and profitability, (for instance on the basis of a discounted cash-flow method that would explore price to earnings rations), because often there are no revenues or costs of inputs to analyse. Usage is more important than revenues. Various methodologies have been put forward for the evaluation of crypto-assets[107]. These rely on the relative valuation of crypto-assets, on the basis of a comparison of the relative use of the network over time, or alternatively on the square of the number of connected users to different blockchain systems ('Metcalfe's Law'). However, there are also absolute valuation methods based on the cost of production or on an analysis of the total addressable market ('TAM') for which the token is going to be used (the 'INET model'). There are other methods to model the velocity of money (the 'VOLT model').

In view of the crucial role of ICOs in incentivising blockchain developers, at the initial stages of the launch of a blockchain project, it is important to consider the process of market valuation in order to understand the competitive strategies developed by the blockchain developers. Valuation by financial markets also plays a significant role in driving competitive strategies for digital platforms. The most important driver of value creation is not based on net cash flows and expected profits short-term but on pots of gold being found far into the future[108]. However, in the context of the blockchain, market valuation is even more devoid of a link with present revenues. These links do not exist: the token sales are pre-sold and short-term performance in identifiable product markets is complex as it is quite probable that the native token may not necessarily be used in for a specific product.

IV. Blockchain Competition: Architectural Advantage

Competition fights are not only won through the use of traditional strategic competitive advantage, in terms of lower costs, higher quality products etc. Increasingly, firms engage with the overall structure, economic and legal, of the industry in which they are active seeking opportunities to frame their architecture in a way that favors their position. Section A will explain the concept of 'architectural advantage'. Section B will explore the specific strategy of

[105] See CoinDesk, ICO Tracker, (coindesk.com) <https://www.coindesk.com/ico-tracker/>.

[106] See Telegram Open Network, <https://drive.google.com/file/d/1ucUeKg_NiR8RxNAonb8Q55jZha03WC0O/view>.

[107] See Federico Caccia, "A Review of Cryptoasset Valuation Frameworks" (blog.coinfabrik.com, 18 July 2018) <https://blog.coinfabrik.com/a-review-on-cryptoasset-valuation-frameworks/>.

[108] See The Economist, "Are Technology Firms Madly Overrated" (*economist.com*, 23 February 2017) <https://www.economist.com/business/2017/02/23/are-technology-firms-madly-overvalued>.

building architectural advantage by influencing the regulator and shaping, through regulation, the rules of the competitive game. In Section C, a short case study on the financial services value chain, one of the first economic sectors to be affected by the implementation of DLT, will provide an illustration of how this architectural advantage may operate in practice.

A. Architectural Advantage: the Concept

At the early years of technological transformation, when new players emerge, the industry is likely to be marked "by relatively high price-cost margins, at least for the more competent firms"[109]. This may lead some of the actors that have acquired superior resources and developed superior capabilities to benefit from 'abnormal profits'. These erode as the industry matures; there is new entry and industry capacity is aligned with industry demand[110]. However, the industry is still marked by firm heterogeneity. Some firms continue to benefit from high rates of return and sustainable 'abnormal' profitability, 'in spite of competition'[111], while others see their profits erode when the market, following the initial hype generated by the newness of the technology, returns to equilibrium[112].

This heterogeneity as to the profitability of firms present in the industry may be due to the business acumen of firm's leaders, the creativity and persistent effort of the firms' human resources, a timely purchase of key resources that establish entry barriers to potential competitors, or even happenstance. Some authors submit the view that it may also be explained by investments made in the possession of 'idiosyncratic rent-earning resources' or by developing capabilities that cannot be imitated by competitors[113]. These resources and capabilities are acquired through a process of customization that ties them with the specific firm. One could therefore distinguish between generic resources and capabilities, which may be easily acquired through the market, and customized or specialized resources and capabilities that can only be developed within the firm, often following a long period of investment and institutional learning[114]. The acquisition of these 'idiosyncratic' resources and capabilities, often after a lengthy process of customization so that they become part of the firm's 'productive fabric', constitutes one of the possible routes for achieving a sustainable competitive advantage[115]. These resources and capabilities may be leveraged by a number of strategies put in place by the firms in order to ensure they can maintain their scale advantage, such as denying efficient scale to their competitors or raising barriers to entry, for instance through the use of exclusionary practices and aggressive IP rights strategies.

In addition to these competitive strategies that engage directly with the actual and potential sources of competition, a firm may also acquire a durable competitive advantage if it holds a position that enables it to reshape the 'industry architecture' in its own advantage. The concept of 'industry architecture' follows David Teece's seminal contribution on how profits

[109] Michael Jacobides, Sidney Winter and Stefan Kassberger, "The Dynamics of Wealth, Profit, and Sustainable Advantage", (2012) 33 *Strategic Management Journal*, 1386.
[110] *Ibid*.
[111] *Ibid*, 1388.
[112] *Ibid*, 1385.
[113] *Ibid*, 1404.
[114] *Ibid*, 1386.
[115] *Ibid*, 1406.

from innovation and how the various governance arrangements between the innovator and other vertically-related firms may influence the distribution of these innovation gains[116]. Teece suggested a theoretical framework. First, it focuses on the co-specialization of firms so that their assets are tailored to each other and the firms develop a high degree of complementarity, as the combination of assets yields a higher value. Second, it focuses on 'factor mobility', which relates to the ability of a firm to appropriate value without necessarily owning the complementary asset. Teece focused on the dyadic relation between the innovator and outside asset holders finding that complementarity usually leads to lower factor mobility. However, more recently, Michael Jacobides et al. disentangled the two constituent components of co-specialization by finding that a firm may manage to "obtain *both* high complementarity *and* high mobility in their vertically adjacent segments", which led him to expand Teece's analytical framework beyond 'dyadic relations' to also cover the 'industry architecture', which is "the various templates circumscribing the division of labor among co-specialised firms at the level of an industry, or economic sector"[117]. According to Jacobides et al.,

> "(t)he concept of industry architecture ('IA') describes how labor is typically organized and structured within an industry ('who does what') and which firms capture value and profit as a result ('who takes what'). It encompasses features such as the degree of vertical integration, the division of labor between firms and the 'rules and roles' that determine how firms interact and the business models, available to them. While IA reflects the conditions under which firms operate, it is influenced, in the medium term, by firms' attempts to reshape those conditions to their own advantage"[118].

As Jacobides further explains, "(a)rchitectures provide the contours and framework within which actors interact: they are usually partly designed (e.g. by regulation or *de facto*, by standards), and partly emergent (by the creation of socially understood templates and means to coordinate economic activities)"[119].

Industry architecture is framed by the various economic actors at the birth of a new industry, the new players defining the interfaces (technological, institutional or social) that allow different entities to co-specialize and divide labor[120]. As the industry progressively matures, we observe the emergence of 'winners' who strive to frame the industry architecture in their own advantage by developing complex strategies. The objective of these strategies is to capture a disproportionate amount of the surplus value created by the innovation. In some situations, the most effective strategy will be to opt for an 'open architecture' that nurtures complementarity through an open eco-system, should a system of 'open innovation' be the most effective way to generate higher value in this industry. In other situations, firms may opt for a 'walled garden approach', opting for a closed architecture with regard to firms with competing assets and capabilities entering the value chain while keeping it open for firms with complementary assets. Finally, in other circumstances, firms may opt for vertical integration;

---

116 David Teece, "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy", (1986) 15(6) *Research Policy*, 285.

117 Michael Jacobides, Thorbjørn Knudsen and Mie Augier, "Benefiting from Innovation: Value Creation, Value Appropriation and the Role of Industry Architectures", (2006) 35 *Research Policy*, 1201.

118 Michael Jacobides, "Industry Architecture" in The Palgrave Encyclopaedia of Strategic Management (edited by Mie Augier and David Teece, Palgrave Macmillan, London, 2016).

119 Jacobides et al., (115), 1203.

120 *Ibid*,.

taking full control over the rents generated by the complementarities brought by the innovation whilst maintaining the possibility to exclude or marginalize any new entrant, for instance, by denying interoperability with regard to some indispensable technological interfaces.

Industry architectures are not meant to last forever, although they tend to be relatively stable for some time once the technology has sufficiently diffused. There are various reasons for this stability, such as the requirement for any new technology to be interoperable with the technical standards of the industry architect who benefits from an installed base, the quality certification barrier from which the technologies of the industry architect benefit, to the extent that consumers' expectations have been framed according to the industry architect's quality standard, the favorable legal framework from which the industry architect benefits as it may have been framed so to respond to the risks generated by the technology of the incumbent or to accommodate the needs of the industry architect. However, as Jacobides et al. observe, "(i)ndustry architectures can… also change whenever new ways are found to put together the various industry participants: legal innovations that alter transaction costs…, new ways of safeguarding against loss from transactional hazards…, and technical innovations that alter the payoff to bundling specialized production factors… could inspire adjustment of an industry's architecture"[121].This shift from the dyad to industry-wide networks of relationships regarding the allocation of the financial returns of innovation also explains the reason for the competitive game being more complex and wider than the usual focus of competition law on a relevant market.

Various factors may influence industry architecture. One is technological path dependence which results from a self-reinforcing process triggered by an event, such as a first mover advantage leading to the choice of a widely used technology standard, which leads to a 'lock-in' to a less optimal, from a quality of technology perspective, equilibrium, without that being the intention of the agents at the first place[122]. The legal/ regulatory framework may also play a crucial role in the definition of the boundaries of an industry and of its governance. Quite often it supports the existing industry architecture. Finally, path dependence and 'lock-in' may result from intentional strategies seeking to manipulate the industry architecture so to create a bottleneck. This is a segment of the value chain where there is limited mobility[123]. The firm controlling the bottleneck is in a position to extract all surplus value in the specific segment as well as a higher percentage of the surplus generated by innovation in vertically adjacent segments[124]. This may take different forms, such as manipulating the setting of technology standards as often standards shape industry architecture or influencing the regulators and/or the legislative framework shaping the architecture of the industry, either directly through lobbying activity and pressure groups or indirectly by developing a narrative that will catch the imagination of policy-makers and legislators so that the emergent regulatory framework serves the interests of industry architect.

In conclusion, being in a position to influence the way the industry is organized or structured and the value allocation between the industry (or ecosystem) actors, provides

[121] *Ibid*, fn 3.
[122] Arthur, (23), 116.
[123] Jacobides et al., (115), M.G. Jacobides, T. Knudsen & M. Augier, Benefiting from innovation: Value creation, value appropriation and the role of industry architectures, (2006) 35 Research Policy 1200, fn 13.
[124] Jacobides et al., (115), 1208.

‘architectural advantage’[125]. This may be a quite important source of sustainable abnormal profits. This is probably the reason why ‘architectural fights[126]’ have characterized the evolution of all industries. The competition to become the industry architect plays a crucial role in periods of profound technological transformation, such as the development of new GPTs; in periods when new technologies that confer significant advantages, such as reducing costs or increasing productivity are progressively integrated in the production process in the context of a specific industry[127]. These technologies offer a higher rate of return on investment and often attract capital from other industries. In the context of the inter-industry competition that is one of the characteristics of financial capitalism[128]. The important role of financial markets in the development of the digital economy and the monetization of digital inputs also shifts attention away from the traditional focus of competition law on competition within an industry, to competition between industries, capital (in the sense of value-enhancing activity, which does not constitute labor) moving from one industry to another in search of higher profits. The concept of ‘ecosystem’ offers an additional space where intra- and inter-industry competition occurs.

According to the architectural advantage approach, the boundaries of an industry should not be considered as a given. Firms with superior performance (due to superior resources and capabilities[129]) aim to shape ‘industry architectures’ in a way that provides them control of a ‘bottleneck’, i.e. that would enable them to leverage their position of strength over all other companies that collaborate with them in the creation of surplus value[130]. Hence, to understand this process of value extraction that motivates strategies of competition, it is important to analyze the market level and the industry and eco-system levels. It also challenges the idea that there are cycles in the life of an industry: an industry being marked by a dominant design, with an established hierarchy and stable market shares that slowly erodes as the industry matures with product innovation mainly occurring through new entry. According to this view, the competition of capabilities takes place not only at market or segment level (e.g. among mobile handset manufacturers) but also at the value-chain level (e.g. among mobile handset manufacturers, network providers, content providers etc.). Contrary to (industrial) economics, which assumes that “(f)irms compete only within a market, and it is their performance, within that market, relative to other firms, that determines their profitability”, the architectural advantage perspective focuses on the role of vertical competition and the way this affects the relative proportion of value (i.e. the ‘NPV of future profits’) that each segment captures, which may lead to important value shifts from one part of the value chain to another. The firms acquiring architectural advantage (the ‘kingpins’) take a central role in the overall industry

[125] *Ibid*, 1200.
[126] *Ibid*, fn 13.
[127] Charles Ferguson and Charles Morris, “How Architecture Wins Technology Wars”, (1993) 71(2) *Harvard Business Review*, 86.
[128] Anwar Shaikh, *Capitalism: Competition, Conflict, Crises* (Oxford University Press, 2016).
[129] Birger Wernerfelt, “A Resource-Based View of the Firm”, (1984) 5(2) *Strategic Management Journal*, 171; C. K. Prahalad and Gary Hamel, “The Core Competence of the Corporation”, (1990) *Harvard Business Review*, 79.
[130] Michael Jacobides and Jennifer Tae, “Kingpins, Bottlenecks, and Value Dynamics Along a Sector”, (2015) 26(3) *Organization Science*, 889.

architecture, influencing not only the segment they belong to but also multiple segments within a single industry or ecosystem[131].

However, acquiring a bottleneck is not the only way architectural advantage converts to abnormal profits. Focusing on the appropriation of value from other value chain participants makes sense if one conceptualizes competition (horizontal or vertical) as essentially a process taking place on product or technology markets or eco-systems and focusing on capturing value through the protection and/or leveraging of innovation. However, value may also be created by "investing in assets that will appreciate"[132] and will, thus, increase the market value of the firm from the perspective of financial markets. Jacobides et al. note how this "subtle shift of mindset from profit (and isolating mechanisms) to wealth creation (and the potential for asset appreciation)", explains why an industry architect may favor imitation by competitors, even if this reduces profitability, provided this strategy of openness increases the value of the underlying assets[133].

B. Architectural Advantage Through Performative Regulation

In view of the newness of the technology and the absence of a well-established legal framework regulating its use so as to limit the eventual social costs that may flow from its diffusion in the rest of the economy, it becomes crucial for the economic actors promoting the use of DLT to engage with the legal field, and, in particular, to influence the government in favor of adopting policies that will either promote the new technology, or will not, at least, negatively affect its development. It is a well-known fact that the economy mirrors technological change[134], and that, sooner or later, the economic regulator will have to deal with the economic implications of this change. However, the culture of innovation, which has in recent times become the holy grail sought by governments in the various public policies they pursue and the narrative of disruption that has overtaken that of order as the dominant logic driving state intervention have produced significant changes in the way regulators engage with new technologies and has literally shifted their approach from being re-active to being, or at least aspiring to be, pro-active. This change is perceptible in the way the economic actors that promote the use of this new technology have engaged so far with regulators and the narratives they have put forward in their interactions with them.

As mentioned earlier, regulation and regulators may be used as weapons in fights for architectural advantage. These fights may divide, on the one side, economic actors that rely on the new technology to foray economic sectors and to disrupt existing industry architectures, and, on the other, industry architects who would prefer to either slow down the process of diffusion of this new technology, in order to maintain their competitive position, or to control it in their interest by emulating the successful strategies of the new players and/or incorporating them in a way or another, in their existing ecosystems.

---

131 *Ibid*.
132 Jacobides et al., (115), 1201.
133 *Ibid*, 1212.
134 Brian Arthur, *The Nature of Technology* (Penguin Books, 2009), Chapter 10.

It is clear that to the extent that blockchain technology, and the automation and decentralization it brings forward, expands to different industries, there is need for the legal system and for the regulatory State as a whole to respond to such rapid changes and to re-conceptualize the philosophy and mechanisms of its intervention. As for any GPT, regulators are confronted with difficult choices regarding the application of the existing regulatory framework if this is judged appropriate for the technology or the development of a new regulatory framework with a better 'fit' to the specific GPT. Regulators also rely on foresight to predict the possible problems that may emerge from the implementation of the GPT in its later stages, the choice being here between a strategy of incremental changes to the existing regulation or the design of a new regulatory framework upfront. The latter option may be more appropriate if the regulator feels less empowered to deal effectively with such problems in the future because of path dependency and sunk costs.

Quite often there is still uncertainty over the risks of the new technology and the lack of appropriate empirically-based knowledge. In this case, regulators may appeal to first principles (or meta-principles), which will determine the broad direction of their regulatory strategy. In the absence of a solid body of knowledge or expertise in the technology and its possible implications, the choice of regulatory strategy will, most likely, not only been driven by empirical evidence or solidly established theory but also by the struggle between competing narratives communicated to the regulators. These often represent the interests of the main stakeholders concerning the implementation of the specific technology.

With regard to the regulation of DLT, it is possible to identify two paradigms that may influence the dominant regulatory narrative: (i) a market failure paradigm that perceives the State as taking action against the possible risks that the implementation of blockchain may entail for market and non-market actors, and (ii) a 'Schumpeterian' paradigm, which may perceive the role of the State as being that of nurturing or facilitating the innovation process in industries, even if this has the potential to generate market failures, such as, for instance, the constitution of bottlenecks in some segments of the value chain. Even in the presence of some empirical evidence about the social effects of a specific regulation of such technology, the prior beliefs the specific regulator has on the regulatory paradigms discussed will very much determine his action.

The tension between these paradigms of State action is particularly intense in periods of technological change when regulators have to make clear choices about either taking a hands-on (and possibly prophylactic) approach, addressing all the possible social costs following the implementation of this technology, even if these have not yet materialized, thus, implementing the principle of precaution with however the risk of stifling innovation, or a hands-off approach of 'permission-less innovation', thereby effectively accepting that the 'public good' may be better pursued if entrepreneurs are left undisturbed in their effort to develop new business models and to explore new ways of implementing the GPT. There is also the possibility of a compromise to continue regulating as usual but to open spaces for monitored experimentation that may later, if proved successful, be generalized and lead to structured regulatory change.

These meta-principles of regulatory action form the broader institutional context that economic actors riding the wave of new technology consider when they shape their strategies to gain architectural advantage. They often realize that the permanence of the existing industry architecture, which is dominated by the industry architect that emerged victorious out of past technology wars, largely depends on the support of the existing regulatory framework that has been shaped over time to fit the dominant business models imposed by the winners of these wars. Influencing State action so that it assists the industry architect to maintain bottlenecks and to limit the possibility of new entry is one of the key competitive strategies deployed in order to preserve abnormal profitability as the industry matures. Drawing on rent-seeking theory, one may argue that influencing the government and the broader institutions of our societies (the rules of the social game) in order to reduce competition has become a prevalent competitive strategy if one judges by the 'investments' made in lobbying in recent years[135].

The narrative of de-centralization and disintermediation was very much an important feature of the presentation of the blockchain technology to the specialized community and the general public[136]. Blockchain evangelists often referred to the disruptive innovation potential of the new technology in industries dominated by stable oligopolies or by dominant digital platforms with poor consumer satisfaction, little innovation and rising concerns over privacy. Policymakers were particularly receptive to this narrative. Although some have embraced it to the extent of adopting a paradigm of 'permissionless innovation', they have opted for an experimental approach that has provided blockchain-based disruptors the opportunity to influence regulators so that they are able to curtail the architectural advantage of the incumbents and, eventually, become the industry architects. This experimentalism has taken various forms; the constant is the focus on innovation as the driving principle of regulatory action.

However, in the absence of a clear body of expertise determining objective and systematic instruments to measure innovation and, consequently, to guide State action in this context, regulation loses its substantive/ rule-based or economic-based approach and becomes performative. By performative I mean, first, that regulation takes the form of a "more dispersed intangible authority built into relationships and practices"[137]. Power is deployed in a dramaturgical way through symbolic interaction between the regulators and the industry. The struggle between worldviews that are trying to prevail becomes visible in these contexts before eventually giving rise to 'socio-technical agencements'[138] that shape the form of the industry architecture. In the absence of a clear, expert body determining the boundaries of State action, the activity of the regulators through the focus on innovation and their objectives, meet those of the industry, the regulators transforming themselves to facilitators instead of their traditional role of prescribers.

---

135 James Bessen, "Accounting for Rising Corporate Profits: Intangibles or Regulatory Rents?", (2016) Boston University School of Law, Law and Economics Research Paper No. 16-18.

136 See Wessel Reijers and Mark Coeckelbergh, "The Blockchain as a Narrative Technology: Investigating the Social Ontology and Normative Configurations of Cryptocurrencies", (2018) 31 *Philosophy & Technology*, 103–130, noting the development of blockchain as a "narrative technology" re-configuring social reality, in particular by promising the decentralisation of authority.

137 Susie Scott, "Revisiting the Total Institution: Performative Regulation in the Reinventive Institution", (2010) 44(2) *Sociology*, 219.

138 I borrow this term from Michael Callon, "What Does it Mean to Say That Economics is Performative?" in *Do Economists Make Markets? On the Performativity of Economics* (edited by Donald MacKenzie, Fabian Muniesa and Lucia Siu, Princeton University Press, 2007), 311.

However, by 'performative' I also mean that through these interactions the authority comes to internalize the values of the dominant narrative and, to the extent that regulation may shape industry architecture, the dominant narrative becomes a self-fulfilling prophecy. Performative regulation will naturally play a more significant role in industries "marked by futurity". Swartz provides a good explanation of this fundamental characteristic of blockchain:

> "(a)s soon as a proposal is offered – whether as a white paper, a slide deck, or a blog post – it is treated as though it already exists, ready to go. Indeed, blockchain projects exist in a particular temporality and have their own sense of the past and future, of change. It performatively leans into a future, always just around the corner, which might as well be here already"[139].

This reflexivity obviously influences the strategies of economic actors in their interaction with the State, in particular as regulation becomes 'performative' in the two senses I give to this term. The interaction of banks and Fintechs in the architectural fight opposing them in the financial value chain provides a useful illustration of interplay between strategies to gain architectural advantage and performative regulation.

C. Competing over Industry Architecture: FinTechs and Banks

1. The FinTech revolution in the Financial Services Industry

The financial services industry has seen some remarkable changes brought about by the application of information and communication technologies, including digitalization in recent years. Banks, since the 1960s, have been pioneers in the use of 'in house' IT with these systems evolving over the years to enable electronic interfaces to consumers (through the use of ATMs and online banking)[140]. Banks have also been active in the payment services segment of the value chain where they have put in place a number of card networks, such as Visa and Mastercard, and have set the technical infrastructure and rules for payment processing. Finally, in the interbank area, banks have put in place multinational electronic networks, such as SWIFT and TARGET, in order to handle international transactions that require an international interface to bank's internal systems. Banks are also present in both retail and wholesale banking, promoting themselves as a supermarket for financial services providing a single source of financial products to their customers. Banks typically offer a broad product portfolio in retail, private, commercial, investment and transaction banking, along with wealth and asset management and insurance (the 'universal banking model'). The universal banking model has enabled customers to have easy access to just one single source of financial products. Banks are present in both the conventional deposit and loan services and in the provision of investment advice and insurance products. This vertical integration provides banks with a stable retail funding which ensures sufficient liquidity and facilitates risk-pooling and risk-bearing. A large capital base also serves as a buffer to absorb losses, thereby providing the bank more credibility and also an easier access to capital by issuing debt or equity in larger issue sizes. However, this

[139] Swartz, (14), 89.
[140] Rainer Alt, Roman Beck and Martin Smits, "FinTech and the Transformation of the Financial Industry", (2018) 28 *Electronic Markets*, 236.

industry architecture also leads to very limited customer switching and limited consumer engagement[141].

The digital revolution has affected the banking sector in many different ways. Its most important implication is the opportunities this opened for modularizing the banking sector and unbundling the various segments of it. The shift from the branch to online banking in the 1990s, was followed by mobile banking in the 2000s, and the use of Big Data in the 2010s, with the current account and the interface linking banks with their customers providing a wealth of valuable data relating to various dimensions of the life of their clients, such as consumption patterns, propensity to save and invest, travel preferences etc. During this period of digitalization, the number of banks has considerably decreased[142] and the sector has become increasingly more concentrated[143]. It is unclear if this consolidation of the banking industry may be explained by the lack of competition or by the fact that the endogenous sunk costs resulting from the banks' investments in new technologies, communication networks and specialized human capital lead to a 'natural banking oligopoly'[144].

In recent years, a number of start-ups developed new business models, on the basis of big data, machine learning and blockchain technology with the aim to disrupt financial intermediaries and banks. Fintechs developed peer-to-peer lending platforms (e.g. Zopa in the UK) matching borrowers and lenders in the most effective way, sometimes the lenders choosing the borrowers. Their capacity for innovation is certainly larger than the traditional vertically integrated model of universal banking. Although the payment systems market is still dominated by banks, through Visa and Mastercard, big tech digital platforms and companies, such as PayPal, Apple, or Google have developed important payment innovations. One of the most interesting payment innovations is the multi-purpose social media/ messaging service/ payment app 'WeChat' developed by the Chinese company, Tencent. Amazon has recently launched a lending service and social media platform taking advantage of their knowledge of the characteristics and preferences of their users to cross-sell financial services.

DLT may transform various activities in the financial services value chain[145] (see Figure 2). It may bring important cost savings. It has been reported that the implementation of blockchain in clearing and settlement which records loans and securities will bring significant

[141] See, for instance, the findings in the Competition and Markets Authority, "CMA, Retail Banking Market Investigation" (2016) Final Report, [64]-[66], noting that the level of customer engagement is quite low with only 8% of the customers having switched to other retail banks the last three years. According to the report, "despite variations between banks in prices and quality and the gains from switching, market shares have remained broadly stable with those banks offering the lower average prices and/or higher service quality only gaining market share slowly".

[142] See the figures reported in Alt et al., (139), 237 noting that in both the US and Germany the number of institutions has almost been reduced by half.

[143] Concentration is usually measured by reference to the share of assets of the three largest banks in total banking system assets in a domestic system, which is not relevant, as such, for competition assessment, which focuses instead on the markets for deposits and for loans to small and medium enterprises: see, OECD, Competition, Concentration and Stability in the Banking Sector (2010) Report, 20.

[144] For a discussion, Xavier Vives, "Competition in the Changing World of Banking", (2001) 17(4) *Oxford Review of Economic Policy,* 541.

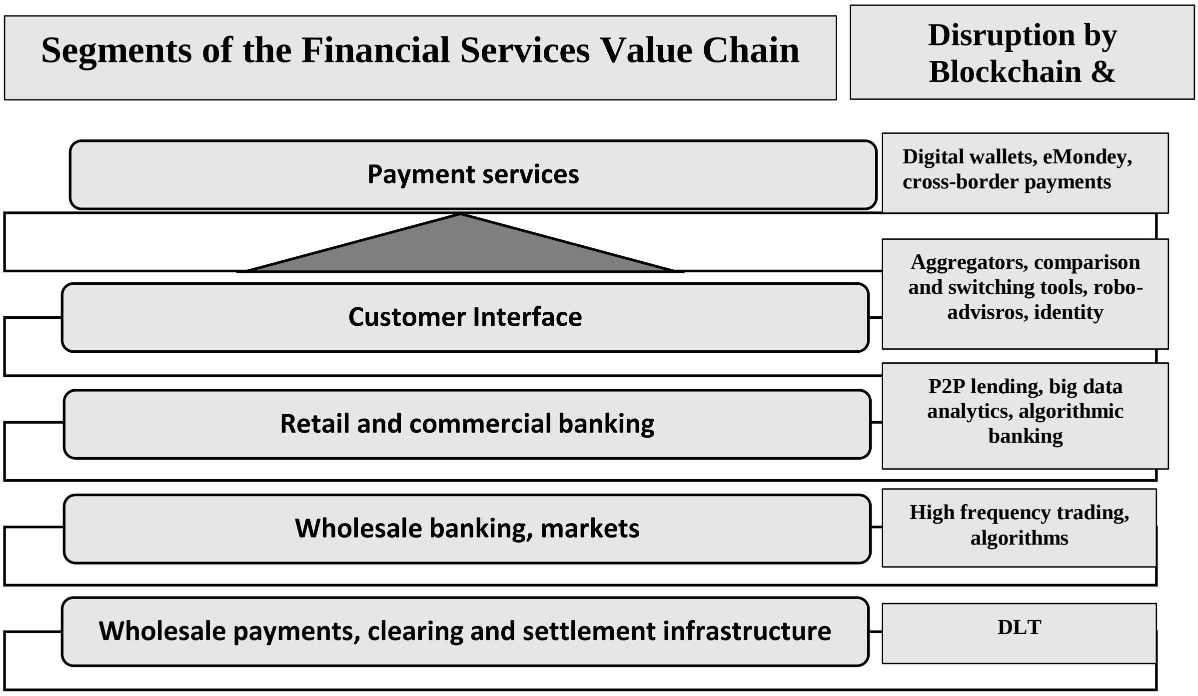
[145] See Martin Arnold, "Five Way Banks are Using Blockchain" (*ft.com,* 16 October 2017) <https://www.ft.com/content/615b3bd8-97a9-11e7-a652-cde3f882dd7b>.

reduction of costs for the largest investment banks[146]. Similar cost reductions are also expected in trade finance, identity verifications of customers and other back office activity, as well as cross-border payments, security trading, and compliance[147]. Hence, blockchain may enable traditional banks to cut down their cost and improve their efficiency. The use of blockchain technology has the potential to considerably lower the costs of financial intermediation and to provide a more consumer-centric and personalized approach to the provision of financial services. For instance, access to data may provide a better picture of the creditworthiness of loan applicants and enable price discrimination strategies.

However, blockchain also has the potential to disrupt the traditional financial system in more fundamental ways. If one takes, for example, the payment system segment. 'Ripple', an open source Internet software using DLT protocol, enables users to conduct cross-border payments in multiple currencies blockchain, competing with traditional cross-border payment system, which because of the lack of a global central settlement institution is currently relying on a highly complex system managing the interface between separate national settlement processes[148]. Ripple facilitates cross-border payments through a distributed settlement system, the ledger being distributed among the collective action of Ripple users rather than through a central settlement authority. This "flips the correspondent-banking model on its head"[149]. The nature of its decentralized Internet payment protocol is quite different from traditional payment systems, thus, creating important challenges for regulators[150]. More importantly, blockchain provides new actors, merging technology with financial expertise (the so called 'Fintechs'), the opportunity to make an efficient entry into the financial services value chain at only one 'niche' segment without having to compete with the vertically integrated banks at all other segments of the chain. This constitutes an important threat to the universal banking model. Not all Fintechs are implementers of blockchain technology nor rely heavily on Blockchain technology for their business models. However, the blockchain disintermediation and decentralization narratives form an integral part of their communication strategy and explain their emphasis on disruptive innovation and the opportunities that it brings to new market players.

[146] See David Treat, "Blockchain: Do the Numbers Add Up?" (*accenture.com*) <https://www.accenture.com/gb-en/insight-perspectives-capital-markets-blockchain-numbers>.
[147] See Santander, "Fintech 2.0: Rebooting Financial Services", (2015) Paper.
[148] For a discussion, see Marcel Rosner and Andrew Kang, "Understanding and Regulating Twenty-First Century Payment Systems: The Ripple Case Study", (2016) 114 *Michigan Law Review*, 649.
[149] *Ibid*, 658.
[150] For an in-depth discussion, see *Ibid*, 664-681.

Figure 2: Blockchain, Fintech and the Financial Services Value Chain[151]



Fintechs test two traditional sources of competitive advantage from which traditional banks benefit . First, banks can borrow cheaply as they have access to cheap deposits and benefit from an explicit or implicit insurance by the government. Second, they enjoy a stable relationship with their customers and have a large customer base; this enables them to sell a range of products[152]. The integration of messaging and social media functions with the payment functions challenges the second source of competitive advantage. It provides tech companies a deeper knowledge of the preferences of their client base, thereby potentially enabling them to develop a more customer-centered and personalized service, which challenges the traditional relationship between banks and their customers. However, banks still hold a massive amount of customer data, the current bank account being the principal financial gateway for customers and a major social and technological interface that could be considered a bottleneck. Most tech companies have not yet integrated into core banking segments by applying for a banking license. This may be explained by the first source of competitive advantage from which retail banks benefit, access to cheap deposits due to the relative stability of their client base customer and the implicit or explicit insurance by the government.

In envisioning competition between traditional banks and Fintechs, it is important first to analyze when the services offered by each may act as strategic substitutes for or complements to each other. Banks may take advantage of their reputation and capacity to

[151] The diagram is inspired by that in Mark Carney, "The Promise of FinTech – Something New Under the Sun?", (Speech, 25 January 2017).
[152] Xavier Vives, "The Impact of FinTech on Banking, in European Economy Banks, Regulation, and the Real Sector" (2017) 2, 101.

provide omni-channel experience to their customers in order to adopt a leveraging strategy, eventually blocking or marginalizing the Fintech threat by making it quite difficult for Fintechs to enter in the lucrative segments of the banking value chain. This strategy can be achieved through bundling or tying strategies, for instance leveraging the substantial market power of the banks in the current account and mortgages market to the more competitive credit cards and insurance markets. Bundling/tying may be used either to deter or to accommodate competitors. Vives explains:

> "As a deterrence strategy, it increases the aggressiveness of the incumbent and makes life for entrants more difficult, since the entrant has to succeed in both markets. Tying makes sense to foreclose entry when it is irreversible and A and B are not very complementary, since then the incumbent is more aggressive; when there are cost links between markets, or when entry in B is uncertain since then tying makes entry more costly and uncertain since the entrant has to succeed in both complementary markets. As an accommodating strategy, it may serve as a price discrimination device among heterogeneous customers. Typically, tying by the incumbent will decrease the incentives to innovate by the rival but increase those of the incumbent. It is worth noting that innovations in payments systems are primarily generated by non-banks like PayPal, Google, and Apple. Banks may prefer accommodation of entry because they gain interchange fees paid to them by new service operators and because the cut in revenues to banks for each purchase may be more than compensated by the increase in aggregate transactions performed by customers. In summary, the incumbents may partner with the new entrants, buy them up partially or totally, or decide to fight them. The details of each segment of the market will matter for the decision as well as the extent of legacy technologies in each institution. Indeed, the response of institutions is likely to be heterogeneous according to their specificity"[153].

Banks may also try to properly compete with Fintech, by adopting new technologies, such as blockchain, AI and Big Data. There is clearly the perception that Fintech, and the disintermediation and decentralization they may bring forward, puts various aspects of the financial institutions' business at risk [154]. Banks have made considerable investments in upgrading their technology systems and have also started acquiring Fintechs with the number of banks/Fintechs M&A transactions rising considerably in 2017. However, the majority of the banks have not yet acquired a Fintech and there are important challenges to integrate Fintechs in the traditional hierarchical organizations of the banking industry[155].

Another option for banking institutions is to partner with Fintechs integrating them into their eco-system. This could take place in different ways. The banks may opt to abandon the universal banking model by limiting their activity to commoditized banking services, such as deposits, for which they benefit from a large and stable installed base of customers, while using open platform capabilities in order to connect their consumers with a number of Fintech players

---

[153] See CBInsights, "Banks are Finally Going After Fintech Startups" (cbsinsights.com, 13 February 2018) <https://www.cbinsights.com/research/top-us-banks-fintech-acquisitions/>.

[154] PwC, "Blurred Lines: How FinTech is Shaping Financial Services", (2016) Report.

[155] See Yizhu Wang and Elizabeth Lim, "Banks Face Challenges Acquiring Fintech Firms", (*forbes.com*, 5 January 2018) <https://www.forbes.com/sites/mergermarket/2018/01/05/banks-face-challenges-acquiring-fintech-firms/#34ca6512428a>.

offering superior or specialized products. The bank may even develop a multi-sided platform pricing strategy that charges both groups of users or only one side of the market and subsidises the other. Although, in theory, the bank will face competition in the provision of high-added value services to its customers, the trade-off may be positive overall for the bank, if such strategy increases its market share vis-à-vis other banking eco-systems, or if it has the effect to increase the value of its brand and other intangible assets, which may be significant drivers of financial value.

Alternatively, banks may re-brand themselves as platform-based digital banking ecosystems offering their customers a wide range of financial services from a single source. Banks may in this case opt for a ‘walled garden’ strategy. While opening programming interfaces in their IT systems so as to incentivize Fintechs to join the eco-system, banks will retain control over the software, the hardware and the content displayed. This control enables an easier monetarization of the products and services provided[156]. A ‘walled garden’ approach requires interoperability and open interface policy with regard to Application programming interfaces in order to tie third parties more easily to the eco-system and enable a seamless connection between interfaces whilst also providing incentives for innovation[157]. This will also offer banks the possibility to ‘lock-in’ customers and third-parties, such as external retailers, for instance, by integrating a mobile payment system through proprietary technology into retail banking and integrating different technological standards than those of other banking platforms[158]. Cross-subsidization strategies may also be used in this context; the banks supplying their customers with free smartphone devices made by other manufacturers but with the bank’s branding in order to monetarize financial services sold through the banking app store[159]. A ‘walled garden’ strategy may, however, face some constraints from a competition law perspective, in particular, if this leads to the leveraging of a dominant position or a position of market power in vertically adjacent markets.

Similarly, Fintechs have the choice to join existing banking eco-systems, or to apply for a full banking license and compete with them directly, something that has already been tried by some peer-to-peer lenders[160]. They may also strive to form their own eco-system, taking advantage of the unbundling of financial services that has been quite disruptive for banks. Traditional financial institutions may form part of this eco-system but their role will be confined to the banking infrastructure level thereby leaving the most lucrative consumer interface to the Fintechs, which may collaborate with technology companies to offer one stop-shop social media/payment and financial services solutions to consumers. The unbundling and consequent re-organization of the industry towards a more decentralized model may enhance consumer choice with consumers no more relying on a single financial institution for their

---

[156] For a discussion of the benefits of such a strategy, see Deutsche Bank, “Fintech Reloaded – Traditional Banks as Digital Ecosystems”, (2015), 8-12.
[157] *Ibid*, 10.
[158] *Ibid*, 11.
[159] *Ibid*, 11-12.
[160] See, for instance, the recent application of Zopa, ‘the world’s oldest P2P lender, for a baking licence’,: Financial Times, (*ft.com*, 3 August 2018) < https://www.ft.com/content/6ce5f960-96e1-11e8-b67b-b8205561c3fe>. Transferwise, which has launched cross-border bank accounts: Financial Times, (*ft.com*, 23 May 2017) <https://www.ft.com/content/29adbe9a-3efd-11e7-82b6-896b95f30f58>.

needs but being able to choose from a variety of Fintech companies, some of them exclusively offered online.

2. Regulatory Interventions and the Quest for Architectural Advantage in the Financial Services Value Chain

These architectural fights over the control and the structure of the competition game in the financial services value chain have naturally framed the regulatory intervention in this area. The regulation of the financial industry, in particular, following the emergence of Fintech, has been the first regulatory response to the challenges introduced by blockchain as well as the decentralization and disintermediation narrative that identifies with DLT. There has been a considerable effort in recent years, in particular, following the financial crisis of 2008, to move the regulatory paradigm in financial industry, from its exclusive focus on the traditional prudential and systemic risks concerns, based onthe conventional 'market failure' analysis, to a 'innovation-focused' paradigm that emphasizes the duty of regulators to promote competition and innovation.

UK regulators struggled to introduce some degree of flexibility and spaces of experimentation, largely relying on the quite important discretion provided to them for the regulation of the financial system, and, in particular, the emphasis put by the framework legislation on the values of competition and innovation[161]. The overall rationality of their intervention has been to favor the unbundling of the banking sector and the development of 'open banking standards' that would enable the FinTechs to flourish either by developing their own eco-system or by joining those of traditional banks. It is noteworthy that the regulators seem to have completely embraced the disruptive innovation narrative of FinTechs and seem to question the essence of the universal banking model. Parallel developments in competition regulation have also been inspired by the same principles and indicate that the architectural advantage of traditional banks is in jeopardy.

In its 2015 Productivity Plan, the UK Government required regulators to develop regulatory frameworks that support disruptive business models, innovation, emerging technologies and the digital economy, imposing on them the duty to publish innovation plans which cover how they are creating a more supportive and agile regulatory and enforcement framework[162]. If we look to the regulators of the financial sector in the UK, each of them has the statutory duty to promote competition and innovation. The Financial Conduct Authority ('FCA') has a duty to promote effective competition insofar as that is compatible with its consumer protection or market integrity objectives. It also has an operational objective to promote effective competition in the interests of consumers in the markets it regulates.

The Payment Systems Regulator ('PSR'), an independent subsidiary of the FCA, has a specific objective to promote innovation in the UK payments sector. This complements its two other objectives to promote effective competition in the markets for payment systems and

[161] See, for instance, the discussion in Financial Conduct Authority, "Our Approach to Competition", (*fca.org.uk*, 11 December 2017) <https://www.fca.org.uk/publications/corporate-documents/our-approach-competition>.
[162] HM Treasury, "Fixing the Foundations: Creating A More Prosperous Nation", Cm 9098 (2015), Policy Paper, Section 13.6.

associated services and to promote the interests of actual or likely users of services provided by payment systems. The PSR has strong powers over the main interbank and international card schemes to promote these objectives.

The Prudential Regulation Authority ('PRA') is a part of the Bank of England and has a secondary competition objective to act, as far as is reasonably possible, to facilitate effective competition in the markets it regulates when discharging its functions in a way that advances safety and soundness and insurance policyholder protection.

The aim of these regulators is to facilitate disruptive innovation – which presumably satisfies both the competition and innovation objectives.

These regulators were confronted with the emergence of a plethora of new actors and business models following the introduction of blockchain technology in the financial services sector and the development of Fintech. The regulators viewed these changes positively, as an opportunity to infuse more innovation and competition in the relatively stable oligopolistic structure of the financial industry, which has been dominated for a long time by a few large commercial banks. The financial crisis of 2008 and the risks raised by 'too big to fail' banks, which has led to a process of regulatory unbundling, provided further impetus to the need for change by promoting the unbundling through the market this time of many activities that were traditionally organized and being held under the control of banking institutions. In October 2014, the FCA launched 'Project Innovate' in order to encourage and support innovation in financial services[163]. This work is central to delivering the FCA's competition objective – it aims to encourage innovation in the interests of consumers and to promote competition through disruptive innovation that offers new services to customers and challenging existing business models. Project Innovate has embedded constructive engagement with innovative firms – from smaller start-ups to mass market new models –its aim being to 'remove unnecessary barriers to innovation'. The purpose of the Project was to assist innovative firms to gain access to 'timely and frank feedback' on the regulatory implications of their concepts, plans and choices, but also, more generally, to tackle the structural issues that impede the progress of innovators entering the market.

A central part of Project Innovate was the 'Innovation Hub', which aims to help new and established businesses (both regulated and non-regulated) to introduce innovative financial products and services to the market, essentially providing an end-to-end experience for new entrants. Firms that receive initial support from the Innovation Hub have their applications for authorization handled via a specialized Project Innovate authorization process. The FCA provides firms with dedicated supervisory support, usually for one-year post-authorization, which gives firms a seamless regulatory experience and minimizes the risk of unnecessary delay. There are no restrictions on the areas of financial services covered by the Innovation Hub: firms innovating in mortgages, capital markets and pensions can all access the Innovation Hub for help in introducing their products to market. The Innovation Hub also performs a horizon-scanning role by identifying new technologies and areas where the regulatory framework needs to adapt to enable further innovation in the interests of consumers.

[163] Financial Conduct Authority, "Project Innovate: Call for Input", (2014) Feedback Statement FS14/2.

In November 2015, the FCA published its plans to open a 'regulatory sandbox'[164]. This was defined as "a safe space where both regulated and unregulated firms can experiment with innovative products, services, business models and delivery mechanisms without immediately incurring all the normal regulatory consequences of engaging in such activity". This is akin to Phase III clinical trials, where new products, services and delivery models can be safely tested with customers. Given the high demand for this service, the FCA expanded the sandbox team and the scheme beyond the initial period of its deployment.

The sandbox may be useful for unauthorized firms that need to become authorized before being able to test their innovation in a live environment. It provides for a tailored authorization process for unauthorized firms that want to join the sandbox. Successful firms are granted restricted authorization that only allows them to test their ideas. These firms will still need to apply for authorization and meet threshold conditions but only for the limited purposes of the sandbox test. This will make it easier for firms to reduce regulatory costs and the time they need to set up. It is explicitly mentioned that the restricted authorization is not available to firms looking for a banking license. The sandbox may also be useful for authorized firms looking for clarity around applicable rules before testing an idea that does not easily fit into the existing regulatory framework. These may benefit from individual guidance from the FCA that can instruct them in how the financial regulator will interpret relevant rules. This creates a safe space because if firms act in accordance with this guidance, the FCA will proceed on the basis that the firms have complied with the aspects of the FCA rules that the guidance relates to. It also provides waivers or modifications to the FCA rules where these rules were considered unduly burdensome or not achieving their purpose and this waiver or modification would not adversely affect the advancement of any of FCA's objectives. Finally, firms may benefit from not receiving enforcement action letters; this should provide them some comfort because so long as they deal with the FCA openly, keep to the agreed testing parameters and treat customers fairly, there will be no disciplinary action for any unexpected issues that may arise.

The FCA also recommended the establishment, with the support of Project Innovate, of a Fintech industry-led virtual sandbox, which would allow firms to experiment in a virtual environment without entering the real market, using their own or publicly available data and a sandbox umbrella company[165]. The virtual sandbox could allow collaboration between innovators to develop solutions quicker and in a more informed way.

As well as directly supporting firms through the Innovation Hub and the Regulatory Sandbox, the FCA has introduced broader changes to help innovators, such as using informal steers on proposed innovations to enable more direct communication with firms or working with the government to create a bespoke regulatory regime for peer-to-peer lending. Also, in June 2016, it launched an 'Advice Unit' to provide regulatory feedback to firms developing automated advice models with the potential to deliver lower cost advice to unserved or underserved consumers, following the 2015 Financial Advice Market Review ('FAMR')[166].

[164] Financial Conduct Authority, "Regulatory Sandbox", (2015) Research Paper .

[165] For more details, see Industry Sandbox, "A Blueprint for an Industry-Led Virtual Sandbox for Financial Innovation" (2016) Consultation Guide .

[166] See Financial Conduct Authority, Advice Unit, (*fca.org.uk*, 25 July 2017) <https://www.fca.org.uk/firms/advice-unit>.

The Advice Unit focuses on models in the investments, protection and pensions sectors. Since September 2015, the FCA has also facilitated a series of themed weeks, designed to stimulate intense engagement with stakeholders interested in a particular area of innovation. The FCA also promotes RegTech — encouraging the adoption of new technologies (and new companies) to support the delivery of regulatory requirements[167].

The PSR has strong objectives to promote innovation and competition in the UK payments sector. The promotion of innovation in payment systems can be driven either competitively or collaboratively, or as a combination of the two.

The PRA, in order to assist innovative firms to come to the market, in January 2016, established a Bank Start-Up Unit ('NBSU') to help prospective new banks enter the market and through the early days of authorization. This Unit comprises staff from both the PRA and the FCA and provides new banks the information and materials they need to navigate the process to become a new bank.

The Bank of England has finally set up a Research Hub in order to facilitate open dialogue between the Bank and the research community to support the Bank's work. In June 2016, the Bank launched its own FinTech Accelerator to partner with new technology firms to help it harness FinTech innovations for central banking applications. By running proofs of concept, the Bank is able to explore the benefits new technology can bring whilst mitigating some of the associated risks.

Similar developments favoring FinTechs in this architectural fight over the financial services value chain have taken place, from a competition law and policy perspective, in the value chain segments relating to customer relationships. These may finish by eroding the bottleneck from which traditional banks benefit because of the central role played by current accounts in the consumer/financial service providers interaction[168]. The UK Competition and Markets Authority ('CMA') paved the way towards 'Open Banking' by implementing a competition law remedy it had imposed in 2016, following the retail banking market investigation[169]. The Open Banking regulatory intervention requires the six largest deposit-taking financial institutions (i.e. banks) in the UK to enable personal customers and small businesses to share their data securely with other banks and third parties and to manage their accounts with multiple providers through a single 'digital app'. This also provides them with more possibilities to compare financial services and products from competing providers, including account information service providers ('AISPs') and payment initiation service providers ('PISPs'). During this same period, however, this time in the payment system segment of the financial services value chain, the EU Payment Services Directive ('PSD2')[170] was transposed into UK law. It provides a similar access to APIs for any payment account (including credit card accounts) in favor of third parties, again with the same idea to promote

[167] See Financial Conduct Authority, RegTech, (*fca.org.uk*, 28 June 2018) <https://www.fca.org.uk/firms/regtech>.

[168] These developments are discussed in detail in Paolo Siciliani, "The Disruption of Retail Banking: A Competition Analysis of the Implications for Financial Stability and Monetary Policy", (2018) CLES Research Paper Series 3/2018.

[169] Competition and Markets Authority, (140), 441-461.

[170] Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on Payment Services in the Internal Market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No 1093/2010, and repealing Directive 2007/64/EC, [2015] OJ L 337/35.

competition in the provision of account aggregation services aiming to help consumers manage their finances by bringing all of their bank account data together in one place[171]. Finally, following a decision, the Bank of England decided to provide its non-bank payment service providers access to its real-time-gross settlement system, thus, enabling them to not have to rely on an agent bank for accessing the UK payment system[172]. These regulatory interventions have the potential to increase competition among banks, to further unbundle the financial services value chain and to promote competition in these unbundled segments by Fintech companies by connecting the banks' IT systems through open APIs with the third-party apps thereby leading to further disintermediation in this sector[173].

The financial services industry provides an interesting case study for the deployment of architectural advantage strategies and the role performative regulatory intervention may play in this. The next Part aims to take stock of these developments and to explain how these different forms of competitive advantage may transform blockchain competition.

V. Preliminary Conclusions on Blockchain Competition: From 'Winner-Takes-Most' Platform Competition Dynamics to Co-Opetition in Ecosystems?

The rise of platforms and online intermediaries in the governance of the digital economy has changed the competitive game and has led to the emergence of a new Industry Architecture characterized by 'winner-takes-most' competition. A more concentrated market structure in the various domains of activity that became digitized and interconnected through the Internet developed as a consequence. The result, after a little more than two decades of development of the Internet economy, is that the top five companies in the world, in terms of capitalization, are tech companies and all of them are platforms. 'Network effects' has become the buzzword to explain the phenomenally rapid rise of digital platforms as well as their impressive profitability. Economies of scale make it difficult for new entrants to challenge the position of these digital platforms once network effects have enabled it to build a strong position on a part of the digital economy. While some may have thought that these positions of power will soon erode due to innovation competition, it is increasingly clear that this process might take a considerable period of time, counted in decades, as the industry matures and a stable industry hierarchy has now emerged with a small group of industry leaders controlling the industry. This permanence of positions of power is not only due to network effects, but to the ability of these industry leaders to shape the industry architecture for their advantage and to impose their rules in the competitive game. This stems from the central role platform operators play as a certain type of intermediary in the digital economy, match-making different groups of users and enabling them to enter in transactions that would not have occurred but for the presence of the platform. The demand of different customer groups for the platform is related to the supply of other platform customer groups and vice versa. The main function of

[171] Payment Services Regulations 2017, SI 2017/752.
[172] See Bank of England, "First Non-Bank Payment Service Provider Directly Accesses UK Payment System", (*bankofengland.co.uk*, 18 April 2018) <https://www.bankofengland.co.uk/news/2018/april/non-bank-psp-access-to-the-payments-system-announcement>.
[173] For a discussion of the possible implications and counter-strategies that may be adopted by the banks, see Siciliani, (167).

the platform operator is to internalize the indirect network externalities that are generated by the fact that the decisions of each group of users affects the outcomes of the other group of users. Platforms take advantage of these interdependencies of demand when designing their business models and choosing the level and structure of their pricing. These multi-sided market strategies focus on platform profitability, rather than on market profitability, and have considerable implications on the shaping of the boundaries of markets as traditional one-sided market players are not able to defend their position and fight back, even if their products are of superior quality. The result is that they are forced to join the dominant industry architecture devised by the platforms or, otherwise, face extinction.

This active shaping of the industry architecture may explain the durability of positions of power of a few digital platforms, even in the presence of intense innovation competition that characterizes the modern digital economy. Although, a platform is not the only form of organizing economic activity in the digital economy, its success as an organizational tool has led other intermediaries, such as traditional resellers, to organize their activity in a way that emulates the multi-sided markets strategies of digital platforms. Platforms have therefore, for a considerable part, substituted the organizing role of markets as the dominant form of ordering economic activity. The emergence of industry architectures completes this process of re-ordering of the digital economy, which was, ironically, initiated by the dream of competition and decentralization at the beginning of the Internet era.

The dynamic forces of innovation competition may, however, sooner or later, erode the barriers set by the current industry architecture. The development of technologies that accentuate the distributed imaginary of the Internet and question the architectural advantage of digital platforms may accelerate this process. DLT plays precisely this role; it offers an opportunity to eliminate the centralized control of digital platforms and, consequently, to re-design the industry architecture in order to promote competition. As innovation competition intensifies, due to the introduction of technologies enabling a new industry architecture, the dominant digital platforms face an important strategic choice. They can, of course, stick to the competitive advantage provided by their scale and installed base in order to develop strategies that suppress any effort to question their hold of the industry, through leveraging and discriminatory practices, or by buying their potential competitors and, thus, profiting directly from their innovative efforts. Imposing a ‘winner-takes-most’ rationality through a set of designed leveraging strategies may, of course, result in the disgruntlement of customers and could be jeopardized by the enforcement activity of competition authorities and/or regulatory intervention. Furthermore, in the long-term it prove counter-productive as the bottlenecks controlled by the platforms become less and less relevant for competition.

Another option is to reshape the industry architecture in a way that enables the incumbents to take advantage of the dynamism and innovation brought about by the new industry players, by initiating an effort of co-specialization that requires cooperation, as well as competition between them, to the extent that a firm may be (at least, partially) vertically integrated. The ‘eco-system’ forms this new space where strategies of cooperation and competition take place. The concept of ‘co-opetition’, ‘war and peace’ simultaneously, as “(c)reating value, i.e. a bigger pie, is fundamentally a cooperative activity involving customers and suppliers that a company can't accomplish alone and ‘on the other hand, the act of dividing up the pie is fundamentally competitive', has been advanced as an essential characteristic of business strategies in the digital economy[174]. In this co-opetition framework, business is not a 'winner-takes-all' or 'zero-sum' game nor cannot it be a 'winner-takes-most' game as the industry architecture should be judged by all economic actors as being 'fair', in order for them to maintain their incentives to participate in it and for the relations between the various firms forming the eco-system to maintain some form of stability[175].

Developed in the early 1990s[176], the concept of 'ecosystem' has been defined in broad terms as "a group of interacting firms that depend on each other's activities"[177]. Teece notes that a characteristic of eco-systems is their 'co-evolution', in the sense that the "attributes of two or more organizations become more closely complementary, the system being typically reliant on the technological leadership of one or two firms that provide a platform around which other system members, providing inputs and complementary goods, align their investments and strategies", and 'co-creation' as two or more organizations "combine forces to pioneer new markets"[178]. Adner observes that "the ecosystem is defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize", this alignment structure being defined as "the extent to which there is mutual agreement among the members regarding positions and flows"[179]. The concept of 'eco-system' has emerged as the dominant idea to depict the competitive environment in the modern digital economy. The 'eco-system manager' will determine the elements of the value chain that need to be internalized and which of these elements will be supported externally in order to capture value. Most studies on eco-systems focus on the role of the eco-system as a 'hub' of interfirm relations taking place within the context of a platform, often referred to as the 'lead firm' or 'ecosystem captain', which "defines the hierarchical differentiation of members' roles and establishes standards and interfaces", a number of formal mechanisms, such as the management of standards and interfaces, platform governance, IP rights etc. forming the "key tools that hubs use to discipline and motivate ecosystem members"[180]. However, from a theoretical perspective, a platform eco-system has never been the only option, even if practically the platform model has become dominant: it is possible to imagine an eco-system where power will not be centralized in a hub and governed by a platform but where authority will be distributed among various economic actors and stakeholders who will take decisions by consensus.

---

[174] Barry Nalebuff, "Co-opetition: Competitive and Cooperative Business Strategies for the Digital Economy", (1997) 26(6) *Strategy and Leadership*, 28.
[175] For the importance of fairness in order to keep stable a social equilibrium, see Ken Binmore, *Natural Justice* (Oxford University Press 2005), 3-14, who takes an 'evolutionary approach to social contract theory', advancing that a social contract may be 'internally stable' if it combines efficiency and fairness.
[176] James Moore, "Predators and Prey: A New Ecology of Competition", (1993) 71(3) *Harvard Business Review*, 75.
[177] Michael Jacobides, Carmelo Cennamo and Annabelle Gawer, "Towards a Theory of Ecosystems", (2018) 39 *Strategic Management Journal*, 2255.
[178] David Teece, "Next-Generation Competition: New Concepts for Understanding How Innovation Shapes Competition and Policy in the Digital Economy", (2012) 9 *Journal of Law and Policy*, 105-106.
[179] Ron Adner, "Ecosystem as Structure - An Actionable Construct for Strategy", (2017) 43(1) *Journal of Management*, 42.
[180] Jacobides et al., (176), 2258-2259 and the literature review provided.

The definition of 'eco-system' by Jacobides et al. espouses this broader theoretical canvass that accepts that there are 'different *types* of ecosystems'[181], which can include a 'platform eco-system' among other alternative governance structures, while also providing some criteria in order to distinguish 'eco-systems' from markets or supply chains managed hierarchically. The possibility of 'modular architecture' constitutes the starting point for an ecosystem to form. Its main function is to "help coordinate interrelated organizations that have significant autonomy" from each other[182]. The fact that modularity acts as an enabler for ecosystems to form does not, however, exhaust all the necessary conditions for the emergence of an ecosystem, as this is the dominant trend in the organization of economic production in a global digital economy[183]. As Jacobides et al. rightly observe, "modularization and the subsequent reduction of frictional transaction costs are more likely to lead to the emergence of *markets*"[184]. Thus, if the concept of ecosystem is to be useful it will need to rely on something additional. This is the mutual dependency between the members of the ecosystem, which is driven by the nature of the multilateral complementarities that exist between them. The nature of multilateral complementarities that underpin eco-systems is indeed quite specific: these are of 'non-generic' type; they are unique (as they lead to some degree of co-specialization) or 'supermodular' requiring "the creation of a specific structure of relationships and alignment to create value" (i.e. 'A is more valuable to X in the presence of B')[185].

The mutual dependence resulting from these unique and supermodular complementarities requires some (formal or informal) governance structure, which will manage how the different types of complementarities between the members of the ecosystem will create value. However, there are important differences here with some other forms of organization of value-generating activity in the digital economy. In contrast to supplier-mediated arrangements, such as supply chains, "final customers can choose among the components (the elements of the offering) that are supplied by each participant, and can also, in some cases choose how they are combined"[186]. Hence, the level and structure of prices, quantities and product bundles are not determined hierarchically in ecosystems. In contrast to market-based arrangements, "end customers choose from a set of producers or complementors who are bound together through some form of interdependencies – by all adhering to certain standards"[187]. Hence, to the extent that they require some degree of affiliation of the participants to the standards, conventions and rules of the ecosystem, ecosystems appear to have more shape than markets. This does not mean that these standards and rules are set by a hierarchy. Jacobides et al. explain that "ecosystems allow for some degree of coordination without requiring hierarchical governance precisely because of the ability to use some standards or base requirements that allow complementors to make their own decisions … while still allowing for a complex interdependent product or service to be produced"[188].

[181] *Ibid*, 2259.
[182] *Ibid*, 2260.
[183] See, for instance, the analysis in Richard Baldwin, *The Great Convergence: Information Technology and the New Globalization* (Harvard University Press, 2017).
[184] M Jacobides et al., (176), 2260 (emphasis in the original).
[185] *Ibid*, 2263.
[186] *Ibid*, 2260.
[187] *Ibid*, 2261.
[188] *Ibid*.

For some, "the concept of ecosystem might now substitute for the industry for performing analysis"[189]. The essence of this new insight comes from the realization that competition analysis should engage with the 'value capture strategies' put in place by economic actors competing for strategic or architectural advantage[190]. That should form the starting point of competition analysis, rather than the relevant market concept which no longer constitutes the sole reference point that firms take into account when devising their strategies and the competitive constraints to which they are subject. Abandoning the sole focus on the relevant market also stems from the relatively more limited role of price competition in the digital economy.

Firms often compete for customers in order to enlarge their customer base, to take advantage of network effects and to be perceived by financial markets as holding a 'bottleneck', even if such trade, from a price/cost perspective, may not be profitable. This struggle for a large customer base explains why firms offer 'free goods' and may continue to do so, even if these gains in market share and, consequently, the harvesting of consumer data (personal data being the 'price' to pay for these 'free goods'), may not be immediately monetized in data markets. However, capturing a large customer base at reduced or negative profitability is not the ultimate aim of these strategies. This strategy makes sense if, by acquiring a large customer base, firms are able to develop dynamic capabilities (for instance the use of consumer data will enable them to improve their algorithms). These benefits do not only materialize in the long-term but may also be enjoyed through higher market valuation by financial markets in the short-term. Due to their futurity, financial markets realize that such strategies bring a sustainable architectural advantage, as other suppliers (of competing or complementary products) realize that the ecosystem leader benefits from idiosyncratic dynamic capabilities, which may not be replicated by other firms in the industry, as well as a privileged access to an important customer base. By providing a limited (the 'walled-garden approach'), or more open ('the open innovation' approach) access to this customer base, while considering the appropriability regime that applies to the given innovation[191], the firm is in a position to frame the industry architecture to its own advantage and capture most of the value that is generated by innovation.

The implementation of blockchain in larger parts of the digital economy has the potential to accelerate this shift of attention from platforms to ecosystems. Although in some settings blockchain technology may produce network effects, one of the inherent characteristics of DLT is that network effects are less pronounced as there are less barriers, in comparison to centralized digital platforms, for the participants to abandon a blockchain and join a fork[192]. Hence, a blockchain participant may invest in a blockchain, knowing that such investment is to a certain extent fungible and can be redeployed elsewhere. However, for an ecosystem to form, the investment should not be fully-fungible, thus, indicating that there may be some opportunity cost should one decide to abandon the specific eco-system. Of course, competition

[189] David Teece, "Business Ecosystems" in *The Palgrave Encyclopaedia of Strategic Management* (edited by Mie Augier and David Teece, 2016), 1.

[190] David Teece, "Business Models, Value Capture, and the Digital Enterprise", (2017) 6(8) *Journal of Organizational Design*.

[191] See Teece, (114), 285; David Teece, "Profiting from Innovation in the Digital Economy: Standards, Complementary Assets, and Business Models in the Wireless World", (2018) 47 *Research Policy*, 1367.

[192] See the analysis in Part II.

between ecosystems may provide good reasons to a participant to switch. However, by its very essence, the ecosystem cannot be 'hierarchically controlled'. The lack of hierarchical controls and the fact that members retain residual control and claims over their assets distinguishes it from traditional firm groupings or captive supply networks[193]. Jacobides et al. highlight that "ecosystems need to be run, both *de jure* and *de facto*, with decision-making processes that are to some extent distributed, and without *all* decisions (especially on both prices and quantities) being hierarchically set…"[194]. Depending on the governance protocol chosen for the specific blockchain, DLT enables each participant to contribute to the formation of a consensus over the standards, rules and interfaces that will apply, these no longer being set by a lead firm or a platform. However, our discussion on the difficulties of decentralization and disintermediation shows that even in permissionless blockchains many of the rules of the game will be set by a hub formed by the core developers and the new blockchain intermediaries.

These intricacies of the classifications of the various forms of organization of economic activity, competition and cooperation in the digital economy notwithstanding, it becomes clear that DLT fits perfectly well into this new paradigm of competition in the ecosystem and the development of new forms of acquiring strategic, but also architectural, advantage. In order to succeed an economic actor needs a strategy for the whole ecosystem. The emergence, demise and mutation of ecosystems[195] puts emphasis on the process of value creation and appropriation within ecosystems, but also value migration between ecosystems, that characterizes today's financialized economy, where value is negotiated day-by-day in financial markets on the basis of a reflexive system where perceptions or broader narratives about future expectations of return on investment plays a crucial role[196]. The role of industry architects and industry architectures in this process has not yet been examined in depth. I is still unclear how the different ecosystems and their interactions will affect final consumers. This impact can, of course, be determined at the level of a relevant market and that should of course continue. However, the changes brought, first, by platform competition, and then by ecosystem co-opetition, raise questions as to the continuing relevance of the sole relevant market framework for conducting a competition analysis. This also raises questions as to the different dimensions of ecosystem power, combining both sources of strategic and architectural advantage and appropriate metrics. The next Part will examine some competition law implications.

VI. Blockchain and competition law: setting the agenda

Any discussion over the implications of blockchain on competition law will, in the absence of any decisional practice on this issue by competition authorities, be quite general and

---

[193] Jacobides et al., (176), 2266.
[194] *Ibid*, 2267.
[195] Note that in his seminal contribution James Moore had described an ecosystem lifecycle consisting of four phases: birth, expansion, leadership and self-renewal: Moore, (175), 75.
[196] Indeed, to the extent that there is interaction between various agents and non-linear feedback between the actors and their environment, the system of interactions that emerges is 'reflexive' and cannot be adequately described by equilibrium systems, as agents frame their strategies observing the broader environment, assessing their position in it and determining their actions in order to alter the environment according to their aims: see George Soros, "General Theory of Reflexivity", (*ft.com*, 26 October 2009) <https://www.ft.com/content/0ca06172-bfe9-11de-aed2-00144feab49a>.

hypothetical. First, one may ask if the implementation of blockchain technology may increase the risk of anticompetitive conduct, either because it facilitates cooperation between rivals or because its implementation may facilitate exclusionary conduct, which are issues that will be explored in Section A. Second, it becomes important to examine if the existing competition law doctrines and tools may still be relevant with this new technology, or whether there is a case to re-conceptualize competition law so as to make it more aware of the complexities of blockchain competition.

A. The Competition Risks of the Implementation of Blockchain Technology

The decentralized nature of the public permissionless blockchain seems, at first sight, be beneficial to competition as it enables the contestability at least of the back-office segments of the value chain. This fares better than the current, highly concentrated structure of the digital economy dominated by digital platforms or than the stable oligopolistic structure we may observe in the financial services sector. Blockchain technology makes possible the substitution of centralized systems, where one entity controls the information about transactions and effectively is able to monetize this asset in product or financial markets, with a decentralized distributed ledger. This is achieved by reducing the network effects barrier that usually protects the position of digital platforms.

According to Catalini and Tucker, "(i)n theory, blockchain technology can be used to overcome the coordination challenges that otherwise lead network effects to be a source of market power, as it allows platform architects to design digital ecosystems where the benefits from adoption and growth are shared among different stakeholders such as users, developers of complementary applications, and providers of key resources"[197]. Blockchain implementations may also promote multi-homing, with consumers using competing platforms and facing lower switching costs as they keep control over their data at all times because this has not been collected and kept by a centralized digital platform[198]. Being open-source, permissionless blockchain platforms allow other applications and platforms "to interface with their network as long as they comply with the requirements of their protocol"[199]. Furthermore, "many platforms have a native token that not only facilitates exchanges on the platform, but also makes it extremely easy to convert assets between different ecosystems"[200]. Heavily inspired by libertarian ideals, the world of the blockchain is one of minimal friction. The technology empowers direct peer-to-peer interaction, without involving an intermediary. It is also a world where consensus, rather than power, become the default governance method. Forking provides a credible exit option for disgruntled developers and users with the "team maintaining the code or the rules through which the protocol forms consensus over time and allocates rewards to contributors", recognizing them the possibility to start "a separate, backwards compatible blockchain"[201]. This reduces the likelihood of hold-up strategies.

---

[197] Catalini and Tucker, (22), 6.
[198] *Ibid*, 7.
[199] *Ibid*.
[200] *Ibid*.
[201] *Ibid*, 8.

This optimistic scenario only concerns permissionless public blockchains. The situation is different for private permissioned blockchains, which may raise challenges similar to those raised by an entity controlling a database[202]. However, there is a more pessimistic scenario in which even permissionless blockchains could raise some competition concerns. I will examine the various competition law concerns different types of blockchain may raise.

1. Facilitation of Collusion

The most obvious concern, raised by both permissioned and permissionless blockchains, is the possible facilitation of collusion. This may result from the public character of the blockchain and the enhanced data visibility that it offers. Indeed, a key characteristic of the most well-known blockchain technologies, those supporting cryptocurrencies, is that all transactions are visible to all users. This increasing sharing of data may accommodate broader public policy to make data more open and less proprietary (e.g. Open Banking), but data transparency may also facilitate collusion between competitors. There are two possible concerns.

One may envisage the possibility where a cartel (i.e. explicit collusion) is enforced, not through law as this would be illegal and would constitute a restriction of competition by nature, but through code, by devising a smart contract that will enforce collusion, in particular, if this is coupled with pricing algorithms that are adjusted automatically when the conditions of the smart contract are satisfied. For instance, it is possible to envisage a smart contract between members of a cartel, which could condition the release of a 'guarantee', paid in cryptocurrency by each of the members of the cartel and kept in an 'escrow account' at one the digital wallets, automatically if certain conditions with regard to the deviation of prices from the cartelised price are identified by one of the parties to this cartel arrangement. The implementation of this smart agreement could be ensured by algorithms relying on off-blockchain data harvested by oracles. Firms may also constitute a federated blockchain (a 'consortium') where they will exchange data on their prices, output in real time and other sensitive, or non-sensitive information. In this case, the arrangement to establish this federated blockchain will constitute an information exchange agreement/concerted practice, that would first need to be assessed under Article 101(1) TFEU[203], and, in the case that it constitutes a restriction of competition, potentially be justified under Article 101(3) TFEU[204].

Once it is found that the information-exchange results from collusive action, the next step is to examine, at least in EU competition law, if it leads to a restriction of competition, by object or by effect. The context and the nature of the information exchanged will be particularly important in this context. For instance, strategic information, which relates to prices (for

[202] *Ibid*.
[203] See, for information exchange arrangements, Case T-35/92 ***John Deere Ltd v Commission of the European Communities*** **[1994] ECR II-957***;* Case C-238/05 *Asnef-Equifax, Servicios de Información sobre Solvencia y Crédito, SL v Asociación de Usuarios de Servicios Bancarios* (*Ausbanc*) [2006] ECR I-11125. This analysis will include a counterfactual test, exploring if the information exchanged was liable to lead to a collusive outcome, a pure information exchange not necessarily leading to a finding of a restriction of competition under Article 101(1) TFEU.
[204] Guidelines on the Applicability of Article 101 TFEU to Horizontal Cooperation Agreements [2011] OJ C11/1, [77]-[104].

example, actual prices, discounts, increases, reductions or rebates), customer lists, production costs, quantities, turnovers, sales, capacities, qualities, marketing plans, risks, investments, technologies and R&D programs and their results, is more likely to produce restrictive effects to competition and be caught by Article 101 than exchanges of other types of information[205]. Historic data is unlikely to lead to a collusive outcome as it is unlikely to be indicative of the competitors' future conduct or to provide a common understanding on the market[206]. However, there is no predetermined threshold when data becomes historic, that is to say, old enough not to pose risks to competition. Whether data is genuinely historic depends on the data's nature, aggregation, frequency of the exchange and the characteristics of the relevant market. Finally, exchanges of genuinely public information are unlikely to constitute an infringement of Article 101 TFEU.

If the parties form a consortium, this may be analyzed as a cooperative joint venture agreement[207]. In this situation, the case law provides that the analysis under Article 101(1) TFEU requires analysis of whether there is a restriction of competition among the undertakings forming the joint venture and, in particular, to explore if there were possibilities of competition between the parent undertakings in the absence of the joint venture agreement, thus, conducting some form of counterfactual analysis. The second step in the analysis is to examine if there is a restriction on competition vis-à-vis third parties, in particular, if third-party access to the relevant markets is likely to be impeded by the existence of a special relationship between the joint venture and its parent undertakings thereby placing other competing operators at a disadvantage. However, even if there is a restriction of competition under Article 101(1) TFEU, it is possible to justify the joint venture arrangement under Article 101(3) provided the the conditions of this provision are satisfied[208].

A possible theory of harm is the fact that a public ledger, visible to all, on which industry data may be published in real time and which could be easily accessible, will *facilitate* collusion. Information exchange may occur at the initial steps of forming a cartel, as the cartelists will need to identify the parameters of their cooperation and the selection of the cooperative equilibrium, for instance, by determining the price or output level of the cartel or of its individual members but may also facilitate the maintenance of the stability of a cartel by supporting the monitoring of any possible deviations from the cartel equilibrium reached by the parties. However, for Article 101 TFEU to apply, the information exchange should result from some form of collusive action, which can take the form of an agreement, concerted practice or a decision of an association of undertakings. Would the fact of making data publicly available to a public blockchain constitute, in this case, an agreement or a concerted practice that could fall under Article 101 TFEU, or would it consist in a unilateral practice that may escape this provision?

The issue here would be that the transparency created by the public communication of information between actual or potential competitors in real time may soften competition

[205] *Ibid*, [86].
[206] *Ibid*, [90].
[207] See, Joined Cases T-374/94, T-375/94, T-384/94 and T-388/94 *European Night Services Ltd (ENS) et al v Commission* [1998] ECR II-3141; **Case T-112/99 Métropole Télévision (M6) and Others v Commission** [2002] ECR II-2459; Case T-328/03, **O2 (Germany) GmbH & Co. OHG v. Commission** [2006] ECR-II 1231.
[208] See Guidelines, (203).

because it can reduce strategic uncertainty in the market. Again, one may here distinguish between private and public blockchains, the former raising more concerns, from a competition law perspective, than the latter. However, even genuinely public unilateral communication of information between competitors may have the potential to dampen competition[209], for instance by constituting price signaling capable of facilitating collusion.

However, note that in the US it is possible to bring in a Section 5, Federal Trade Commission ('FTC') Act case against 'facilitating practices'[210], even in the absence of proof of conspiracy or, more generally, communication provided the conscious parallelism produces anticompetitive effects, at least under certain specific circumstances [211]. Price signaling involving one-way public disclosures of information to third-party investors, was found anticompetitive in the US, under Section 5 of the FTC Act, without any evidence of reciprocity from the competitors, in the case where collusion could be inferred from the overall context[212]. In the absence of a provision equivalent to Section 5 FTC Act in EU competition law, the possibility of applying Article 101 TFEU is quite remote. In *Bananas*, the General Court[213], later confirmed by the CJEU[214], held that price signals removing the degree of uncertainty as to the behavior of competitors on the market in question may be seen as capable of harming competition to a sufficient degree to be considered as by object restrictions[215]. However, price signaling may fall under the scope of Article 101 TFEU if there is evidence of collusion. In *Bananas*, this was not an issue, as there was ample evidence of bilateral and private pre-pricing communications between the undertakings in question, even if these conversations were of more generic nature, and other factors influenced supply and demand. Yet, the Commission, upheld by both the General Court and the CJEU, found that there was a sufficient causal link between these practices and a possible effect, not only on prices for consumers, but more generally on the integrity of the competitive process, as "the pre-pricing communications had the object of creating conditions of competition that do not correspond to the normal conditions

---

209 This possibility is recognised by the Guidelines, (203), [94], noting that the fact that information is exchanged in public may decrease the likelihood of a collusive outcome on the market to the extent that non-coordinating companies, potential competitors, as well as costumers may be able to constrain potential restrictive effect on competition. However, the possibility cannot be entirely excluded that even genuinely public exchanges of information may facilitate a collusive outcome in the market.

210 Section 5 of the Federal Trade Commission (FTC) Act prohibits unfair methods of competition.

211 See, for instance, *E.I. Du Pont de Nemours & Co.* v. *FTC*, 729 F.2d 128 (2nd Cir. 1984) where, although the court of appeal dismissed the case, it acknowledged that Section 5 of the FTC Act can be violated by "non-collusive, non-predatory and independent conduct of a non-artificial nature, at least when it results in a substantial lessening of competition if "some indicial of oppressiveness" exist, such as evidence of anticompetitive intent, or the absence of an independent legitimate business reason for the conduct.

212 See, for instance, Valassis Communications, Inc., Analysis of Agreement Containing Consent Order to Aid Public Comment, 71 Fed. Reg. 13976, 13978-79 (Mar. 20, 2006), where the FTC noted that "given the obligation under the securities laws not to make false and misleading statements with regard to material facts, Valassis' invitation to collude, made in the context of a conference call with analysts, may have been viewed by News America [its competitor] as even more credible than a private communication".

213 Case T-588/08, *Dole Food Company, Inc. and Dole Germany OHG* v *European Commission*, ECLI:EU:T:2013:130.

214 Case C-286/13 P, *Dole Food Company Inc. and Dole Fresh Fruit Europe* v *European Commission*, ECLI:EU:C:2015:184.

215 See also the recent European Commission's proceedings against contained liner shipping companies for making regular public announcements of their (intended) future increases of prices through press releases on their websites and in the specialized trade press: Communication of the Commission published pursuant to Article 27(4) of Council Regulation (EC) No. 1/2003 in Case AT.39850 – Container Shipping, [2016] OJ C 60/7.

on the market"[216]. Determining the 'normal conditions of the market' in the context of a blockchain may require some in-depth analysis of the characteristics of the blockchain and the possibilities it offers to identify the various parties. The use of encryption technology does not always guarantee anonymity, as it is possible to link organizational information, such as an IP address, to a real entity. This may be more achievable in the context of a private or permissioned blockchain where the identity of the users exchanging information can be more easily identified.

2. Risks Flowing from the Development of Oligopolistic Structures

Mining constitutes an obvious illustration of the development of oligopolistic structures in the blockchain eco-system. There are twenty major mining pools, more than two thirds of them are based in China. It is estimated that three mining pool operators, BTC.com, Antpool and ViaBTC, currently control 52.5% of hashing power[217]. The six largest operators, the three just mentioned, and in addition, Slushpool, F2pool and BTC.Top, control more than two thirds of the hashing power[218]. Although mining was more consolidated a couple of years ago[219], this is a cause for concern for policy-makers requiring them to be vigilant so that the industry does not become more concentrated and that there is adequate monitoring for the possibility of coordination between some of the pools, for instance, by secretly partnering to gain control over new block generation.

The oligopolistic structure of mining is problematic because, depending on the governance of the specific blockchain, it may provide control levers for its overall activity to just a few players and, in particular, increase the risk of a 51% attack, thus, compromising the integrity of the blockchain. This could provide arguments for introducing a threshold automatically breaking mining pools in case their size reaches a particular limit that may increase the risk of a 51% attack in order to protect the integrity of the blockchain. Furthermore, the consolidation of industrial mining also raises competition concerns because a concentrated market structure may increase the risk of tacit collusion and lead to anticompetitive practices, such as charging excessive transaction fees. However, in the absence of clear evidence of an agreement or concerted practice restricting competition, this may not fall under Article 101 TFEU.

The concept of collective dominance may provide an alternative ground for action against practices in oligopolies, even if there is no agreement or concerted practice, when there is a 'connecting factor' between the undertakings forming part of the oligopoly and their conduct constitutes an abuse of a dominant position[220]. Although tacit collusion is covered by

216 Case C-286/13, (213), [134], referring to the Commission's decision.
217 See Jordan Tuwiner, "Bitcoin Mining Pools" (buybitcoinworldwide.com, 30 June 2018) <https://www.buybitcoinworldwide.com/mining/pools/>.
218 *Ibid*.
219 See the figures for 2016 in Rob Price, "The 18 Companies that Control Bitcoin in 2016" (ukbusinessinsider.com, 30 June 2016) <http://uk.businessinsider.com/bitcoin-pools-miners-ranked-2016-6/#18-p2poolorg-01-1>.
220 See, Case C-395/96 P *Compagnie Maritime Belge* [2000] ECR I-1365, [45], noting that "the existence of an agreement or of other links in law is not indispensable to a finding of a collective dominant position; such a finding may be based on other connecting factors and would depend on an economic assessment and, in particular, on an

Article 102 TFEU, there has not been any case where tacit collusion was considered as sufficient to constitute the requisite 'connecting factor' for a finding of a collective dominance position.[221] The DG Staff Discussion Paper, published in December 2005, recognized that "[u]ndertakings in oligopolistic markets may, sometimes, be able to raise prices substantially above the competitive level without having recourse to any explicit agreement or concerted practice", yet it confirmed the possibility of applying Article 102 TFEU only to the extent that the cumulative criteria for the application of the theory of tacit collusion are satisfied.[222] Yet, the Commission's priority Guidance briefly mentioned the concept, without providing any details as to the criteria for each use, thereby indicating that collective dominance cases are not within the priorities of the Commission, at least with regard to exclusionary practices.[223] There are considerable uncertainties as to the content of the concept of abuse in collective dominance cases. Some authors take a broad perspective, suggesting that abusive excessive prices (but one could also argue any form the exploitation of consumers takes: e.g. quality) charged by tacitly collusive oligopolists may be found an abuse[224]. Others take the more traditional, and narrower, approach of targeting facilitating practices, which can be the only 'conduct' found abusive.[225]

The possible emergence of oligopolistic structures is not only limited to mining but could also affect other blockchain intermediaries, such as exchanges, digital wallets etc. The risks raised by oligopoly may be accentuated in the context of the important technological progress recently made in artificial intelligence, the development of algorithms and deep machine learning in the modern digital economy[226]. Businesses become 'algorithmic' by using algorithms to automatize processes relating to their relations with their customers, suppliers, with the aim to gain an 'algorithmic' competitive advantage against their competitors. In principle, such use of algorithms should not raise any issues, unless it leads to the exploitation of consumers through algorithmic discrimination, algorithmic pricing or other exploitative practices or, may impose unfair conditions to their suppliers, in the event that these could be considered as a competition law problem, to the extent that these firms may reinforce their superior bargaining power. They may also be tempted to employ these algorithms in order to collude with their competitors in ways that escape the scrutiny of competition authorities[227].

---

assessment of the structure of the market in question"; Case T-193/02 *Laurent Piau v Commission* [2005] ECR II-209.

[221] See, for instance, the General Court and CJEU in Case T-296/09 *European Federation of Ink and Ink Cartridge Manufacturers (EFIM) v Commission* [2011] ECR II-425; Case C-56/12 P *European Federation of Ink and Ink Cartridge Manufacturers (EFIM) v Commission* ECLI:EU:C:2013:575, where both the General Court and the CJEU refused the existence of a collective dominant position in view of the aggressive competitive strategy of some of the undertakings in question.

[222] DG Competition, "The Application of Article 82 of the Treaty to Exclusionary Abuses", (2005) Discussion Paper, [47].

[223] Communication from the Commission — Guidance on the Commission's Enforcement Priorities in Applying Article [102 TFEU] to Abusive Exclusionary Conduct by Dominant Undertakings [2009] OJ C 45/7, [4].

[224] Richard Whish and Brenda Sufrin, "Oligopolistic Markets and Competition Law", (1992) 12 *Yearbook of European Law*, 59.

[225] Giorgio Monti, "The Scope of Collective Dominance under Article 82 EC", (2001) *Common Market Law Review*, 131.

[226] See, OECD, Algorithms and Collusion: Competition Policy in the Digital Age (2017) Report (hereinafter 'OECD, 2017'); Ariel Ezrachi and Maurice Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (of Competition, Market Dynamics and Society)" (2017) Oxford Legal Studies Research Paper No. 24/2017.

[227] See, our discussion in Section 1 in this Chapter.

The transparency offered by the blockchain may facilitate such strategic use of algorithms. Indeed, "algorithms make collusive outcomes easier to sustain and more likely to be observed in digital markets"[228]. This is achieved, first, by the capabilities of algorithms "to identify any market threats very fast, for instance, through a phenomenon known as 'now-casting', allowing incumbents to pre-emptively acquire any potential competitors or to react aggressively to market entry"[229], thus. increasing strategic barriers to entry. Second, they increase market transparency and the frequency of interaction, making the industries "more prone to collusion"[230]. Prices can be updated in real-time, "allowing for an immediate retaliation to deviations from collusion", as well as accurately predicting rivals' actions and anticipating any deviations before these actually take place[231]. Third, they can act as facilitators of collusion is in monitoring competitors' actions in order to enforce a collusive agreement, enabling a quick identification of cartel price' deviations and retaliation strategies[232]. Fourth, they may facilitate 'hub-and-spoke' strategies, for instance, the firms in an industry may outsource the creation of algorithms to the same IT companies and programmers[233]. Fifth, 'signaling algorithms' may enable companies to automatically set very fast iterative actions, such as snapshot price changes during the middle of the night, that cannot be exploited by consumers but which can facilitate collusion with rivals possessing good analytical algorithms[234]. Finally, 'self-learning' algorithms may eliminate the need for human intermediation. With deep machine learning technologies, the algorithms may assist firms in actually reaching a collusive outcome without them being aware of it[235]. This raises some quite interesting issues with regard to the scope of the concept of agreement or concerted practice under Article 101 TFEU, as we have hinted above, and also highlights the need to develop a more holistic approach to the risks of algorithmic collusion, in particular, in the context of blockchains.

It is also possible to consider the concerns raised by a more concentrated oligopolistic structure in the context of merger control. It may seem reasonable to carefully scrutinize mergers between mining farms or mining pools, not only in the context of the PoW framework where this is indispensable in order to preserve the system from the possibility of a 51% attack, but also in the context of a transfer of control taking place in the context of a PoS system, in view of the competition concerns raised by concentrated oligopolistic structures in the digital economy. Furthermore, competition authorities dispose the tools of sector enquiries, or, in the context of the UK, market or cross-market investigation references, which provide additional tools to take on industry-wide practices that may cause consumer detriment[236].

---

[228] OECD (2017), (225), 20.
[229] *Ibid*, 21.
[230] *Ibid*.
[231] *Ibid*, 22.
[232] *Ibid*, 26.
[233] *Ibid*, 28.
[234] *Ibid*, 29-31.
[235] *Ibid*, 32-33.
[236] In the EU, see, Article 17 of Regulation 1/2003. In the UK, the Competition and Markets Authority ('CMA) may conduct market studies under its general function in section 5 of the Enterprise Act 2002, as modified by the Enterprise and Regulatory Reform Act 2013, which includes the functions of obtaining information and conducting research. These market studies may lead to various outcomes, including investigation and enforcement action under the provisions of the CA 98 and/or the TFEU, and a market investigation reference: Competition and

3. Standardisation Issues

The implementation of blockchain technology in various economic sectors will require the development of various standards, as DLT will inevitably lead to a more fragmented IT eco-system, also due to the 'forking' of existing DLTs, which could increase fragmentation and slow down transaction processing speeds. For example, one may cite the work undertaken in the context of the International Organization of Standardization, established following Australia's proposal in September 2016, where ten ISO DLT-related standards are in development (relating to interoperability, security, privacy, identity, interactions among cloud computing systems and DLT, smart contracts and their application)[237] or the work in the context of the International Communication Union ('ITU')[238].

Another possible standardization issue could emerge when blockchain technology is used to develop certification and labelling standards in order to promote social and environmental sustainability or other public interest aims[239]. Horizontal cooperation agreements between undertakings restricting competition may provide benefits, not only directly to the category of consumers affected by the anticompetitive practice as this results from the relevant market definition, but also to the economy and the 'public at large'. These benefits relate to broader public interests, linked either to existing regulations or more broadly to values and principles animating public policy at a more general level. In this case the standardization is not related, as such, to blockchain technology, but to the definition of social and environmental standards and their implementation through DLT technology. This could raise questions as to the possibility of justifying possible restrictions of competition resulting from these standardization agreements for broader public-interest related purposes, such as the protection of the environment, a possibility that is not available under the current mainstream interpretation of Article 101(3) TFEU[240].

Markets Authority, "Market Studies and Market Investigations", (2014) Annex, Supplemental Guidance on the CMA's Approach, 33 . Cross market references are possible since passage of ERRA 2013: Sections 131(2A) and (6) of the EA02.

[237] See International Organisation for Standardisation, "ISO/TC 307 Blockchain and Distributed Ledger Technologies", <https://www.iso.org/committee/6266604.html>**.**

[238] See, for instance, ITU-T Focus Group on Digital Financial Services, "Distributed Ledger Technologies and Financial Inclusion", (2017) Technical Report; and many study groups including the ITU-T Study Group on the development of the blockchain of things as decentralized service platform, ITU-T Work Programme, "Declared Patents", (2017) Recommendation [SG20]:[Q4/20]; the ITU-T Study Group on scenarios and capability requirements of blockchain in next generation network evolution, ITU-T Work Programme, "Declared Patents", (2017) Recommendation [SG13]:[Q2/13].

[239] For a discussion, see Margaret Fowler, "Linking the Public Benefit to the Corporation: Blockchain as a Solution for Certification in an Age of Do-Good Business", (2018) 20 Vanderbilt Journal of Entertainment and Technology Law, 881.

[240] In the CECED case, the European Commission took into account the "collective environmental benefits" brought by an agreement between washing machine manufacturers to cease production and importation of less energy efficient machines Case COMP IV.F.1/36.718 *CECED* Commission Decision **2000/475/EC [2000]** OJ L 187/47. However, the Commission's 2011 horizontal cooperation guidelines do not include a separate section on "environmental agreements", nor did their 2000 version. Note also, that even the 2000 Guidelines were careful not to refer to the existence of "collective benefits" arising out of these agreements and was referring instead to "economic benefits", "either at individual or aggregate *consumer* level".

Standards provide increased compatibility between different products, (i.e. increased interoperability), thereby enabling the launch of a network. At the same time, standardization may impose costs; it may lock in consumers to a legacy system, enable hold up in cases where 'essential' IPRs have not been declared prior the standard or enable dominance by big players. The way the industry standard emerges is of particular importance for assessing its effects on competition. A cooperative standard is likely to enable multiple firms to be active in the industry, while the development of a *de facto* standard may lead to a single, proprietary product, controlled by a dominant undertaking.

The development of standards in the context of Standard Setting Organizations ('SSOs') are viewed positively in EU competition law. For instance, the Commission's Guidelines on Horizontal Cooperation note that, from an economic perspective, "standardization agreements usually produce significant positive economic effects", by enabling, among other things, the development of new and improved products or markets and improved supply conditions[241]. The positive economic effects may not be only for the specific parties to the agreement but to 'economies as a whole', in view of the lower output and sales' costs, the maintenance and the enhancement of quality, the provision of information and interoperability or compatibility, which provide value to the consumers. However, the EU Guidelines also recognize that standardization agreements may also produce anticompetitive effects by potentially restricting price competition and limiting or controlling production, markets, innovation or technical development[242]. The Guidelines identify the following theories of harm or anticompetitive scenarios, noting the competition risks of standard terms becoming industry practice, in particular, and, thus, access to them may be vital for entry into the market[243].

Standardization agreements raise particular competition concerns if they also involve Intellectual Property Rights ('IPRs'), such as patents. One may refer to situations where there has been deceptive conduct in the context of a SSO, when a patent holder adopts the strategy to conceal a patent that he holds on a specific technology during the standard-setting process, letting the other stakeholders agree on a standard incorporating a patented technology and, upon the standard gaining widespread acceptance, later revealing the information that the technology is covered by a patent at a point when the negotiating position of the other stakeholders will be weakened as they would have made standard specific investments and will be kept hostage (i.e. 'patent ambush')[244]. The holder of a standard essential patent ('SEP') may also seek a court injunction to block companies from producing any products compliant with the standard and to ask for higher royalties than that which he would have asked for prior to the adoption of the standard[245]. The issue may arise if the SEP holders have made a commitment to license on (F)RAND terms[246]. The risk of hold-up is particularly important in

[241] Guidelines, (203), [257]-[260] and 263.
[242] *Ibid*, [264].
[243] *Ibid*, [265]-[271].
[244] See, for instance, Case COMP/38.636 *Rambus* (2009) Commission Decision.
[245] See Case C-170/13 *Huawei Technologies Co. Ltd v ZTE Corp. and ZTE Deutschland GmbH* [2015] ECLI:EU:C:2015:477.
[246] FRAND stands for "fair and reasonable non-discriminatory prices".

complex technically markets in which detailed standards have been developed cooperatively by many companies.

The assessment of the restrictive effects of standard-setting should take into account their legal and economic context with regard to their actual and likely effect on competition and should, in particular, focus on the following relevant markets: (i) the product or service market(s) to which the standard or standards relates; (ii) where the standard-setting involves the selection of technology and where the rights to intellectual property are marketed separately from the products to which they relate, the relevant technology market; (iii) the market for standard-setting may be affected if different standard-setting bodies or agreements exist; (iv) where relevant, a distinct market for testing and certification[247]. However, even if the process of standardization gives rise to possible restrictions on competition, it is possible to justify these restrictions under certain conditions, under Article 101(3) TFEU.

4. Vertical Conduct and Abuse of a Dominant Position

As analyzed above, one of the possible strategies that may be adopted by blockchain firms to maintain a strategic competitive advantage and extend the period for which they may gain abnormal profits, beyond the initial hype about the new technology, is to adopt strategies linking blockchain with complementary spheres or markets where the firm maintains some absolute strategic advantage. These will most often be markets with significant network effects, thus 'off-blockchain', but one may also envisage the possibility that an economic entity acquires such a preeminent position in the blockchain space.

One may, for instance, envisage that Ethereum could develop to the dominant platform for decentralized applications ('DApp') and smart contracts in the blockchain space. It is very hard and irresponsible to make predictions in a nascent space like blockchain but since its launch, Ethereum has seen rapid development and mass adoption. The reasons behind that are that Ethereum benefitted from a first-mover advantage, as it was the first DApp and smart contract platform to enter the market, the flexibility and simplicity offered by the Solidity programming language in DApps are written on the Ethereum platform and the network effects that followed because most smart contract applications are written for the Ethereum platform (more than 250000 developers using the Ethereum platform). The fact that Ethereum enables the implementation of blockchain technology in the wider economy, captured the attention of big corporations, banks and consulting firms (such as Intel, JP Morgan and Deloitte), which invested in the technology. Furthermore, Ethereum is supported by a non-profit organization, the *Enterprise Ethereum Alliance*, connecting "Fortune 500 enterprises, start-ups, academics and technology vendors" with the community of Ethereum subject matter experts, which forms a big network of collaboration and innovation promotion[248]. The openness and flexibility of Ethereum led to a number of DApp and smart contract applications being launched on the basis of this platform, which following the ICO explosion of the last three years has led to the

[247] Guidelines, (203), [261].
[248] See Enterprise Ethereum Alliance, "Introduction and Overview", (*entethalliance.org*, 2017) <https://entethalliance.org/wp-content/themes/ethereum/img/intro-eea.pdf>.

emergence of the Ethereum ecosystem with a market capitalization worth around US$45 billion in the second quarter of 2018[249].

A number of other platform projects for DApps have also emerged since the launch of Ethereum in 2015, such as NEO (often called the 'Chinese Ethereum'), Waves (providing a scalable smart contract platform for decentralized applications), Lisk, (deploying *blockchain* applications in JavaScript and making use of Sidechains), Microsoft-compatible Stratis, Cardano, (uses the Haskell and Plutus programming languages and is split in two layers), the Cardano Settlement Layer ('CSL'), which is the value ledger, and the Cardano Computation Layer ('CCL') which handles the reasons why value transfers from one account to the other. In a decentralized ledger world, with weaker network effects, having multiple concurrent platforms interacting with each other, exchanging both data and value, is a plausible scenario. Blockstack also offers a platform for DApps that enables users to have access to the apps on the platform through a browser, and not an app store, the apps running locally on their computer with software installed from Blockstack[250]. Users create their ID to log in to Blockstack apps. Blockstack provides users a choice of where to store their encrypted data, a choice of their own server or a storage network powered by Blockstack.

Before concluding on the possibility for a dominant DApp platform to emerge, it is important to explore how a dominant position may be identified and evaluated in the context of the blockchain. This remains an open question that will be discussed in a subsequent Section.

Access to private or permissioned blockchains constitutes one form of conduct that may raise competition concerns, in particular, if this is used by incumbents in an industry in order to raise entry barriers to potential competitors. Companies operating in supply chains may collaborate through a digital supply chain managed by blockchain technology and smart contracts, with a public ledger of transactions copied to all nodes of the blockchain network. This may enable better monitoring and tracking of information, which may bring efficiency gains, but may also be used to monitor the implementation of some vertical foreclosure strategies vis-à-vis competitors. When blockchains are set by collaborations or consortia that set up blockchains, this may raise concerns over a horizontal restriction of competition, if the consortium includes actual or potential competitors. A recent OECD 'Issues Paper' also raises the possibility that a "(r)efusal to access the blockchain might be used to exclude maverick firms or new entrants' and, in general, to "exclude or raise the costs of rivals outside of the consortium" (foreclosure)[251]. The competition risks increase as access to the permissioned blockchain becomes indispensable for non-members to compete[252]. Eventual business reasons

---

249 See Statista, "Market Capitalization of Ethereum from the 3rd Quarter 2015 to 2nd Quarter 2018" (statista.com) <https://www.statista.com/statistics/807195/ethereum-market-capitalization-quarterly/>.

250 See Blockstack, "The Easiest Way to Start Building Decentralised Blockchain Apps", <https://blockstack.org>,.

251 OECD, Blockchain Technology and Competition Policy (2018) Issues Paper by the Secretariat, [19].

252 A refusal to grant access may fall under the scope of the prohibition of the abuse of a dominant position (under Article 102 TFEU) in competition EU law: see Case C-7/97 *Oscar Bronner GmbH & Co KG v Mediaprint Zeitungs- und Zeitschriftenverlag GmbH & Co KG* [1998] ECR I-7791, [46], on the requirement of the indispensability of access to the specific input. The possibility that a unilateral refusal to grant access be considered as an infringement of Section 2 of the Sherman Act is more remote. See, for instance the position of the US Supreme Court in *Verizon Communications Inc v Law Offices of Curtis v Trinko*, LL P, 540 US 398 (2004), where the Court noted that there are several problems with imposing a duty to deal. However, when such refusal

justifying the refusal to grant access to the permissioned blockchain should also be taken into account.

Other vertical exclusionary restraints may also raise concerns. These may attempt to leverage the dominant position an undertaking may hold in complementary markets. For instance, an OECD 'Issues Paper' provides the example of "firms that sell the specialized hardware that is required for mining tokens, which might find themselves with market power over inputs required by blockchain users which may seek to leverage their market power in (specialized) mining hardware into downstream markets"[253]. Another practice could consist in a vertical agreement, between a cryptocurrency and a provider of an ancillary services (e.g. digital wallet or exchange), bundling the uses of a dominant cryptocurrency to the use of a specific digital exchange or wallet. Similar bundling effects may occur if an undertaking links the use of the blockchain with ancillary services offered outside the blockchain, on which an undertaking holds a dominant position[254]. Østbye gives the example of a cryptocurrency with market power that bundles ancillary services upon its cryptocurrency, or a digital wallet provider that builds in a digital exchange into its wallet, or vice versa[255]. One may also envisage the possibility that a digital content platform controlling a dominant oracle service provider leverages its dominant position off-blockchain within the blockchain or attempts to maintain its dominant position off-blockchain, for instance, by adopting bundling practices that link the use of the specific oracle services with the data sources it controls.

Exclusive dealing agreements linking the decentralized environment of the blockchain with the centralized environment off-blockchain, or exclusionary discriminatory/preferential treatment practices, may also raise similar vertical (input or customer) foreclosure concerns. As Østbye observes, predatory pricing may also be a concern, if, for example, a large block validator or a mining pool set transaction fees below cost so as to exclude a rival cryptocurrency, or cross-subsidizes certain key merchants and suppliers in order to prevent a competing cryptocurrency from reaching efficient scale and, thus, profitably entering the market. These practices may be successful as they will not usually require the dominant undertaking to sacrifice profits; this usually acts as a disincentive for adopting exclusionary practices. In view of the lower likelihood of successful entry, because of these exclusionary practices, investors may be discouraged to participate in the ICOs launched by potential entrants, which, in view of the significance of this upfront method of attracting investment for blockchain projects, will certainly be sufficient to deter entry. Hence, because of the specificity of the funding of blockchain technology, the dominant firm may achieve its exclusionary purposes by just a credible commitment to employ exclusionary strategies, without effectively incurring any cost.

Possible exploitative practices include excessive pricing, for instance by mining pools, with market power, that decide to raise the transaction fees charged when validating the blockchain[256].

---

to grant access concerns a blockchain put in place by a joint venture or consortium of industry incumbents, US antitrust law provides more possibilities to take antitrust action.

253 *Ibid*.

254 Østbye, (22), 28.

255 *Ibid*.

256 OECD, (250), [19].

5. Mergers

Mergers between undertakings participating in the blockchain eco-system may also raise horizontal and vertical competition concerns. This would be, for instance, in the case of a horizontal merger between two undertakings active at the same level of the specific value chain related to the blockchain: e.g. a merger between undertakings active in industrial mining, or between digital exchanges or between undertakings operating digital wallets, which raises concerns over collusion. Østbye also describes the possibility of a horizontal mergers occurring across cryptocurrencies, for instance when a person holding significant mining resources in one PoW consensus managed cryptocurrency or a significant stake in a PoS cryptocurrency buys significant mining power or a significant stake in a competing cryptocurrency, to the extent that the merger brings the two cryptocurrencies in single control[257], and may produce horizontal unilateral or coordinated effects.

A merger between an entity controlling high stakes in a specific cryptocurrency (in particular, if the consensus is managed by a PoS governance arrangement) and a dominant digital wallet or exchange could raise foreclosure concerns, to the extent that it may exclude or marginalize the use of competing cryptocurrencies.

One may also envisage a conglomerate merger between a digital platform which, for instance, holds a dominant position in an oracle services market, has access to indispensable (Big) data and algorithms or controls specific smart modules or smart objects markets in the context of the IoT, with a blockchain platform, providing the new entity with the incentive and capability to bundle the use of the blockchain platform in order to launch DApps and smart contracts with the use of the off-blockchain services on which the digital platform holds a dominant position, thus, leveraging its dominant position off-blockchain within the blockchain.

B. Implications for Competition Analysis

1. The Scope of Competition Law: the Concept of 'Undertaking'

The various provisions of EU competition law apply to 'undertakings'. Article 101 TFEU applies to agreements between undertakings, decisions by associations of undertakings or concerted practices between undertakings. Article 102 TFEU applies to the abuse of a dominant position by an undertaking. EU Merger Regulation 139/2004 applies also to a concentration between undertakings or part of undertakings, either this takes the form of a merger or through "the acquisition, by one or more persons already controlling at least one undertaking, or by one or more undertakings, whether by purchase of securities or assets, by contract or by any other means, of direct or indirect control of the whole or parts of one or more other undertakings"[258]. In *Klaus Höfner and Fritz Elser v. Macrotron,* the CJEU explained that any entity "engaged in an economic activity, irrespective of the legal status in which it is

[257] Østbye, (22), 28.
[258] Article 3(1) of Council Regulation 139/2004 of 20 January 2004 on the Control of Concentrations Between Undertakings [2004] OJ L24/1.

financed' may be qualified as an undertaking for the purposes of competition law"[259]. In *Commission v. Italy*, the CJEU explained that the concept of 'economic activity' should be interpreted as "any activity consisting in offering goods and services on a given market", an often-repeated definition of the concept of economic activity[260]**.** EU competition law takes a functional approach, focusing more on the concept of 'activity', rather than that of 'entity'. Hence, the first question one needs to ask with regard to the definition of the material scope of the competition law, is not 'who' is an undertaking but 'what is economic activity'[261]. Such analysis differ depending on the conduct examined and the facts of the specific case. It is possible that the same entity might be found to be an 'undertaking' for some activities but not qualified as such for other activities.

Hence, it is crucial to examine the various forms of anticompetitive conduct in the context of blockchain, before answering the question, each time in view of the specific facts, as to whether the activity in question could be qualified as 'economic' and, thus, the entity exercising it, an 'undertaking'.

Determining if the activity in question is an undertaking can be relatively simple. If, one takes the example of collusion managed or facilitated by DLT, it will all depend on the activity of the owners of the nodes (e.g. any active electronic device connected to the Internet and disposing of an IP address) supporting the network by maintaining a copy of a blockchain and eventually processing transactions. To the extent that the owners of the nodes willingly contribute their computing resources to store and validate transactions, earning a transaction fee or a reward in the native token of the specific blockchain, they exercise an economic activity. EU case law accepts that even if the activity is non-profit, it could still be considered as an economic activity if it has the potential to be 'at least, in principle' exercised by a "private undertaking in order to make profits"[262]. The absence of a profit-motive does not mean that the entity does not exercise an economic activity. EU competition law does not make any distinction between altruistic entities and entities motivated by profits, as in both cases it is possible that the specific conduct reduces competition and/or welfare regardless of the motives and preferences of the producers. A similar conclusion may be reached if one examines the activity of other intermediaries of the blockchain, such as oracles, digital wallets, digital exchanges, DApps providers, or even Blockchain as a service ('BaaS') providers. However, it is also possible that the blockchain activity may not be qualified as economic, if, for instance,

[259] See Case C-41/90, Klaus *Höfner and Fritz Elser v. Macrotron* [1991] ECR I-1979, [21]; Case C-244/94, *Fédération Française des Sociétés d'Assurance (FFSA) and Others* v. *Ministère de l'Agriculture et de la Pêche* [1995] ECR I-4013, para. 14; Case C-55/96 *Job Centre coop arl* [1997] ECR I-7119, [21]; Case C-138/11 *Compass Datenbank v. Republik Őstereich*, [35]; Case C-440/11 P *Commission v. Stichting Administrattiekantoor Portielje*, [36].

[260] See Case C-118/85 *Commission v Italy* [1987] ECR 2599, [7]; Case C-82/01 P *Aéroports de Paris v Commission* [2002] ECR I-9297, [79]; Case C-49/07 *Motosykletistiki Omospondia Ellados NPID (MOTOE*) *v Elliniko Dimosio* [2008] ECR I-4863, [22]; Case C-138/11, (258), [35].

[261] Okeoghene Odudu, "The Meaning of Undertaking within 81 EC" in *Cambridge Yearbook of European Legal Studies*, (edited by John Bell and Claire Kilpatrick, 2005), 212–213.

[262] See Joined Cases C-264/01, C-306/01, C-354/01 and C-355/01, *AOK Bundesverband and others* [2004] ECR I-2493, Opinion of AG Jacobs, [27]. For an example see Case C-437/09 *AG2R Prévoyance v Beaudout Père et Fils SARL* [2011] ECR I-973.

it relates to “the exercise of official authority”[263], for instance the establishment of a public land registry using blockchain technology even if access to the public database (the registry) is provided in return for remuneration[264], or if it is related to an exclusively social function based on the principle of ‘solidarity’, such as a blockchain operating in a compulsory sickness insurance scheme in order to ensure transparency and reduce the opportunity of fraud[265].

Determining the ‘entity’ to be held liable for the competition law infringement presents more difficulties due to the decentralized nature of the blockchain. Although the concept of ‘entity’ is less important in order to determine the existence of an ‘economic activity’, in view of the functional approach followed by EU competition law it becomes crucial when it comes to (i) determining the liability under Article 101 TFEU of two entities because they entered into an illegal agreement or concerted practice, (ii) attributing liability for the illegal conduct, and the related issue of remedies/sanctions, and (iii) determining the market shares of the undertaking involved in the infringement of competition law, either this being in the context of merger control or in the context of an abuse of a dominant position, or in determining the existence of a single undertaking for the application of a Block Exemption Tegulation. I will focus in this sub-Section on (i), issues (iii) and (iii) being examined in subsequent sub-Sections.

The concept of ‘control’ plays an important role in the process of defining the scope of the competition law intervention against an ‘economic entity’. It determines the tangible or intangible assets that constitute the core of the ‘undertaking’, defines its boundaries and are thus presumed to be under the authority of the undertaking’s agents, which may engage through anticompetitive strategies the undertaking’s liability[266]. Under the ‘single entity doctrine’, several legal persons may form an ‘economic entity’ if a control relationship exists between them, the application of the doctrine presupposing the exercise of ‘control’ or ‘decisive influence’[267].

Should an entity, such as a mining pool, a blockchain intermediary or an intermediary or platform off-blockchain, take control of the blockchain, and the existence of ‘control’ will have to be determined according to the specific consensus protocol utilized by the blockchain (and if this is based on PoW, PoS or something else), then it may be considered as reasonable to hold this entity liable for anticompetitive conduct perpetrated in the context of the specific blockchain. The same deterrence reasons that have so far justified the liability of parent

[263] See Case C-343/95 *Diego Cali & Figli SrL v Servizi Ecologici Porto di Genova Spa* [1997] ECR I-1547; Case C-364/92 *SAT Fluggesellschaft mbH v Eurocontrol* [1994] ECR I-43; Case C-138/11, (258).

[264] This was not considered by the CJEU as sufficient on its own right for the activity carried out to be classified as an economic activity, as its payment was laid down by law and not determined, directly or indirectly by that entity: see Case C-138/11, (258), [39] and [42].

[265] See Joined Cases C-159/91 and C-160/91 *Poucet and Pistre v v AGF and Cancava* [1993] ECR I-637**;** Case C-437/09, (261).

[266] Case 170/83, *Hydrotherm Gerätebau GmbH v Compact del Dott. Ing. Mario Andreoli & C. Sas.* [1984] ECR 2999.

[267] See, inter alia, Case C-97/08 P, *Akzo Nobel and Others v Commission* [2009] ECR I-8237; Joined Cases C-628/10 P and C-14/11 P *Alliance One International and Standard Commercial Tobacco* v *Commission* and *Commission* v *Alliance One International and Others*, ECLI:EU:C:2012:479, [46]-[47], with regard to the liability of a parent company for the conduct of its wholly–owned subsidiary or on which it exercises a decisive influence; Art. 3(2) & 3(3) of Council Regulation (EC) No. 139/2004 on the Control of Concentrations Between Undertakings, OJ 2004 L 24/1 (in the context of merger control).

companies for the anticompetitive activity of their subsidiaries may also operate in this case[268]. However, this expansion of the personal scope of liability has also been criticized[269]. The discussions over the boundaries of the 'single entity' doctrine constitute a specific facet of the broader debate over 'enterprise liability' versus business participant liability, and over when the corporate veil should be pierced[270].

This discussion is indirectly related to the debate about the boundaries of the 'firm' in economics, with a number of approaches glossing over Ronald Coase's seminal, but incomplete from a descriptive perspective, distinction between 'markets' and 'hierarchies'[271]. The discussion over the boundaries of the firm has also caught the attention of blockchain experts, who rightly observe that blockchain technology contributes to the 'hollowing out' of the firm as initiated by the digital revolution[272]. It is expected that blockchain technology will challenge the 'efficiency' justification for establishing centralized islands of authority (as this is put forward by the proponents of the TCE/contractual theory approach) whilst also enabling a wider distribution of entrepreneurial finance through its distinctive way of attracting finance, the ICO. 'Hollowing out' the firm does not, however, necessarily imply a corresponding growth of the sphere of activities organized through markets to the extent that the dominant strategy of blockchain developers and intermediaries may be to build 'walled gardens' and to architecture eco-systems that could progressively lead to some form of centralization. In this context, determining the entity that could be found liable for a competition law infringement might be an easier task.

Note that, in contrast to the functional approach of EU competition law in defining an undertaking, US antitrust law applies, in principle, to 'persons', the concept being broad enough to cover entities having various forms without being necessary to define *ex ante* if the specific entity exercises an economic activity. The term 'person' is defined in Section 7 of the Sherman Act as including "[…] corporations and associations existing under or authorized by the laws of either the United States, the laws of any of the Territories, the laws of any State, or the laws of any foreign country", hence, adopting a purely organic definition of the concept,

---

[268] Carsten Koenig, "An Economic Analysis of the Single Economic Entity Doctrine in EU Competition Law", (2017) 13(2) *Journal of Competition Law and Economics,* 281-327.

[269] For a criticism of this case law, see Andriani Kalintiri, "Revisiting Parental Liability in EU Competition Law", (2018) *European Law Review*, 145, noting that it may deprive undertakings of the protection afforded to them by the Charter of Fundamental Rights and the general principles of EU law.

[270] For a discussion, see Eric Orts, *Business Persons – A Legal Theory of the Firm* (Oxford University Press, 2013).

[271] Ronald Coase, "The Nature of the Firm", (1937) 4(16) *Economica*, 386. Williamson added 'hybrids': Oliver Williamson, *The Mechanisms of Governance* (Oxford University Press, 1996). Some approaches explain the emergence of firms, and their boundaries, by transaction costs economics ('TCE') and more broadly contractual theories of vertical integration (see, *inter alia*, Oliver Williamson, *The Economic Institutions of Capitalism* (Free Press, 1985); Paul Joskow, "The New Institutional Economics: Alternative Approaches", (1995) 151(1) *Journal of Institutional and Theoretical Economics*, 248). Others focus on property rights, by identifying the allocation of residual decision rights with the ownership of the assets of the firm (tangible and intangible) Oliver Hart and John Moore, "Property Rights and the Nature of the Firm" (1990) 98 *Journal of Political Economy*, 1119. Others take an agency perspective, defining the firm as 'a nexus of agency relationships including managerial lines of authority, employment and structures of governance': Orts, (269), 13. A more dynamic perspective views the boundaries of a firm as related to its strategy to leverage its internal capabilities in related markets or to exploit its superior management capabilities and resources: Wernerfelt, (128), 171.

[272] Catherine Mulligan, "Blockchain Will Kill the Traditional Firm" (imperial.ac.uk, 16 October 2017), <https://www.imperial.ac.uk/business-school/knowledge/finance/blockchain-will-kill-the-traditional-firm/>**.**

which contrasts with the functional definition of the concept of 'undertaking' in EU law. In the absence of a centralized entity or fiduciary, to which liability for the competition law infringement may be ascribed, it may be difficult to determine the 'person' subject to the scope of the Sherman Act.

2. Blockchain and Collusion: an Oxymoron?

Even if the activity related to the use of blockchain is economic and it is possible to ascribe liability to a specific entity, considered for this purpose as an 'undertaking', there may be additional difficulties in applying the traditional concepts of competition law, such as, for the purposes of implementing Article 101 TFEU, the existence of an agreement or concerted practice (i.e. of collusive conduct). If one takes the example of Bitcoin, miners may be found to exercise an economic activity and, therefore, be qualified as undertakings. However, could their contribution to validate the blocks of the blockchain and maintain its operation qualify as collusion? Ǿstbye presents the hypothetical of the currency-cap used by the Bitcoin protocol, which limits the number of Bitcoins to be released to twenty-one million[273]. Could this amount to an illegal output restriction? It certainly consists in an output restriction but it cannot be illegal unless the restriction results from collusive, not unilateral, conduct. The Bitcoin miners contribute to the operation of the Bitcoin blockchain by validating the blocks, thus, exercising an economic activity, to the extent they may receive compensation for this activity. In performing this activity, they abide by the 'consensus' process put in place by the blockchain protocol: can their activity be qualified as unilateral, or can this be considered as coordination amounting to an antitrust agreement/concerted practice?

A second hypothetical raising similar questions would occur in the context of a decentralized blockchain-based marketplace, where data is exchanged by various industry actors, some being competitors, and where value-added services are provided, such as access to the data pool for training better algorithms. An algorithm based on machine learning may set the prices for data via the blockchain protocol, choosing from multiple pricing models[274]. Would the fact of sharing and pricing this data through this decentralized blockchain-based marketplace constitute a unilateral conduct? Or should we consider the data providers as entering into some form of collusive information exchange-related conduct?

For an antitrust agreement to be formed, it is required that there is evidence of the "concurrence of wills between at least two parties, the form in which it is manifested being unimportant so long as it constitutes the faithful expression of the parties' intention"[275]. The case law explains that this 'concurrence of wills' materializes through the existence of an offer and an acceptance. However, the interpretation of these conditions has been quite flexible, and even tacit acquiescence has been found sufficient[276].

[273] Peder Østbye, "The Case for a 21 Million Bitcoin Conspiracy" (2018), <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3136044>.

[274] Ocean provides an early example of such decentralised blockchain-based data exchange platform: see Ocean, "A Decentralised Data Exchange Protocol to Unlock Data for AI", <https://oceanprotocol.com>.

[275] Case C-2 and 3/01 P, *Bundesverband der Arzneimittel-Importeure eV & Commission v. Bayer* [2004] ECR I-23, [69].

[276] Case T-208/01, *Volkswagen AG* v. *Commission* [2003] ECR II-5141.

It is also possible that the conduct may fit into the category of concerted practice. In this case, it is not necessary to prove the existence of an offer and acceptance, but one should, at least, bring evidence that the concerted action is 'the result of a consensus', which equally encompasses 'tacit approval'[277]. Returning to our first hypothetical, although the miners have not explicitly acquiesced to the Bitcoin protocol that imposed this output restriction, the fact that they are continuously contributing to its operation may amount to acquiescence, to the extent that their apparently unilateral activity (e.g. validating a block) requires a mutual reliance that other miners will accept the new block, generated by the miner who has been the first to solve the mathematical puzzle (in PoW systems). By authenticating the transaction, they make sure that the proof string really solves the encryption puzzle, these being considered as equivalent to 'voting' in favor of the integration of the transaction in the blockchain. Returning to our second hypothetical, it will all depend on the consideration of the practice of sharing data in the decentralized blockchain-based platform as a form of communication between competitors that may be qualified as a concerted practice, to the extent that it is followed by price parallelism implemented through the use of a common learning algorithm.

This will not be the first time the EU case law found the existence of collusion, despite the "unusual nature of the method of communication"[278]. In *E-turas*, the director of E-turas, a common online travel booking system, which is used by most travel agents, had sent an email to the travel agencies having an electronic account in the E-turas system asking them to 'vote' on the appropriateness of reducing the discounts offered on booking made through that system. A few days after sending this message, the administrator of E-turas sent through the internal messaging system of E-turas an additional message indicating that a capping of the discount rate will be introduced "following the appraisal of the statements, proposals and wishes expressed by the travel agencies". Travel agents were not prevented from granting their customers greater discounts but in order to do so they were required to take additional technical steps. The Lithuanian Competition Council considered that the travel agents using the E-turas booking system during the period in question had participated, along with E-turas, in an anticompetitive concerted practice, the E-turas system being used as a tool for coordinating the travel agents' actions and eliminating the need for meetings. In a preliminary ruling, the CJEU held that a finding of a concertation between the travel agencies was justified as they were aware of the content of the message at issue and therefore, had tacitly assented to a common anticompetitive practice[279]. However, it also noted that "if it cannot be established that a travel agency was aware of that message, its participation in a concertation cannot be inferred from the mere existence of a technical restriction implemented in the system at issue", unless there are "other objective and consistent indicia that it tacitly assented to an anticompetitive action"[280].

Therefore, it becomes important to examine if the miners, in our first hypothetical, or the service providers, in our second hypothetical, were *aware* of the anticompetitive nature of the arrangement. This may be inferred by the fact that in both cases, the blockchain protocol is

---

[277] See, the discussion in Opinion of AG Szpunar, in Case C-74/14, Eturas UAB et al v. Lietuvos Respublikos konkurencijos taryba**,** ECLI:EU:C:2015:493**.**
[278] *Ibid*, [61].
[279] *Ibid*, [44].
[280] *Ibid*, [45].

well known in advance, as it is usually published when the blockchain developers release their white paper and further documentation, and its anticompetitive potential may be, more or less easily assessed. The Bitcoin cap is explicitly mentioned in the Bitcoin protocol. The situation is not as straightforward with the second hypothetical; it will all depend on the design of the pricing algorithm and how much autonomy it is afforded, to the extent that the service providers may not be able to understand how pricing decisions are made. This issue has raised important questions in recent literature focusing on algorithmic collusion[281]. If the collusive outcome is just the result of the use of the system (i.e. the 'learning algorithm'), without any other objective and consistent indicia of collusion it is unclear how the practice may fall under the scope of Article 101 TFEU, at least as evidence of direct collusion.

EU competition law offers an additional possibility by bringing some forms of indirect collusion within the scope of Article 101(1) TFEU. The literature on cartels has noted the operation in some horizontal price fixing conspiracies of an undertaking/agent, situated at a different relevant market than the one covered by the cartel, whose function is to serve as "an intermediary that speaks individually to each of the competitors and then relays each competitor's agreement […] to the other competitors in a series of one-to-one conversations"[282]. The main concern of the participants to these conspiracies is to facilitate the implementation of the cartel even if they do not benefit from its effects directly (although they might receive some other form of compensation from the cartel members).

The presence of these intermediaries on vertically related upstream or downstream markets or on markets that are simply not related to the one the cartel operates may introduce some non-horizontal/triangular element in the collusion, making its qualification more complex with the concerted practice being indirect rather than direct. A common characteristic of these situations of indirect concerted practice is that the undertakings in this triangular relation are all concerned with the implementation of the horizontal collusion scheme. According to well-established case law, this intermediary may be found to infringe Article 101 TFEU, which strictly precludes 'any direct *or indirect* contact' between competitors[283]. This is the case if, for instance, information on future prices is exchanged between competitors through this intermediary. In *AC-Treuhand AG v. Commission,* AC-Treuhand (a consultancy firm) did not trade on the relevant markets or on related markets, but was found to play an essential role in the infringement as it had organized meetings for the cartel participants which it attended and in which it actively participated, collecting and supplying to the participants data on sales on the relevant markets, offering to act as moderator in case of tensions between the cartel participants and encouraging the parties to find compromises[284]. The CJEU found AC-Treuhand *directly* liable for the commission of the infringement, finding that the subjective element of the offence was satisfied in this case as its conduct was directly linked to the efforts of the cartelists[285]. This broad interpretation of the direct nature of liability leaves open the

---

[281] See OECD, (225); Joseph Harrington, "Developing Competition Law for Collusion by Autonomous Price-Setting Agents" (2017) University of Pennsylvania.
[282] George Hay, "Horizontal Agreements: Concept and Proof" (2006) *Antitrust Bulletin*, 882.
[283] Joined Cases 40-48, 50, 54-56, 111, 113-114/73 *Cooperatieve Vereniging 'Suiker Unie' UA v Commission* [1975] ECR 1663, [174] (emphasis added).
[284] *Case COMP/38589 Heat Stabilisers* [2009].
[285] Case C-194/14 P, *AC-Treuhand AG v. Commission*, [2015], ECLI:EU:C:2015:717, notably para. 38.

possibility of broadly interpreting the concept of 'indirect' contact. Could this be expanded to impose a fiduciary duty not to infringe competition law to all blockchain intermediaries if they are involved in or are in contact with a DLT system that has led to an infringement of competition? Could one compare this situation to that of the parent company vis-à-vis the conduct of its subsidiaries? This is an important issue that does not only relate to competition law but more broadly raises the issue of the 'distributed liability' concerning the legal risks emerging from the use of blockchain systems[286].

Returning to our first hypothetical, it is possible that, in view of their contribution to the day-to-day operation of the Bitcoin blockchain, the miners could argue that they may benefit from the 'single economic entity' doctrine and that, despite not having any employment contract, they are, in reality, operating as employees of the blockchain. If they are qualified as employee, they cannot then be qualified as an undertaking exercising an autonomous economic activity, in the sense of offering goods or services on a market and bearing the financial risk attached to the performance of such activity[287]. Hence, their activity could not be considered as constituting collusion between undertakings under Article 101 TFEU. The CJEU focuses on the *nature* of the relation before concluding on the existence of an 'undertaking'. In its most recent case law, the CJEU has taken a more cautious approach, rejecting categorical distinctions, such as workers and self-employed. It addresses these situations as a *continuum* going from situations of complete dependence (in which case the relation will be considered as akin to employment) to a situation of complete independence (in which case the entity in question will be considered as an independent undertaking)[288]. This is quite unlikely in this context as industrial mining activity is concentrated in a limited number of mining pools, many of which contribute to the activity of several crypto-currencies and other crypto-assets.

One may finally refer to the agency theory and consider that the miners constitute the agents of a principal (the blockchain), the existence of a genuine agency relation immunizing their conduct as this could be considered as taking place within the boundaries of a 'single economic entity'[289]. This approach has already been tried in analyzing the relations between digital platforms, such as Uber and the various economic operators linked to that platform (Uber drivers)[290]. However, even assuming that miners would be considered as the agents of

286 For a thorough discussion, see Dirk Zetzshe, Ross Buckley and Douglas Arner, "The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain", (2017) *University of New South Wales Law Research Series*, 52.

287 Case C-22/98 *Criminal proceedings against Jean Claude Becu, Annie Verweire, Smeg NV and Adia Interim NV* [1999] ECR I-5665.

288 Case C-413/13, *FNV Kunsten Informatie en Media*, ECLI:EU:C:2014:2411.

289 EU Vertical Restraints Guidelines [2010] OJ C 130/1, [12]–[20].

290 See, for instance, a recent judgment of the UK Employment Appeal Tribunal ('UKEAT') regarding the employment status of Uber drivers, which although relating to employment law may provide some insights for competition law. Although the UKEAT noted that the drivers incurred commercial risks as they were responsible for all costs incidental to owning and running the vehicle, and were also able to work for or through other organizations, including direct competitors with Uber operating through digital platforms, which could hint to the existence of an agency relation, it rejected this qualification in favour of an employment relation in view of the relative bargaining power of the parties (Uber being much more powerful than the drivers, acting individually), the integration of Uber drivers into Uber's business, in particular as, among other things, they were prevented from building up a business relationship with the end user of the service, they were in practice obliged to accept all trip requests if they wanted to keep their account status, and Uber held a significant market share in London, which left them no other equally effective competitive alternative.

the blockchain, this cannot immunize horizontal collusion between miners, the scope of the immunity being limited to vertical relations between the principal and the agent[291].

3. Reconceptualising (Market) Power in Blockchain Competition

The digital economy gives rise to a variety of strategies to acquire competitive advantage and convert this to surplus value to be later collected in product and financial markets. In this fast-moving environment, innovation competition provides the main constraint to 'winner-takes-most' competition, as new economic actors rely on cost-cutting technology to break into markets, disrupt the existing competitive structure and eventually acquire a position of economic power, before they give way to new actors making a more efficient use of the technology or relying on a better technological alternative. As explained above, the boundaries of markets and industries become blurred. The financialization of the economy leads to the superposition of global financial markets, characterized by higher volatility, the operation of complex information systems and future-driven rationalities which sit on top of the various product markets on which competitive interactions have traditionally been thought to occur. Competition does not only take place within a product or a technology market, or even an industry, but also within broader competition 'ecosystems'[292], which may include various industries, as inter-industrial investment flows focus on the lowest cost techniques that provide higher rates of return for the capital invested, capital moving from one industry to another in search of higher profits[293].

The disruptive promise of the blockchain lays exactly in its ability to contest hard-won positions of market power, held by digital platforms, which have emerged victorious in the different 'competition for the market' contests that opposed them to 'old economy' incumbents. If digital platforms have relied on the complex economics of multi-sided markets to question the dominance of incumbents on single relevant markets, the competitive strategies of blockchain participants may challenge the centralizing role of platforms. The competitive game does not only refer to neck-to neck rivalry but, as explained in Part V, takes more complex dimensions finding expression in the concept of co-opetition. Co-opetition does not only take place on relevant product markets but also on financial and technology markets and at various segments of the value chain. The allocation of the surplus value does not result from competition within an industry but also from competition between industries.

These changes certainly influence the concept of economic power relevant for competition assessment. This cannot only be defined as power over price exercised on a specified relevant market but it also needs to consider that most competitive strategies take place at the level of the eco-system with firms competing for architectural advantage in it.

Usually, economic concentration indexes serve as an appropriate proxy for inferring the existence of market power in its traditional dimension of power over price. In the absence of barriers to entry, a highly concentrated relevant market provides a good indicator that the entity controlling a large market share in a product or technology market has the ability to raise

[291] Vertical Restraints Guidelines, [20].
[292] Jacobides et al., (176) .
[293] Shaikh, **(127).**

prices profitably or to negatively affect other parameters of competition (i.e. the entity has market power')[294]. Determining the existence of a dominant position will usually require the definition of a relevant market and the computation of the market share held by the specific entity (or entities). The relevant market may be narrow or wide depending on the availability of substitutable products and technologies. There are various ways to evaluate market power on the basis of market shares: one may refer to the users of the blockchain, the number of recorded transactions, the position of the blockchain participants on markets off-blockchain, among other options[295]. The hashing power spent to validate the blockchain is also a relevant assessment criterion, to the extent that the community of nodes running the protocol and validating the transactions indicate the attractiveness of a specific blockchain vis-à-vis competing ones, eventually also a blockchain fork, should some of the members move to a different one. It is also possible that all competitors within the market use the same blockchain, in which case the number of participants, recorded transactions and hashing power may prove relevant. Product differentiation, the control of IP rights and other barriers to entry may also be relevant for the analysis.

Cryptocurrencies also raise difficult questions of market definition, in view of their volatility and the fact that they may be considered in competition with each other, with other national fiat currencies and private currencies as a means of payment[296], or in competition with other investments, if they are perceived as providing a store of value. Network effects and product differentiation, such as emphasis on security, capacity, speed, and anonymity, may protect the position of a dominant cryptocurrency. Blockchain developers may also link additional services with a cryptocurrency. Some of them, such as Ripple, which act simultaneously as a cryptocurrency and a real-time gross settlement system, currency exchange and remittance network, may even be considered in competition with traditional payment systems. Indeed, Ripple provides an open-source Internet software enabling users to conduct international payments in multiple currencies. The emergence of the blockchain has unleashed enormous amounts of creativity, generating an ever-increasing number of idiosyncratic crypto-assets, and Dapps. Hence, competition authorities should proceed to a concrete analysis of the specific economic context and of the facts of each case always focusing, as a starting point for the analysis, on the competitive strategies that may adopted by the various economic actors.

However, it becomes apparent that the problem with the traditional measures of market power is that, even if they do provide an accurate picture of the position of the blockchain participant on a product or technology market, they do not necessarily account for its position in the broader eco-system (what I will call 'eco-system power'), which is, in view of the central importance of eco-systems in the competitive interactions in the digital economy, the most important factor to consider. Eco-system power does not only refer to the ability of the

---

[294] According to the Commission's Transfer of Technology Block Exemption Regulation Guidelines '[t]he relevant technology markets consist of the licensed technology rights and its substitutes, that is to say, other technologies which are regarded by the licensees as interchangeable with or substitutable for the licensed technology rights, by reason of the technologies' characteristics, their royalties and their intended use': Guidelines on the Application of Article 101 of the Treaty on the Functioning of the European Union to Technology Transfer Agreements [2014] OJ C 89/3, [22].

[295] Schrepel, (22).

[296] Østbye, (22), 8, noting that "all cryptocurrencies cannot necessarily be considered to be sufficiently substitutable to be considered competitors".

blockchain participant, or another entity, to limit horizontal competition on a product or technology market in order to increase its profitability, but also to its capacity to restrict vertical competition by constituting a bottleneck that may enable it to extract a larger percentage of the surplus value generated by the specific value chain. This capability to restrict both horizontal and vertical competition may also signal to financial markets the existence of a sustainable strategic or architectural advantage that could create expectations for abnormal profits in the medium and long-term, thus, attracting capital and leading to an increase of the market value of the entity or of the funds that can be raised through an ICO.

Competition law still lacks the operational and measurement tools to map competitive interactions taking place outside the relevant market, something that may lead to a quite myopic competition law enforcement that would only focus on restrictions of horizontal competition in relevant markets to the detriment of the vertical competition dimension and co-opetition taking place at the boundaries of relevant markets or industries. Although it has focused increasingly on innovation and has started to develop specific tools to deal with the innovation effects of horizontal mergers[297], it has yet to engage with all the dimensions of futurity, that influence, through the evaluation mechanism of financial markets, the perceived competitive promise of blockchain projects and the arrangements governing the allocation of surplus value between the various participants and stakeholders in the specific eco-system. I have advanced elsewhere the concept of 'digital value chain' as a useful mapping tool and conceptual framework for the full canopy of competitive interactions in the digital economy[298]. There is still work to be done in order to operationalize this concept and also develop specific tools that would measure eco-system power. However, the lack of adequate metrics for the time being should not constitute an insurmountable barrier to widening the scope of competition assessment and to providing a real, as opposed to distorted, picture of competition, taking into account the various forms of competitive advantage.

A natural extension of this project is to also account for the various dimensions of 'power'[299]. The concept of market power is remotely linked to resource dependency theories of power, with the entity controlling more resources, or indispensable resources, having power over entities that control less-resources or need access to this indispensable resource[300]. Controlling access to a strategic bottleneck certainly provides the entity in question with the capability to charge supra-competitive prices and to, eventually, restrict quality and innovation competition. However, this is not the only type of power in operation in the blockchain arena, and more generally, in the digital economy. Power may also take the form of being in a position to control the agenda of what is considered for decision[301]. This dimension is particularly important when accounting for architectural advantage. The blockchain community is still

[297] See Giulio Federico, Gregor Langus and Tommasso Valletti, "Horizontal Mergers and Product Innovation", (2018) 59 *International Journal of Industrial Organization*, 1; Bruno Jullien and Yassine Lefouili, "Horizontal Mergers and Innovation", (2018) Toulouse School of Economics Working Paper, 18-892.

[298] Ioannis Lianos, "Digital Value Chains in Competition Law", (2018) CLES Research Paper 4/2018.

[299] For an in-depth discussion see, Ioannis Lianos, The different dimensions of economic power in competition law: concepts and measurement (mimeo, 2017).

[300] For a discussion, Richard Emmerson, "Power-Dependence Relations", (1962) 27(1) *American Sociological Review*, 33; Karen Cook and Richard Emerson, "Power, Equity and Commitment in Exchange Networks", (1978) 43(5) *American Sociological Review*, 721.

[301] Mark Granovetter, *Society and Economy* (Harvard University Press, 2017), 101.

quite small and a number of actors have achieved almost totemic position with thousands of 'followers' in their twitter accounts, blogs, and social media often exercising an important influence on the valuation of crypto-currencies and other crypto-assets or in promoting an optimistic narrative as to the competitive prospects of the technology vis-à-vis competing ones[302]. These narratives also influence policy-makers and regulators, which, as I have previously described, constitute an important dimension of acquiring competitive advantage vis-à-vis incumbents relying on competing technologies. Developing operational theoretical frameworks and adequate metrics in order to measure architectural advantage is an area for further research.

4. The 'Unregulatability' of the Blockchain: Remedies and Sanctions

Blockchain may also curtail the ability of competition regulators to identify the entities that would be liable for competition law infringements and to adopt appropriate remedies and sanctions. At the early stages of the development of the Internet, the thesis of the 'unregulatability' of the Internet was refuted by authors claiming that there were clearly points of control and entities that could be held liable for the risks their activity contributed in surging[303]. Like the Internet, blockchain is borderless, but crucially it is decentralized, which makes it difficult, in particular if the activity takes place in the context of public permissionless blockchains, to determine who should bear the responsibility for the social costs and the private harms generated by the blockchain-related activity. A distributed ledger may need forms of 'distributed liability': "all entities in the system need to consider contingent liability risk"[304]. Should that extend to all the blockchain participants, irrespective of their governance roles, or only to those that exercise a significant influence on the activity that led to the specific social costs or to the specific private harm to be compensated? And if the option of collective responsibility is finally chosen, how would this be apportioned between the various nodes, to the extent that node owners in a permissionless blockchain may not even be aware of the specific conduct, or on who were the other node owners involved. Zetzsche et al. emphasize the governance structure of the DLT system, noting the existence, in most DLT projects, even permissionless blockchains, of a 'DLT hierarchy' consisting of the following groups:

(i) "the core group that sets-up the code design and (*de facto*) governs the DLT, for instance by having the technical ability and opinion leadership to prompt a hard fork of the system (under certain conditions);
(ii) the owners of additional servers running the distributed ledger code for validation purposes […];
(iii) qualified users of the distributed ledger, such as exchanges, lending institutions, miners etc.; and

[302] See, for instance, Feng Mai, Zhe Shan, Qing Bai, Xin Wang and Roger Chiang, "How Does Social Media Impact Bitcoin Value? A Test of the Silent Majority Hypothesis", (2018) 35(1) *Journal of Management Information Systems*, 19.
[303] See Jack Goldsmith and Tim Wu, *Who Controls the Internet? Illusions of a Borderless World* (Oxford University Press, 2006), cited by De Filippi and Wright, (21), 50.
[304] See Zetzche et al., (285), 9.

(iv) third parties affected by the system without directly relying on the technology, for instance, [..] simple users, clients of intermediaries […] etc."[305].

Some of these blockchain participants, but not all, may be qualified as undertakings, in that they offer goods and services on a market. For instance, it is clear that category (iv) will most likely comprise end users or consumers that do not offer products or services on a market and, therefore, will not be qualified as 'undertakings'. Of course, being a natural person does not exclude *ipso facto* the possibility of being qualified as an 'undertaking' if that person exercises an economic activity and does so independent of the power or influence exercised by the specific natural person in the governance of the DLT. For instance, it is likely that the members of the core group will not be qualified as undertakings in the case that they are employees, who they lead their DLT activity outside their normal working hours and without supervision of their employer, on a voluntary basis. In any case, it becomes crucial to identify the entities that form part of, at least the first four groups of the DLT hierarchy, before determining the governance structure of the DLT.

The knowledge about the governance structure of the DLT may assist regulators and competition authorities in deciding to expand, or not, the scope of liability to all DLT participants, even if they have not actively contributed to the governance of the blockchain. Legal fictions, such as the concept of 'business networks' may provide the conceptual framework to expand the scope of liability beyond the confines of pure 'enterprise liability', in order to also include entities that facilitated and/or took advantage of the activities assisted by the DLT in their own economic activity, such as the owners of nodes and qualified users. These can be various forms of blockchain participants, such as code developers (for blockchain-based protocols and smart contracts), miners, oracles, digital exchanges and wallets, information intermediaries, hardware manufacturers (in particular, for the IoT) and other commercial operators interacting with the blockchain system[306]. However, one should be careful before expanding the scope of liability too far, in view of the principle of personal responsibility for infringements of competition law[307] and the requirements of the European Convention on Human Rights ('ECHR'), notably the presumption of innocence[308].

[305] *Ibid*, 22.

[306] The various layers of blockchain technology that may be subject to regulation are discussed in De Filippi and Wright, (21), 184-187.

[307] This principle explains why some fault or negligence is usually required for holding an undertaking liable for infringing competition law. The case law of the EU courts also requires, in case the conduct to which the undertaking contributed is found to be an infringement of competition law results from some collective activity with other undertakings, that the 'undertaking in question was *aware* of the offending conduct of the other participants or that it could *reasonably have foreseen* it and that it was prepared to take the risk': Case T-410/09 Almanet v. Commission , ECLI:EU:T:2012:676, [153] (emphasis added). According to the General Court, what counts is the intention of the undertaking to "help bring about the infringement as a whole": *Ibid*. Although this case law concerns the concept of 'single overall agreement', in my view it shows the importance of the principle of personal responsibility in EU competition law.

[308] The jurisprudence of the EU Courts is constrained by the presumption of innocence, or the principle *in dubio pro reo* (literally: 'when in doubt, in favor of the accused'), enshrined in Article 6(2) of the European Convention of Human Rights and Article 48(1) of the Charter of Fundamental Rights of the European Union, which requires that "any doubt in the mind of the Court must operate to the advantage of the undertaking to which the decision finding an infringement was addressed", in particular for decisions imposing fines or periodic penalty payments: see, Case T-44/02 *Dresdner Bank AG and others v. Commission* [2006] II-3567, [60]-[61]; Case T-36/05, *Coats Holdings Ltd v. Commission*, [2007] ECR II-110, [69].

Deciding on how wide this liability net should extend depends on a first-principles analysis of the values of the specific enforcement system: corrective justice or economic efficiency and the least cost-avoidable principle. These first principles will influence the conceptualization of the causal link that would be required to ascribe liability to a specific entity, from the various groups listed above. One may expect the development of standards reflecting social values and concerns with regard to the allocation of risks and responsibilities, once the technology and governance structure of DLT becomes more widely understood by courts and policymakers. This may lead to different choices. A corrective justice perspective focusing on deterrence, will insist on the liability of any entity that may have contributed with its actions or omissions to the social harm. An efficiency perspective on the basis of the least cost avoidance principle will focus on the liability of the core group of developers in view of their crucial role in the design of the governance of the system[309]. Others may focus on engineering the right incentives for key blockchain participants, for instance by extending liability to miners or owners of the nodes, in view of their crucial role in the operation of the DLT.

The type of sanctions and remedies will also be a matter for further analysis. Individual sanctions may constitute the best otion, for instance imposing a fine to the core developers. However, there is no such possibility in EU competition law if these core developers cannot be qualified as undertakings. Similarly, in EU competition law, these sanctions can only be administrative; not criminal. Remedies may also raise different challenges. With regard to infringements of Articles 101 and 102 TFEU, they intervene *ex post* and, in these fast-moving technology sectors, they often come too late, although one may not exclude the possibility of prophylactic remedies in some circumstances. Behavioral remedies will require a continuous supervision by the competition authority of the operation of the blockchain, which, in view of the fact that it is public and transparent, may be more easily implemented than behavioral remedies imposed against centralized platforms, which have led to a quite cumbersome process because of the mistrust between the competition authority and the undertaking controlling the platform with regard to the accuracy of the information provided to the authority. Structural remedies may be more difficult to design in view of the lack of clear points of control on which the competition authority may act, for instance by ordering divestiture and other conventional structural remedies. It is more likely that the competition authorities will adopt a mechanism design approach taking into account the complex system of incentives in operation in blockchains to promote competition-compatible blockchain architectures.

Competition authorities may also choose to emphasize ‘compliance by design’, by clarifying in some guidance document(s) the specific duties of blockchain developers and other ‘fiduciaries’ when they design and operate DLT. This will not necessarily require competition authorities to adoption a system of auditing blockchain projects *ex ante* in order to assess the possible competition risks, which will be quite cumbersome and will eventually require a significant revamp of the capabilities of competition authorities, in terms of technical expertise

[309] According to the cost-avoidance principle, responsibility should be imposed on the person best placed to avoid the loss most cheaply.

and legal tools at their disposal. The 'competition by design'[310] agenda may be promoted through competition advocacy and a more active informal engagement of competition authorities with the blockchain community so to nudge them to the right direction.

Blockchain technology does not only set challenges to competition authorities. It also provides a lot of opportunities to assist them in their work. For instance, cartel enforcement may become more effective if DLT is used for the submission of leniency applications, but also in order to handle the sheer amount of evidence usually collected in a competition law case. Access to the file will also be more easily managed, thus, more effectively protecting the rights of defence. Competition authorities and courts may also have access to a data stream kept on blockchain with all the relevant transactions. This could be valuable information in order to provide evidence of a competition law infringement, but also in the context of actions for damages. The availability of this data will also facilitate the monitoring of markets by competition authorities and the early detection of cartels as well as other anticompetitive activity.

VII. Conclusion

The first industrial revolution offered interesting insights as to the interaction of technology with economic regulation, and more specifically the regulation of railways, the new GPT at that time. The 1844 Railways Act (the 'Parliamentary Trains' Act), which followed Gladstone's Committee of Inquiry into Railway Policy, was animated by the classical theory of economics with its fear of oligopolies, even at a time when Cournot's work on oligopoly was not known in the English-speaking world. Gladstone had cautioned, in his Committee report, on the discriminatory practices of railways monopolies that charged fares guaranteeing a substantial operating profit but which also undercut stagecoach fares. This incident built the foundations of subsequent work in the regulation of fares. The concepts of natural monopoly and market failure were later generalized in other economic sectors and built the broader rationale for State intervention in the form of regulation.

Travelling through time to the third industrial revolution and the development of platforms, regulation has been increasingly influenced by the paradigm of two-sided or multi-sided platforms that adds a new level of analysis than the 'market and by the emphasis put on 'disruptive innovation' rather than on just maintaining the competitive 'order'. The customers also become the 'raw material' in platforms' business models, their data monetized in product or financial markets. If customers single-home or multi-home becomes crucial for the competition analysis performed. The concentration of data in few digital hands, and the likely risks of exploitation of Internet users, raise important concerns not only for competition law, but more generally, in view of the centrality of the Internet in modern societies, for our broader constitutional, social and economic arrangements. However, we have witnessed the building in less than two decades of a relative solid, although still evolving, area of economic and legal 'expertise' relating to platforms with the aim to inform collective action regulating them.

[310] On this concept, see Simonetta Vezzoso, "Competition by Design", (2017) Presentation for 12th ASCOLA Conference, Stockholm University.

Blockchains are not similar to platforms. The most revolutionary aspect of blockchain technology is that it can run software in a secure and decentralized manner. With a blockchain, software applications no longer need to be deployed on a centralized server. They run instead on a peer-to-peer network that is not controlled by any single party. Furthermore, DLT applications can be used to coordinate the activities of a large number of individuals, who can organize themselves without the help of a third party. Ultimately, blockchain technology is a means for individuals to coordinate common activities, to interact directly with one another and to govern themselves in a more secure and decentralized manner. This change in the governance of the digital economy towards a more competitive and decentralized model, similar in some respects to that contemplated by the original Internet project, has so far constituted , the main appeal of blockchain for the general public, including competition lawyers and economists. The challenge of regulating a decentralized network and the global character of the blockchain also raise broader questions about the effectiveness of competition law enforcement in the DLT era.

As important as these concerns may be and how useful the static competition analysis offered by some studies may be from a practical perspective, this work has not yet provided a leap forward by promoting the effort to understand the full implications of blockchain competition for competition law and policy. This study has attempted to explore the quite complex dynamics of competitive advantage in blockchain competition in an effort to build the foundations of a conceptual framework for analyzing how DLT may affect existing constellations of power and may lead to new ones. This bottom-up re-conceptualization of the competition game in the DLT space, by drawing on the competitive strategies of economic actors, rather than on the formal theoretical frameworks of neoclassical price theory, is crucial if one is to fully grasp the different dimensions of economic power and its potential abuse that competition law should aim to tame and eventually curtail in the blockchain space.

The study also offers a broader conceptual mapping that may assist competition authorities to form an informed view of blockchain competition from a strategic and dynamic perspective, and, in particular, to reflect on new concepts, methods and tools that may be required for competition law analysis. Blockchain competition is an illustration of what some authors have called the ‘next-generation’ or ‘turbo-charged’ competition already in operation in the digital economy[311]. This is a complex economy with various spaces of competitive interaction (industries, platforms, value chains, ecosystems), the study of which requires a greater degree of sophistication in the analytical tools employed. The ambition of this study was to advocate for a more holistic view of the competitive process, as this is transformed by new GPT, such as DLT, and to share some broader insights and preliminary conclusions for competition law analysis in the digital economy.

[311] Teece, (177), 98.