Corporations on Blockchain: Opportunities & Challenges

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Blockchain technology has the potential to change the way corporations are managed and how they function. A system that offers greater decentralization and ability for shareholders to more actively and accurately engage in decision-making processes will be fundamental for modern corporate governance. We observe that shareholders in recent years have become more active and interested in the corporate matters of the companies that they invest in. Decades after Adolf Berle and Gardiner Means' elemental publication, the division between investment and control persists primarily because of the existing architecture of the corporate system. But the architecture is changing and blockchain technology represents a new component. Thanks to the technological development, shareholders could strengthen their voice and take part in long-term corporate decisions. Could technology be the answer to the long-lasting division between corporations and their investors as well as the division between investment shareholders and retail shareholders? If we organized a corporation, its information, and its decision-making mechanisms based on a new technology that promotes collaboration and can easily encompass incentive mechanisms, we might have a tool to provide more efficiency and transparency, and even potentially address the values (or a lack thereof) that govern our corporate system today. This Article provides an analysis on the opportunities and potential challenges of using blockchain technology for the purposes of corporate governance in publicly traded corporations. Beside the inquiry into the technology behind blockchain, the Article reflects on what value, if any, blockchain technology would have for shareholders and suggests how the technology could be used in publicly traded companies.

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Introduction

Blockchain is for the upcoming decade what Internet was for the 1990's. It is a technology that represents, in the simplest terms, a new infrastructure for communication, data storage, and management. It is a database which can operate without a central administrator. Many automatically associate blockchain with Bitcoin or other cryptocurrencies, yet the essential idea behind blockchain is much more intriguing. Blockchain is a database, a foundation, on which a platform, software, or application can operate. Blockchain is bringing a new opportunity to create new systems that will be able to function without a central administrator. This ultimately changes the dynamic in the cyber world and provides an opening for a new generation of decentralized solutions.

Blockchains are widely accessible and can facilitate economic and legal transactions. They are being tested to manage the operations of existing legal entities, serving as frameworks that can potentially develop into networks. Such networks might prove beneficial for diverse organizations across the world, be it an international corporation, lengthy supply chain, or a government. Blockchains aim to help diverse stakeholders come to an agreement even if they do not know each other and provide them with an infrastructure for flow of information, data, money, or anything that can be digitized. They can provide a space for decentralized communication platforms, file-sharing applications, social networks, and voting mechanisms in publicly traded companies.

This Article reflects on the possibility of corporations using blockchain technology, focusing on empowering the position of sharehold-

ers in publicly traded companies. The technology, its advantages, risks, and limitations are critically reviewed in order to understand how the technology works, but also whether the technology provides any additional value for shareholders and companies. Besides the efficiency rationale, one could argue that using blockchain could streamline voting and increase shareholder participation. Blockchain could eliminate plausible fraud by making votes immutable, verifiable, and traceable. The decentralized ledger of shareholders would also reduce the need to enlist proxy solicitation firms to track shareholders because the information would be easily accessible. Empty voting could also be minimized. Therefore, there are a number of theoretical benefits that blockchain could bring. However, not even a perfect, golden ledger of shareholders is likely to be a panacea for all the challenges encapsulated in modern corporations, the division between shareholders and Boards, and the conflict between long-term and short-term interests.

There are also additional risks that a novel and untested technology brings. Information might be sent to outdated addresses, the data might simply be wrong, and extremely sensitive documents can suddenly become exposed. Implementing the technology could also eliminate diverse intermediaries who are gatekeeping the system, and thus harm the functioning of the company or even the market. Moreover, shareholders could remain rationally apathetic, and large institutional investors could continue to cast votes according to a prearranged formula even more easily than before, thereby manipulating the voting process. Therefore, as with any other innovation, one should be excited, yet cautious and critical when reviewing its benefits. Hence, the ultimate aim of this Article is to understand the value of blockchain technology for modern, publicly traded companies, and their governance mechanism.

The structure of this Article is the following. In Part I, I explain how blockchain operates, define key terms, and describe constructions within a blockchain. This is because in order to assess the possibilities that blockchain brings for corporate governance, one must understand the construction of blockchain itself. Therefore, in the first section, I rely heavily on existing publications and attempt to clarify them for audiences consisting of lawyers and legal scholars. However, this Article does not aim to be a technological review of blockchain, rather it aims to reflect on how blockchain could be applied in the case of publicly traded companies with thousands, or hundreds of thousands, of shareholders who are scattered all over the world but are nevertheless required to make decisions together. Viewing technology as a tool that can be used to achieve certain goals, I reflect on blockchain's potential to reform voting in a publicly traded company as well as its possible effect on corporate governance therein. Next, in Part II of this paper, I deconstruct the elements of corporate governance that empower shareholders—starting with shareholder record-keeping, moving up to the purpose of general meetings, and closing with the use of proxy voting,—and assess the benefits and risks that blockchain technology would bring for shareholders. Lastly, in Part III of this Article, I offer

an outline of a corporate blockchain infrastructure, highlighting the position of some key partners, including governmental agencies, stock exchange platforms, corporations themselves, and shareholders. Given that I am not a professional blockchain developer, my outline is a simple, structural suggestion as I believe that the future solution for market organizations will combine, as blockchain does, numerous technologies while transforming the existing position of gatekeepers and shareholders.

In light of the above, there are, naturally, limitations to this Article as I do not believe that any technology provides the cure for corporate life or corporate governance. Technology is a tool that needs to be carefully designed in light of the objective we wish to achieve with it. Therefore, the primary goal of this Article is to review and reflect on whether blockchain, as a novel technology, could support greater shareholder democracy and long-term interests, and provide greater clarity and insight into waters that often remain too muddled.

I. Understanding Blockchain

Blockchain started with a public form—which is an open, distributed, decentralized, and global database (or a ledger)—maintained by a distributed network of computers.[1] It is **open** because anyone with Internet connection can join blockchain,[2] which means that anyone can retrieve information stored on a blockchain by simply downloading an open-source software. Anyone can also create a blockchain account (often referred to as a **wallet**),[3] comprised of a public address and a private key, or **password**, in order to engage in transactions with others without a centralized intermediary. Entering into the blockchain framework is similar to creating an email account, yet the logic behind the technology remains mysterious and incomprehensible for many. In a public blockchain, there is no authority that allows or denies access to the blockchain.[4] Being a **distributed** framework means that blockchain is composed of computers across the world, which are connected to each other on the network, directly or indirectly, and are linked together via an overarching **software protocol** without a central administrator.[5]

Decentralization means that there is no single party that controls all

1. The technological concept of blockchain was introduced by Stuart Haber and Scott Stornetta's paper, arguing for digital time-stamping of documents to authenticate authorship of intellectual property. *See* Stuart Haber & W. Scott Stornetta, *How to Time-Stamp a Digital Document*, 3 J. CRYPTOLOGY 99, 100 (1991).

2. *See* Roman Beck & Christoph Müller-Bloch, *Blockchain as Radical Innovation: A Framework for Engaging with Distributed Ledgers*, 2017 HAW. INT'L CONF. SYS. SCI. 5390, 5391 (2017).

3. Lucas Mearian, *What's a Crypto Wallet (and How Does It Manage Digital Currency)?*, COMPUTERWORLD (Apr. 17, 2019, 3:00 AM), https://www.computerworld.com/article/3389678/whats-a-crypto-wallet-and-does-it-manage-digital-currency.html [https://perma.cc/75CX-Y7CB].

4. *Cf.* Beck & Müller-Bloch, *supra* note 2, at 5391.

5. *Id.* at 5390.

these computers or the operations taking place between them.[6] These computers store copies of a blockchain and coordinate their activities and the content on the blockchain by using a software protocol that precisely dictates how network participants store information, engage in transactions, and execute software code.[7] In other words, there are rules that are governing the blockchain but no one can bypass them because all the other participants on the blockchain are the enforcers of these rules.

Database refers to a location for storing data that can be accessed at any point in time.[8] Besides being of a transactional nature, blockchain stores data in a unique manner, which allows new transactions to be stored, but limits the possibility of modifying past transactions.[9] However, the major problem with blockchain being used as a database is that it has a very limited and expensive storage capacity.[10] Large quantities of data cannot be stored easily, and therefore, blockchain is currently mostly used as a ledger. Blockchain is a database, which aside from the block structure, combines in its operations four technologies: (i) peer-to-peer networks (distributed technology); (ii) cryptography; (iii) consensus mechanism; and (iv) timestamps. In the following section, I will describe the architecture of blockchain and explain the activities that take place on it.

Blockchain looks extremely complicated and technical, but like the Internet, it is sociotechnical in nature. Humans are essential for its architecture, operations, and oversight. Thus, people are critical to blockchain technology in a variety of contractor and curator roles.

A. Structure of Blockchain

Blockchain is a database shared across a network of computers spanning the world without a centralized party.[11] Hence, the first thing to realize is that it encompasses an unlimited number of computers across the world, where each computer is connected to all the other computers. Each computer on the network is known as a **node**.[12]

6. *Id.* at 5391.

7. *What are Nodes?*, BINANCE ACAD., https://academy.binance.com/blockchain/what-are-nodes [https://perma.cc/XXK4-R7QB] (last visited July 19, 2020).

8. Sometimes we refer to blockchain as a ledger. "Ledger" is an accounting term, which originally meant a book of financial accounts of a particular type. Now, it represents data storage. *See* Beck & Müller-Bloch, *supra* note 2, at 5391.

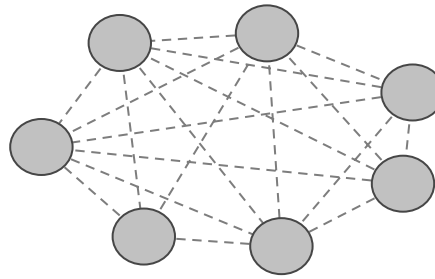
9. *Id.*

10. *Storage Needs for Blockchain Technology*, IBM 1, 7–9 (2018), https://www.ibm.com/downloads/cas/LA8XBQGR [https://perma.cc/X322-F8FD].

11. *See* Beck & Müller-Bloch, *supra* note 2, at 5391.

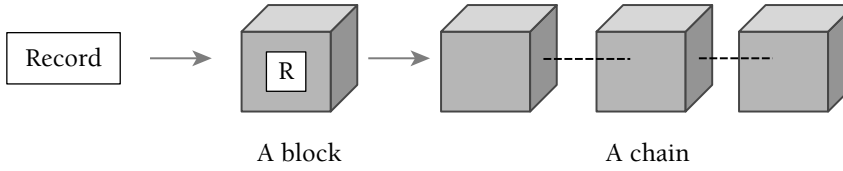
12. *Id.*

Figure 1: Blockchain network: nodes & connections



Each computer has the same copy of the database and there are computers that check that the database remains identical.[13] Everyone can have his or her copy of the database and trust that all those copies remain the same, even without a central administrator. The database consists of three key components: (i) the record, (ii) the block, and (iii) the chain.[14] The **record** can be information, data, contract, money, or almost anything else.[15] The **block** is a bundle of records that is later linked to other blocks thereby creating a **chain**, as shown in the following figure.[16]

Figure 2: Elements of the chain

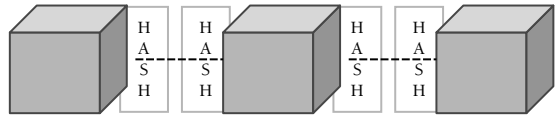


Once a record with a transaction is created, it is checked by the nodes. These nodes check the details of the transaction to make sure it is valid.[17] Nodes in a blockchain are in constant communication with each other in order to remain synchronized.[18] Depending on the type of blockchain, and the content of the transaction, the nodes will carry out different operations. Once the record is checked, the network accepts it and adds it to a block.[19] Each block contains its own unique fingerprint, or **hash**, as well as the hash of the previous block in the chain,[20] and a **timestamp**.[21] Once

13. *See* Fritz Henglein, *Smart Digital Contracts: Introduction*, Univ. Copenhagen 1, 7 (2019), https://www.cs.uoregon.edu/research/summerschool/summer19/lectures/henglein1.pdf [https://perma.cc/QU8C-5USM].
14. Maryanne Murray, *Blockchain Explained*, Reuters Graphics (June 15, 2008), http://graphics.reuters.com/TECHNOLOGY-BLOCKCHAIN/010070P11GN/index.html [https://perma.cc/SC37-8R2V].
15. *Id.*
16. *Id.*
17. *Id.*
18. *See* Volkan Dedeoglu et al., *Blockchain Technologies for IoT*, *in* Advanced Applications of Blockchain Technology 62–64 (Shiho Kim & Ganesh Chandra Deka eds., Springer 2020).
19. *See* Murray, *supra* note 14.
20. *Id.*

a block is created and checked by the network, it is added to the chain.[22] The timestamp cannot be tampered with after being added thereby solving problems of data tracking and information security.[23]

Figure 3: Creating a chain



A hash is generated by using standard, cryptographic hashing functions invented by the U.S. National Institute of Standards and Technology (NIST) and the U.S. National Security Agency (NSA).[24] The hash takes the digital information from the block and generates a unique string of letters and numbers from that information, which is then uniquely associated with that block's transaction.[25] The challenge for a hashing algorithm is to make the hash almost impossible to decipher. One way in which it accomplishes this is by taking an input string of any length and releasing an output string of a fixed length, as seen in the following example.

Input	**Hash**
Alexandra Andhov	8kjfps78
Corporate governance	5sssaw9s
Shareholder democracy	her695as

The output string is always of the same length, which makes it difficult to decode the type of information represented by the hash.[26]

Generating a hash for any given block is difficult. The hash is created by using a mathematical guessing game called a **proof of work**.[27] Nodes must engage in **work** by solving a computational puzzle.[28] The computational puzzle is merely a game of trial and error, which is also called **mining**, and it uses a lot of computing power (as well as electricity).[29] The

21. *See* Priyanka Rathee, *Introduction to Blockchain and IoT*, *in* Advanced Applications of Blockchain Technology 3–6 (Shiho Kim & Ganesh Chandra Deka eds., Springer 2020).

22. *See* Murray, *supra* note 14.

23. *See* Haber & Stornetta, *supra* note 1.

24. Jeremy L. Rasmussen, *Password Authentication*, *in* 3 Handbook of Information Security: Threats, Vulnerabilities, Prevention, Detection, and Management 424, 427 (Hossein Bidgoli ed., 2006).

25. *See* Murray, *supra* note 14.

26. Arvind Narayanan et al., Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction 23 (Princeton Univ. Press 2016).

27. For more about proof of work, see *id.* at 60–70; Aljosha Judmayer et al., *Blocks and Chains: Introduction to Bitcoin, Cryptocurrencies, and Their Consensus Mechanism*, *in* Synthesis Lectures on Information Security, Privacy, & Trust 30–37 (Elisa Bertino & Ravi Sandhu eds., Morgan & Claypool Publishers 2017).

28. *See generally* Judmayer et al., *supra* note 27.

29. *Id.* at 37. In 2015, it was estimated that one Bitcoin transaction required the amount of electricity needed to power up 1.57 American households per day. Christo-

computers that are involved in mining are by themselves trying to solve the mathematical guessing game. The first computer to succeed creates the hash and can be rewarded for its work.[30] The more nodes on the network that are attempting to solve the puzzle, the harder it becomes to generate a valid hash.[31] In return for the mining, members can receive some form of reward.[32] In the case of a Bitcoin blockchain, the reward is Bitcoin tokens. An alternative of mining, offered by some cryptocurrencies through which a hash can be generated, is **proof of stake**.[33] Proof of stake allows a person to mine or validate block transactions according to how many coins he or she holds.[34] This concept allows those with more coins to have more mining power.[35]

Once a node finds a valid hash for a block, the node broadcasts the solution to the rest of the network. Upon receiving the broadcast, other nodes in the network run a simple calculation to make sure that the resulting hash meets the **protocol** requirement. This process is known as **consensus**.[36] The protocol states that if the calculations show that the hash is valid, then the block can be added to the blockchain. Subsequently, a new blockchain is generated across the network and stored on the nodes. This process, introduced by Satoshi Nakamoto,[37] aimed to preserve the security and integrity of the information on the blockchain.

The consensus mechanism makes it difficult and costly for any party to unilaterally remove or modify the data stored on a blockchain. It also helps a blockchain-based network periodically reach agreement as to the current state of the shared database, even if members do not know each other or trust one another. Primavera De Filippi and Aaron Wright compare the Bitcoin blockchain to a tamper-resistant "'book' with identical copies stored on" millions of computers across the world.[38] Anyone can add new content to the book, and once new content has been added, all existing copies of the book are updated on computers running the Bitcoin protocol across the world.[39] Unlike a book, however, blockchains are not organized by pages, but by **blocks**.[40] These blocks are linked together by an underlying protocol based on "a sequential, timestamped **chain**," and "each block

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pher Malmo, *Bitcoin is Unstable*, VICE (June 29, 2015, 12:23 PM), https://www.vice.com/en_us/article/ae3p7e/bitcoin-is-unsustainable [https://perma.cc/E82Q-78KX].

30. *See* Judmayer et al., *supra* note 27, at 20.

31. *Cf.* Joseph Bonneau et al., *SoK: Research Perspectives and Challenges for Bitcoin and Cryptocurrencies*, IEEE SECURITY & PRIVACY, May 2015, at 104, 106–07.

32. *See* Judmayer et al., *supra* note 27, at 20.

33. *Id.* at 88.

34. *Id.*

35. *Id.* The first cryptocurrency that adopted proof-of-stake mining was Peercoin. *Pioneer of Proofstake*, PEERCOIN, http://www.peercoin.net [https://perma.cc/9TD3-F3BT] (last visited Feb. 25, 2020).

36. *See* Judmayer et al., *supra* note 27, at 19–20.

37. *Cf. id.* at 19.

38. PRIMAVERA DE FILIPPI & AARON WRIGHT, BLOCKCHAIN AND THE LAW: THE RULE OF CODE 22 (Harvard Univ. Press 2018).

39. *Id.*

40. *Id.*

also contains a **header** used to organize the shared database" and keep order among the blocks on the chain.[41] The main component of the block's header being the unique hash, which binds together "all transactions contained in that block, along with a timestamp and . . . the hash of the previous block."[42]

B. Blockchain v. Bitcoin

Blockchain was first used in Bitcoin.[43] Bitcoin was introduced in late 2008, when one or more anonymous developers named Satoshi Nakamoto published a nine-page paper titled *A Peer to Peer Electronic Cash System*.[44] Bitcoin represented a decentralized digital currency which operated without any intermediaries or centralized financial institutions. Since its launch in 2009, Bitcoin has become one of the largest decentralized payment systems.[45]

It may appear that Bitcoin and blockchain are used interchangeably. For example, when explaining blockchain, there are often many references to Bitcoin because Bitcoin was released as the first application using blockchain. Hence, blockchain is the technology that underlies the Bitcoin cryptocurrency. Nevertheless, blockchain technology continues to develop and expand its possible applications beyond cryptocurrencies. Blockchain has become a network of numerous peer-to-peer transactions and operations, including voting, real estate registry, and even stock exchange infrastructure.[46]

C. From Bitcoin to Ethereum

Blockchain, as a database, is equipped to store or reference diverse forms of information, and support a framework where other decentralized applications can operate, including small programs called **smart contracts.**[47] The first blockchain to enable the creation of smart contracts was

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41. *Id.*

42. *Id.*

43. *See* Judmayer et al., *supra* note 27, at 19.

44. *See generally* SATOSHI NAKAMOTO, BITCOIN: A PEER-TO-PEER ELECTRONIC CASH SYSTEM (2008).

45. *E.g.*, Judmayer et al., *supra* note 27, at 18.

46. See generally about the application of Blockchain, MOHSEN ATTARAN & ANGAPPA GUNASEKARAN, APPLICATIONS OF BLOCKCHAIN TECHNOLOGY IN BUSINESS: CHALLENGES AND OPPORTUNITIES (Springer 2019); BUSINESS TRANSFORMATION THROUGH BLOCKCHAIN (Horst Treiblmaier & Roman Beck eds., Springer 2019); Marc Pilkington, *Blockchain Technology: Principles and Applications*, *in* RESEARCH HANDBOOK ON DIGITAL TRANSFORMATIONS 225 (F. Xavier Olleros & Majlinda Zhegu eds., Edward Elgar Publ'g 2016); Alexandra Andhov, *Relevance of Blockchain for Corporate Lawyers,* 2020 ERHVERVSJURIDISK TIDSSKRIFT (Den.) 29 (2020). *See also Banking is Only the Beginning: 58 Big Industries Blockchain Could Transform*, CBINSIGHTS (Apr. 2, 2020), https://www.cbinsights.com/research/industries-disrupted-blockchain/ [https://perma.cc/XG8A-PFZG].

47. *See* Alyssa Hertig, *What is Ethereum?*, COINDESK (Mar. 31, 2017, 2:49 PM), https://www.coindesk.com/learn/ethereum-101/what-is-a-decentralized-application-dapp [https://perma.cc/8MTH-E7N5].

Ethereum, which added extra functionality to the blockchain system.[48] "Ethereum is designed to be a general-purpose, programmable blockchain," which itself is able to "execute code of arbitrary and unbounded complexity."[49] Ethereum lets "developers [ ] build powerful decentralized applications with built-in economic functions."[50]

Ethereum is considered the second generation of blockchain, which stipulates that it is Turing complete[51] and does not only track currency ownership as blockchain, but is also able to track general-purpose data.[52] It continues to operate as a peer-to-peer network governed by an open-source protocol, while being based on consensus rules. Ethereum uses a similar proof of work mechanism to update the state of the blockchain, and miners are provided with **Ethers**—a digital currency similar to Bitcoin.[53] Ethereum combines the "general-purpose computing architecture . . . with a decentralized blockchain, thereby creating a distributed single-state [ ] world computer."[54]

Ethereum introduced a new part in the protocol—the Ethereum Virtual Machine (EVM)[55]—which runs all the smart contract programs and makes Ethereum the single, decentralized computer that it is.[56] These smart contracts are capable of processing basic IFTTT logic[57] and can verify signatures, record votes, and implement new blockchain-based governance systems.[58] Every operation processed by the EVM is executed by every active node on the Ethereum network, for which the Ethereum protocol charges a small fee known as **gas**.[59] Gas refers to the value required to

48. *Id.* Ethereum was developed by Vitalik Buterin, a young programmer and Bitcoin enthusiast, who aimed to further the functionality of blockchain. In December 2013, Vitalik proposed a more generalized approach to blockchain and published a white paper that outlined the idea behind Ethereum: a Turing complete, general-purpose blockchain. *See generally* VITALIK BUTERIN, ETHEREUM WHITE PAPER: A NEXT GENERATION SMART CONTRACT AND DECENTRALIZED APPLICATION PLATFORM (2013).

49. ANDREAS M. ANTONOPOULOS & GAVIN WOOD, MASTERING ETHEREUM: BUILDING SMART CONTRACTS AND DAPPS 2 (O'Reilly Media 2018).

50. *Id.* at 1.

51. The term "Turing complete" refers to English mathematician Alan Turing, who is considered the father of computer science. Turing complete, in computability theory, describes abstract machines usually called automata. Referring to Ethereum as Turing complete means that Ethereum is able to execute a stored program through its Ethereum Virtual Machine, while reading and writing data to memory. *Id.* at 8.

52. *Id.* at 6.

53. *Id.* at 1.

54. *Id.* at 8.

55. *Id.* at 7.

56. *See* Hertig, *supra* note 47.

57. IFTTT logic means "If-This-Then-That".

58. *Cf. Ethereum White Paper Made Simple: A Guide to Understanding the Ethereum White Paper for People Without an Advanced Degree in Computer Geekery*, BLOCKCHAIN REV. 21, 24, 26, https://cryptoverze.com/wp-content/uploads/2018/11/02.01._final_Ethereum-White-Paper-Made-Simple.pdf [https://perma.cc/FK63-Y27S] [hereinafter *Ethereum White Paper Made Simple*].

59. DE FILIPPI & WRIGHT, *supra* note 38, at 29. To better explain gas, one needs to realize that Ethereum itself entails a number of smart contracts which are to be executed by a computer. This means that when a smart contract runs, it consumes someone's computing power. That computing power is translated on Ethereum to gas, which is

successfully conduct a transaction or execute a smart contract. In simple terms, "gas is a unit that measures the amount of computational effort that it will take to execute certain operations,"[60] which an active node will be paid for in Ethers.[61]

Even though Ethereum blockchain is updated every ten to twelve seconds, as opposed to every ten minutes like Bitcoin,[62] running a code via EVM continues to be a slow and expensive process. But despite its shortcomings, Ethereum shows that blockchain can be used in diverse forms and that a new paradigm of computing, without a central authority, can be successful. Since the launch of Ethereum, there are currently more than 93 million accounts on Ethereum,[63] which is substantially higher than how many blockchain wallet users there were by the end of 2019—about 47 million.[64]

D. Incentives on Blockchain: Cryptoeconomics

Blockchain is a decentralized, global database using a peer-to-peer mechanism, which does not need a central administrator, but that does not mean that blockchain is free. Rather, it means that blockchain is based on **different incentive models** that encourage miners to engage in transactions and run smart contracts using the computational power of their computers. As a substitute for a centralized or quasi-centralized trust, public blockchains, be it Bitcoin or Ethereum, are secured by **cryptoeconomics**—a combination of economic incentives and cryptographic verification mechanisms such as the proof of work method explained above.[65] Blockchains have incorporated into their protocols block rewards, transaction fees, and other payoff structures in order to compensate the miners for their computational power, and thus maintain a blockchain-based network.[66] This

later paid to the person who provided the computational power. Every command in a smart contract has a price measured in terms of gas. Some commands are more expensive, some less, but they are not free. *See Ethereum White Paper Made Simple*, *supra* note 58, at 17–22.

60. Ameer Rosic, *What is Ethereum Gas? [The Most Comprehensive Step-By-Step Guide Ever!]*, BLOCKGEEKS (2018), https://blockgeeks.com/guides/ethereum-gas-step-by-step-guide/ [https://perma.cc/V5Y3-V8U6]. For more explanation on gas, see Gavin Wood, *Ethereum: A Secure Decentralised Generalised Transaction Ledger*, BYZANTIUM VERSION 5, 7 (2019), https://ethereum.github.io/yellowpaper/paper.pdf [https://perma.cc/N449-MVVS]

61. *E.g.*, Rosic, *supra* note 60.

62. Vitalik Buterin, *Toward a 12-Second Block Time*, ETHEREUM BLOG (July 11, 2014), https://blog.ethereum.org/2014/07/11/toward-a-12-second-block-time/ [https://perma.cc/94TR-9EWG].

63. A year ago, on March 29, there were only 58 million reported accounts on Ethereum. ETHERSCAN, https://etherscan.io/chart/address [https://perma.cc/6QML-R58A] (last visited Apr. 6, 2020).

64. M. Szmigiera, *Number of Blockchain Wallet Users Globally 2016-2020*, STATISTA (May 19, 2020), https://www.statista.com/statistics/647374/worldwide-blockchain-wallet-users/ [https://perma.cc/R2UW-RLVE].

65. Ameer Rosic, *What is Cryptoeconomics? The Ultimate Beginners Guide*, BLOCKGEEKS (2017), https://blockgeeks.com/guides/what-is-cryptoeconomics/ [https://perma.cc/MJ9E-QNJZ].

66. *E.g.*, DE FILIPPI & WRIGHT, *supra* note 38, at 25–26.

incentive mechanism could be incorporated in any blockchain.

Bitcoin and Ethereum have created "built-in incentive mechanisms" to encourage miners to get involved in the proof of work consensus.[67] "Members . . . receive compensation for storing data" and those who "voluntarily agree to store small portions of files (called chunks or shards), which are reassembled on demand by these decentralized file-sharing protocols" are provided with even greater compensation.[68] Hence, there are numerous activities for which those operating or supporting blockchains may be rewarded. The gas system on Ethereum also represents an incentive mechanism.

Any peer-to-peer system which operates based on proof of work is dependent on the work of its miners. The more miners there are in the system, who can provide hash and security for the system, the faster the system. In order to attract more miners into the system, and make the system profitable, Ethereum provides two ways that miners can make money: either by mining the blocks, or by becoming temporary dictators of their mined blocks. The first way—mining the blocks—works the same as for Bitcoin, where the miners are rewarded for each hash they create, and a miner must dedicate processing power to verify the transactions and carry out the mathematical puzzle associated with each block.[69] The second way for generating a reward is connected to the smart contracts on Ethereum, where a miner becomes responsible for putting transactions inside their block—meaning that they need to use their computational power to validate smart contracts on that block.[70] The gas system allows them to charge a certain fee. In the gas system, a person who needs to pay for the transaction pays for the gas, that gas is later converted into Ethers for miners.[71] These reward methods are not problematic in and of themselves, but they raise questions about the level of decentralization and security of blockchains. Therefore, before an incentive mechanism is coded into a blockchain architecture, it should be carefully thought-through.

Nakamoto, foreseeing the popularity of the reward system where the miners use just the computational power of their computers, ensured that Bitcoin (and Ethereum as well) would increase the difficulty of the mathematical puzzle that yields hash, and the difficulty of adding blocks to the blockchain, as the network grew.[72] This means that the more miners there

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67. *Id.* at 30.

68. *Id. See also* VIKTOR TRÓN ET. AL, SWAP, SWEAR, SWINDLE: INCENTIVE SYSTEM FOR SWARM 10–11 (2016).

69. *See* Ioannis Lianos, *Blockchain Competition: Gaining Competitive Advantage in the Digital Economy– Competition Law Implications*, *in* REGULATING BLOCKCHAIN: TECHNO-SOCIAL AND LEGAL CHALLENGES 329, 337–39 (Phillip Hacker et al. eds., Oxford Univ. Press 2019). *See generally* BIKRAMADITYA SINGHAL ET AL., BEGINNING BLOCKCHAIN: A BEGINNER'S GUIDE TO BUILDING BLOCKCHAIN SOLUTIONS (Apress 2018).

70. *E.g.*, DE FILIPPI & WRIGHT, *supra* note 38, at 4.

71. *Id.* at 28–29.

72. *See* Juan Garay et al., *The Bitcoin Backbone Protocol with Chains of Variable Difficulty*, *in* 1 ADVANCES IN CRYPTOLOGY–CRYPTO 2017 291, 292–93 (Jonathan Katz & Hovav Shacham eds., Springer 2017); Jimi S., *Blockchain: The Mystery of Mining Difficulty and Block Time*, GOODAUDIENCE (Sept. 24, 2018), https://blog.goodaudience.com/

are, the more challenging the puzzle becomes and the more computational power the miner needs to commit to solving the puzzle. As a result, miners started to organize themselves into **mining pools**, combining their computational resources and thereby increasing the probability that they would earn a reward.[73] Once the pool earns a reward, it divides it among the members of the pool.[74] Here lies the problem: the bigger the pool, the bigger its computational power, and possibly, its control over the blockchain. On January 2019, Ethereum was *de facto* controlled by two mining pools that collectively controlled more than 50% hashrate (the ability to create hash).[75] This reality makes it justifiable to question the level of decentralization, or rather centralization, on a public blockchain and its autonomy, which for many users is essential. A second part of the pool phenomenon is that the bigger and more powerful the pool becomes, fewer new miners will be interested in participating, as their chance of gaining any reward becomes minimal, or, in case they join a pool, such reward will be divided among many more miners rendering it less profitable. Naturally, the concentration of hashrate represents a concern of overall control on a blockchain. The pools can jointly decide to create a block or not to create a block, but the ability to trace those who have decided so may be limited, and so is the enforcement mechanism for anyone who has suffered loss due to such decision.

A further concern with the existing incentive mechanism is the **growing cost**. Initially, the fees remained relatively low, costing users only a couple of cents to store information, engage in transactions, or execute a smart contract.[76] However, as the blockchains grow and the number of transactions—which require more computational power from miners—increases, the costs grow. Based on the economics of supply and demand, logic dictates that when these transaction fees increase, the use of these blockchains ultimately becomes less attractive.

These issues are solvable and might be addressed differently in different blockchains.[77] Nonetheless, they represent a concern from the incen-

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blockchain-the-mystery-of-mining-difficulty-and-block-time-f07f0ee64fd0 [https://perma.cc/G8DS-YRV6].

73. Judmayer, *supra* note 27, at 38.

74. *Id.*

75. *See* Layla Harding, *Ethereum is Centralized: 2 Mining Pools Control More Than 50%* Hashrate, COINNOUNCE (Jan. 7, 2019), https://coinnounce.com/ethereum-is-centralized-2-mining-pools-control-more-than-50-hashrate/ [https://perma.cc/7J4B-F4ZA]. There are several larger mining pools: "Ethermine controls around 28% of the total network hash rate while SparkPool controls more than 24% of the total hash rate." The third biggest pool is NanoPool with 13.54% total hash rate. *Id.*

76. *See* PEDRO FRANCO, UNDERSTANDING BITCOIN: CRYPTOGRAPHY, ENGINEERING AND ECONOMICS 154–55 (Wiley 2015).

77. Ethereum aimed to move from proof of work concept to proof of stake. In proof of stake, miners do not commit with computational power, but with their money, which renders the system much more energy efficient. The proof of stake works by way of miners storing their Ethers in a wallet through the process of mining. If a miner does not follow consensus rules and acts maliciously in any way, they risk losing all their stored Ethers. Ethereum planned to introduce the proof of stake algorithm for consensus more than two years ago, but still has not adopted it. The more recent expectations are to

tive perspective and that of creating a secure, autonomous, and decentralized infrastructure.

E. Limitations of Blockchain

Opening an account on a blockchain can be as easy as opening an email account. Blockchain offers an open and interoperable protocol that provides access for users to open their pseudonymous accounts, which are secured by public and private key cryptography (a password).[78] However, as described above, the system has its challenges—which are further discussed in this section.

1. Speed

One of the main weaknesses of blockchain has been its speed. Bitcoin blockchain has extremely slow updates, which take place every ten minutes.[79] Therefore, subsequent blockchain-based projects, including Ethereum, were launched with the hope of solving this limitation. Ethereum blockchain has solved the issue of speed, as it is updated roughly every twelve seconds.[80] For some, this might still seem like a long time. Nevertheless, Ethereum proves that the issue of speed can be resolved.

2. Power & Scalability

In addition to the issue of speed, existing blockchains are not as powerful as other data management technologies.[81] The blockchain networks handle comparatively few transactions. For instance, the "Ethereum blockchain processes roughly 500,000 transactions per day,"[82] which is a fraction of the trillions of activities carried out on the Internet each day, or the 150 million daily transactions (averaging at more than 24,000 transactions per second) handled by credit card companies such as Visa.[83] Therefore, for blockchain to become a widely-adopted technology, it would have to be able to handle a similar number of transactions; but solving this scalability issue is not an easy task.[84]

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adopt the PoS sometime in 2020 or 2021. *See* Daniel Won, *Ethereum Proof of Stake Date: Date + What You Need to Know,* EXODUS (Feb. 21, 2020), https://www.exodus.io/blog/ethereum-proof-of-stake-date/ [https://perma.cc/65G6-JXU6].

78. *See* Pilkington, *supra* note 46, at 226; DE FILIPPI & WRIGHT, *supra* note 38, at 14–15.

79. *See* Buterin, *supra* note 62.

80. *Id.*

81. *Cf.* DE FILIPPI & WRIGHT, *supra* note 38, at 56.

82. *Introduction to Ethereum Scaling*, DISTRICT0X EDUC. PORTAL, https://education.district0x.io/general-topics/ethereum-scaling/introduction-to-ethereum-scaling/ [https://perma.cc/GMR7-6VMY]. The amount of transactions fluctuates. *See Ethereum Transactions Historical Chart*, BITINFOCHARTS, https://bitinfocharts.com/comparison/ethereum-transactions.html [https://perma.cc/94C9-JXGJ] (last visited May 26, 2020).

83. *Power Your Retail Business Beyond the Point of Sale*, VISA, https://usa.visa.com/run-your-business/small-business-tools/retail.html [https://perma.cc/K4WK-CH6Y] (last visited May 26, 2020).

84. DE FILIPPI & WRIGHT, *supra* note 38, at 56.

3. Costs

Developing blockchain technology is far from simple or cheap. Based on my understanding, developing a new blockchain corporate solution includes, at the minimum, the following parts: (i) infrastructure, (ii) storage space, (iii) network speed, (iv) P2P network, (v) encryption, (vi) smart contracts, and (vii) user-friendly front-end.[85] There are currently different companies that offer developing corporate (private) blockchain solutions, which cost anywhere from $500,000 to tens of millions of dollars.[86]

4. Hacking

Anyone willing to modify even a single record in the blockchain would have to go through the computationally expensive task of generating new hashes for every subsequent block in the blockchain. The more transactions that occur on the network—and the more blocks appended to the blockchain—the harder it becomes to retroactively modify previously recorded transactions. Nevertheless, if mining pools are able to acquire substantial computational power, there is a possibility that they may change the blockchain. However, because the blockchain operates via consensus, a possible attacker or group of attackers would need to rewrite the transaction history of the blockchain at a pace that is faster than the majority of honest nodes supporting the network. This means that the attackers would have to have 51% of the computational power of the entire blockchain.[87] Given the growth of the network, orchestrating such an attack today could cost hundreds of millions of dollars, if not billions,—an operation that would presumably be far more costly than its potential outcome.[88] Additional cybersecurity vulnerabilities include wallet security, private forks, double spending, network-level attacks, and many others.[89]

85. *See generally id.*

86. Established tech companies that have developed corporate blockchain solutions include IBM and Accenture, and many start-ups, such as Insolar or Alchemy, have followed suit. *See, e.g.*, IBM, https://www.ibm.com/dk-en/blockchain/solutions [https://perma.cc/7G6S-REJ8] (last visited July 19, 2020).

87. ANDREW KIM ET AL., THE STATELESS CURRENCY AND THE STATE: AN EXAMINATION OF THE FEASIBILITY OF A STATE ATTACK ON BITCOIN 11–14 (2014). The 51% attack (or Goldfinger) was first used to attack Bitcoin but can be used also on other blockchain systems. When reliable nodes control at least 51% of the network mining power, a blockchain system can then be considered protected. Otherwise an attacker might not only be able to make changes to the blockchain, but also prevent transactions from being added to the leading chain or obstruct the confirmation of new transactions on the network, thus, in the case of Bitcoin, preventing some or all nodes from receiving funds. *Id.* at 7, 11–12.

88. *Id.* at 13, 17–19. *See also* Huru Hasanova et al., *A Survey on Blockchain Cybersecurity Vulnerabilities and Possible Countermeasures*, 29 INT'L J. NETWORK MGMT. 219 (2019) ("In July 2014, the mining pool ghash.io briefly exceeded 50% of the Bitcoin network's processing power. . . . In August 2016, . . . Ethereum, Krypton, and Shift suffered 51% attacks. An attempt was made to overwhelm the network with at least 51% of the hashing power in order to roll back the transactions and spend the same coins again. A severe case occurs when the attacker has more than 67% of the stake by which the attacker can freely block any transactions and wish to block and reject to form any blocks of the transactions.").

89. For an overview of possible cybersecurity issues, see Hasanova et al., *supra* note 88, at 219.

Ultimately, there continue to be cybersecurity challenges and the potential for fraudulent and criminal activities throughout blockchain, whether it is a Bitcoin blockchain or any other. For that reason, it is important to realize that blockchains are still immature. If blockchains improve in terms of speed, functionality, security, and accessibility, the technology may, over the upcoming years, instruct organizations and corporations on how to become more transparent and accessible, providing more information and decision-making ability to shareholders. Developers, stakeholders, and governments still have the possibility to shape emerging social and regulatory norms relating to this technology. Policy objectives shall be directed to the future of blockchain and how we imagine it should be applied in our corporations, governments, and lives. Similar to the Internet, blockchain will grow while simultaneously encoding laws, regulations, and possibly values into its network, protocols, and associated smart contracts. As any other technology, blockchain will continue to be designed by humans.

II. Technology for Technology, or is There Purpose and Value?

Before initiating an analysis on the possible structure and risks of blockchain for publicly traded companies, I would like to address the added value of using technology for the purposes of achieving transparent and fair corporate governance and enhancing the position of shareholders. Looking around, we see more and more technology in our lives, in our communication, in our education, our daily activities, everywhere. On an organizational level, there is a belief that technology helps organizations remain competitive, agile, and effective. Yet, can we truly prove such statement? Companies are applying diverse methods to measure the value of technology. With increased technology spending, companies are looking for greater transparency and clearer governance practice. Implementing a formal measurement framework means creating a consistent way of evaluating current and future technologies in terms of how they affect businesses.[90] However, how could we evaluate technology in terms of how they affect voting and participation of shareholders, not only from the quantifiable perspective, but also from the perspective of shareholders' engagement, shareholder democracy, voting transparency, or security? Could we also link the use of blockchain to shareholder voting in order to evaluate the quality of corporate communication or management's communication with shareholders? Going a step further, could we use this technology to assess the quality of the decision-making processes based on greater shareholder participation? Could this technology increase the ability of shareholders to raise questions and change corporate policies? There

90. *See generally, e.g.*, John G. Mooney et al., *A Process Oriented Framework for Assessing the Business Value of Information Technology*, 27 ACM SIGMIS DATABASE: DATABASE FOR ADVANCES INFO. SYS. 68 (1996); James W. Tipping et al., *Assessing the Value of Your Technology*, 38 RES.-TECH. MGMT. 22 (1995).

are metrics that could be employed to address some of these issues;[91] but ultimately, we should ask whether blockchain furthers the policy goals of corporate governance—such as limitation of information asymmetry and enhanced transparency into decision-making—and whether blockchain ultimately leads to greater shareholder involvement.[92]

In 1932, Adolf Berle and Gardiner Means, in their seminal work *The Modern Corporation and Private Property*, concluded that the "usual stockholder has little power over the affairs of the enterprise and his vote, if he has one, is rarely capable of being used as an instrument of democratic control."[93] In contemporary scholarship, Professor Lucian A. Bebchuk described shareholder power as a myth.[94] In his empirical study on corporate voting, he stated that "[s]hareholders commonly do not have a viable power to replace the directors of public companies."[95] In 2017, the United States' (U.S.) corporate retail investors comprised just 30% of the world's share ownership in comparison to the 90% they comprised at the time Berle and Means wrote their book.[96] This goes even further, as the institutional investors voted on 90% of their shares, while retail investors only voted on 29% of their shares,[97] which renders their voice somewhere around 10% in all. Yet, voting is the cornerstone of corporate governance, accountability, and legitimacy.[98] Public corporations and their directors owe fiduciary duties to their shareholders—not only to the institutional shareholders, but also the retail shareholders. Therefore, we should con-

91. As an example, there is a balanced scorecard, which is one of the formal measurement frameworks, that relies upon a set of metrics and maps operating-unit performance of corporate objectives. Different metrics can be weighted differently, depending on the priorities of the organization.

92. Existing literature offers different accounts about the direction of corporate governance and its policy goals. Ronald Gilson ascribes the transformation of U.S. corporate governance to changes in the operation of capital markets. *See* Ronald J. Gilson, *Catalysing Corporate Governance: The Evolution of the United States System in the 1980s and 1990s*, 24 COMPANY & SEC. L.J. 143, 149–50 (2006). Jeffrey Gordon attributes the rise of independent directors in the U.S. to greater information on stock market prices. *See* Jeffrey N. Gordon, *The Rise of Independent Directors in the United States, 1950–2005: Of Shareholder Value and Stock Market Prices*, 59 STAN L. REV. 1465, 1469 (2007). Others attribute the change to the enhanced importance of greater shareholder involvement. *See, e.g.*, Brian R. Cheffins, *The History of Corporate Governance*, *in* THE OXFORD HANDBOOK OF CORPORATE GOVERNANCE 46, 52 (Douglas Michael Wright et al. eds., Oxford Univ. Press 2013).

93. ADOLF A. BERLE & GARDINER C. MEANS, THE MODERN CORPORATION AND PRIVATE PROPERTY 83 (Routledge 3d ed. 2017) (1932).

94. Lucian A. Bebchuk, *Essay: The Myth of the Shareholder Franchise*, 93 VA. L. REV. 675, 732 (2007).

95. *Id.*

96. *2017 Proxy Season Review*, BROADRIDGE 1, 2 (Sep. 2017), https://www.broadridge.com/_assets/pdf/broadridge-2017-proxy-season-review.pdf [https://perma.cc/7GN4-AJBF].

97. *Id.*

98. On the importance of voting in modern corporations, see generally Lucian Bebchuk et al., *What Matters in Corporate Governance?*, 22 REV. FIN. STUD. 783 (2008); Daniel R. Fischel, *The Corporate Governance Movement*, 35 VAND. L. REV. 1259 (1982); Oliver Hart, *Corporate Governance: Some Theory and Implications*, 105 ECON. J. 678 (1995).

sider whether blockchain could serve as a more efficient infrastructure for decision-making of shareholders and their respective Boards, and whether it can contribute to a more diverse shareholder democracy. Depending on the definition of democracy, and the division of corporate ownership among diverse types of shareholders across different jurisdictions, the answer will vary. Nevertheless, there are certainly several components of shareholder democracy that can contribute to greater shareholder control, including transparent records of shares, greater access to information, and simpler voting mechanisms. In this section, I aim to reflect on these components in light of blockchain technology, as well as on the benefits and risks that blockchain represents for shareholders.

A. Transparent Records of Shares

Marcel Kahan and Edward B. Rock considered technology to record stockownership as early as 2008, viewing it as a solution for many ongoing problems related to companies' inability to keep accurate and timely records of share-ownership.[99] In this context, there are several issues for which blockchain could serve as a valuable solution. Ownership of shares in publicly traded companies can sometimes become hazy, namely in times of Annual General Meetings (AGMs), or General Meetings (GMs), when mergers, acquisitions, or other major corporate decisions are being discussed and voted on. Investors, or groups of investors, each having diverse incentives, tend to use their information, influence, and vote for their own benefit, disregarding the consequences for the corporation and other shareholders.[100]

Blockchain technology could provide a **transparent overview of ownership.** All of the shareholders of a publicly traded company would be visible, while also allowing for the real-time observation of transfers of shares from one owner to another.[101] Managerial ownership would also become more transparent. The stock ownership would be constantly updated among all of the nodes in the blockchain. It is for consideration which

99. Marcel Kahan & Edward B. Rock, *The Hanging Chads of Corporate Voting*, 96 GEO. L. J. 1227, 1278 (2008).

100. *See, e.g.*, Abha Bhattarai, *Private Equity's Role in Retail Has Killed 1.3 Million Jobs, Study Says*, WASH. POST (July 24, 2019, 11:16 AM), https://www.washingtonpost.com/business/2019/07/24/private-equitys-role-retail-has-decimated-million-jobs-study-says/ [https://perma.cc/Y54H-TCZ5] (depicting a study that reviewed the effects of decision-making of corporations that have been acquired by private equity firms, and their disregard for employees or long-term investment in their target companies). *See also* Jim Baker et al., *Pirate Equity: How Wall Street Firms are Pillaging American Retail*, UNITED RESPECT (2019), https://united4respect.org/wp-content/uploads/2019/07/Pirate-Equity-How-Wall-Street-Firms-are-Pillaging-American-Retail-July-2019.pdf [https://perma.cc/W8HL-49CR].

101. One of the first initiatives in this regard started in Delaware where, in May 2016, the Delaware Blockchain Initiative was launched to enable companies to authorize and distribute their shares directly to investors via the Internet. *See* Michael del Castillo, *Delaware House Passes Historic Blockchain Regulation,* COINDESK (July 1, 2016, 2:54 PM), https://www.coindesk.com/delaware-house-passes-historic-blockchain-regulation [https://perma.cc/SPW2-DJ6H].

form the blockchain should undertake.[102] Yet, irrespective of the type of blockchain, the real-time database of transactions and their character would yield more reliable and complete information about ownership than is currently available, and such information would be visible to the shareholders, and possibly to all the market participants.[103] These accurate records would support and further emphasize the necessity for proper information disclosure to the markets and to the shareholders.

This development would positively not only affect the corporations themselves, but would also be relevant to the new wave of **beneficial ownership regulation** which is being adopted across the world with the view that increased transparency in share-ownership prevents money laundering and terrorist financing.[104] Many governments have been focusing on the formal reporting of beneficial ownership and forcing companies to assess their structure and ensure they meet varying disclosure requirements.[105] An important piece of such legislation has been the European Union's (EU) Fourth Anti-Money Laundering Directive, which, among other things, requires all EU member states to set up registers listing the ultimate beneficial owners (UBOs) of all legal entities.[106] Blockchain tech-

102. *See* discussion *infra* Section III.A.

103. In a majority of the markets, corporate shares have been "immobilized" and are usually held by securities depositories. Therefore, in these markets, corporate shares are issued in the name of central depositories, their nominees, or the participants in the settlement system. Hence, most shares are not held in the name of their owners, the shareholders, but in the name of their intermediaries. In the few jurisdictions where shares are *not* issued in the names of the intermediaries, they are usually, for tax purposes, credited to the intermediaries' accounts. This includes the case where a broker holds the shares in the name of his or her investors. Ultimately, this contributes to a very unclear overview of the relationships in a corporation. *See* Frederico Panisi et al., *Blockchain and Public Companies: A Revolution in Share Ownership Transparency, Proxy Voting and Corporate Governance?*, 2 STAN. J. BLOCKCHAIN L. & POL'Y 189, 189–90 (2019).

104. According to the World Bank Group, over a trillion U.S. dollars flow through diverse jurisdictions and shell companies by way of tax evasion, money laundering, corruption, and a myriad of other crimes. *Corrupt Money Concealed in Shell Companies and Other Opaque Legal Entities, Finds New StAR Study*, WORLD BANK (Oct. 24, 2011), https://www.worldbank.org/en/news/press-release/2011/10/24/corrupt-money-concealed-in-shell-companies-and-other-opaque-legal-entities-finds-new-star-study [https://perma.cc/JTD3-9D2V]. Countries across the world have adopted Beneficial Ownership Guides to tackle this enormous problem. *See Beneficial Ownership Guides*, GLOBAL F. ON ASSET RECOVERY, https://star.worldbank.org/content/beneficial-ownership-guides [https://perma.cc/8NTH-2Q5D].

105. For an overview over national approaches toward beneficial ownership, see generally *Anti-Corruption Initiatives: Beneficial Ownership*, OPEN GOV'T PARTNERSHIP, https://www.opengovpartnership.org/wp-content/uploads/2019/05/Global-Report_Beneficial-Ownership.pdf [https://perma.cc/MK5H-5YGB]; *Best Practices on Beneficial Ownership for Legal Persons*, FIN. ACTION TASK FORCE 1 (Oct. 2019), https://www.fatf-gafi.org/media/fatf/documents/Best-Practices-Beneficial-Ownership-Legal-Persons.pdf [https://perma.cc/F6LC-HVDD]; *Legal Approaches to Beneficial Ownership Transparency in EITI Countries*, EXTRACTIVE INDUS. TRANSPARENCY INITIATIVE 1 (June 2019), https://eiti.org/files/documents/legal_approaches_to_beneficial_ownership_transparency_in_eiti_countries.pdf [https://perma.cc/B279-M9LR].

106. Directive 2015/849 of the European Parliament and of the Council of 20 May 2015 on the Prevention of the Use of the Financial System for the Purposes of Money Laundering of Terrorist Financing, Amending Regulation No 648/2012 of the European

nology would represent a solution for the UBO challenge.

Secondly, an important factor of publicly disclosing the owners of shares is that **minority shareholders** would immediately know what their ownership amount is and could thereby have immediate access to their rights. Even though the degree of protection of minority shareholders varies among jurisdictions, minority shareholders are becoming more active and increasingly ready to protect their interests.[107] A significant advantage of the decentralization of a blockchain is that it grants equal opportunity for everyone to involve themselves in the decision-making.[108] Blockchain could furthermore facilitate communication among the minority shareholders.

In regard to minority shareholders, blockchain could have both positive and negative effects on **activist shareholders.** The technology would provide an overview of the existing shareholders, opening up access to their information and making it possible to contact them directly. This could facilitate the sale of shares,[109] but it could also pose a challenge for activist shareholders, as they often try to control the timing of their self-identification in order to take Boards by surprise.[110] Nevertheless, blockchain would allow activist shareholders to liquidate their position more easily. Thus, share **manipulation** would be quicker but more easily detectable. Moreover, any backdating of stock compensation would become impossible because, on a blockchain, rewriting the history is extremely complicated, if not unattainable. But ultimately, transparency and information accuracy would benefit both, the shareholders and the markets.

B. General Meeting: Information & Participation

Corporate law provides for a formalized, legal model of power sharing between the Board and the shareholders where the Board is hired by, and is accountable to, the company's owners (the shareholders) at the company's general meeting. General meetings have an important role in corporate governance as they have three main functions: (i) to inform shareholders about the state of the corporation, (ii) to provide a venue for discussion

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Parliament and of the Council, and Repealing Directive 2005/60/EC of the European Parliament and of the Council and Commission Directive 2006/70/EC, 2015 O.J. (L 141) 1, 13.

107. *Delaware Supreme Court Issues Favorable Ruling in Dell Merger Appraisal Action*, ANALYSIS GRP. (Dec. 21, 2017), https://www.analysisgroup.com/news-and-events/news/delaware-supreme-court-issues-favorable-ruling-in-dell-merger-appraisal-action/ [https://perma.cc/DU6A-B22X]; Christoph Van der Elst & Anne Lafarre, *Blockchain and Smart Contracting for the Shareholder Community* 2 (European Corp. Governance Inst., Working Paper No. 412, 2018).

108. *Cf. Blockchain Technology in Online Voting*, FOLLOW MY VOTE, https://followmyvote.com/online-voting-technology/blockchain-technology/ [https://perma.cc/P2SA-ZPGD].

109. *Cf.* Alex Edmands et al., *The Effect of Liquidity on Governance*, 26 REV. FIN. STUD. 1443, 1469 (2013).

110. *See* David Yermack, *Corporate Governance and Blockchains* 22–24 (Nat'l Bureau of Econ. Research, Working Paper No. 21802, 2015).

and inquiries, and (iii) to gather members for decision-making. After the 2008 financial crisis, more and more legislators have realized that increased oversight over Boards' decisions is necessary. Hence, the last years have seen a series of legislative measures to increase the accountability of the Boards. These measures include requirements that Boards' compensation be subject to review and approval by shareholders,[111] or the requirement that Board members submit themselves for reelection each year.[112] Boards are also being required to disclose all material information more efficiently to their shareholders and to the markets. For a long time, **transparency and disclosure** have been accepted as the functional pillars of our financial markets.[113] They provide a basis on which the shareholders and other stakeholders can make informed decisions and hold corporate executives accountable, and thus limit the agency costs associated with omnipresent information asymmetry.[114] Transparency consists of five elements: "(i) truthfulness, (ii) completeness, (iii) materiality of information, (iv) timeliness, and (v) accessibility."[115] Implementing blockchain within a corporation could, at minimum, advance the timeliness and accessibility of corporate information.[116] If all the shareholders are on the blockchain, they would be provided with timely and simple access to various documents, which would be timestamped, and thus any later change in the ledger would be traceable. Blockchain does not directly affect the truthfulness or materiality of the information, but it allows shareholders to

111. This new rule is popularly referred to as "say on pay," which requires the shareholder body at its General Meeting to vote on the compensation packages. This rule has been adopted in numerous jurisdictions, including the U.S., U.K., Australia, Denmark, Sweden, and the Netherlands. The U.K. was the first jurisdiction to introduce a nonbinding version of this rule. *See generally* Companies Act 2006, c. 9, § 439 (U.K.) (inferring that, as of October 2009, "say on pay" vote was made binding on all listed companies in the U.K.). This was later followed by Australia in 2004. *See Corporation Act 2001* (Cth) ss 250R (2), 250R(3) (Austl.). And the U.S. in 2010. *See generally* Dodd-Frank Wall Street Reform and Consumer Protection Act, Pub. L. No. 111-203, 124 Stat. 1376 (2010). For other jurisdictions, *see* Jim Corkery & Sabina Medarevic, *Executive Remuneration Under Scrutiny: The Cutting Edge of the 'Shareholder Spring'*, CORP. GOVERNANCE EJOURNAL, 2013, at 1, 9–10.

112. The U.K. Corporate Governance Code requires all Board Members of Standard and Poor's 350 companies to submit themselves for reelection every year. In Australia, if 25% of the shareholders' vote is against adopting the company's remuneration report at two successive AGMs, the shareholders have the right to vote out the Board. *See Corporation Act 2001* (Cth) s 250U (Austl.).

113. *See, e.g.*, Stephen M. Bainbridge, *Mandatory Disclosure: A Behavioral Analysis*, 68 U. CIN. L. REV. 1023, 1023 (2000); Frank H. Easterbrook & Daniel R. Fischel, *Mandatory Disclosure and the Protection of Investors*, 70 VA. L. REV. 669, 669 (1984); Gary F. Goldring, *Mandatory Disclosure of Corporate Projections and the Goals of Securities Regulation*, 81 COLUM. L. REV. 1525, 1525–26 (1981).

114. *See generally* Robert E. Verrecchia, *Essays on Disclosure*, 32 J. ACCT. & ECON. 97 (2001); Michael Welker, *Disclosure Policy, Information Asymmetry, and Liquidity in Equity Markets*, 11 CONTEMP. ACCT. RES. 801 (1995); Joseph E. Stiglitz, *Information and the Change in the Paradigm in Economics*, 92 AM. ECON. REV. 460 (2002).

115. Fiammetta S. Piazza, *Bitcoin and the Blockchain as Possible Corporate Governance Tools: Strengths and Weaknesses*, 5 PA. ST. J.L. & INT'L AFF. 262, 289 (2017). *See also* Benjamin Fung, *The Demand and Need for Transparency and Disclosure in Corporate Governance*, 2 UNIVERSAL J. MGMT. 72, 75–76 (2014).

116. *See generally* Piazza, *supra* note 115.

easily acquire information and, at the same time, monitor transactions and decisions, and recognize possible breaches.[117]

Even though regulations require publicly traded companies to hold AGMs annually, participating in them can be challenging since many publicly traded companies have a large number of individual shareholders coming from all over the world. While we observe the increasing importance and power of minority shareholders, the dispersion of ownership continues to represent a challenge, which proxy firms love to utilize. General meetings are the primary place for shareholder engagement. Yet, the engagement and participation are precarious. Therefore, the use of a new and innovative blockchain solution, where shareholders cannot only vote, but truly participate, share information, raise questions, and affect decision-making could prove beneficial. Naturally, in the context of corporations with hundreds of thousands of shareholders, even technology will not solve the issue of dispersion of ownership and interest, but it could possibly facilitate greater involvement and communication. In a world of decentralized autonomous consensus, collective decision-making could become more prominent, resulting in greater shareholder democracy while maintaining security and transparency.

Shareholder participation is another important element of sound corporate governance, both for decision-making and for supervision. Shareholders represent an efficient tool for capital market oversight,[118] which should also be supported at the policy level. Rational apathy is present among many shareholders as they assume that their small stake will have minimal impact on the result of an election.[119] Based on a simple, cost-benefit analysis, it is illogical for these shareholders to review all the information provided by the Boards and spend their time on the activities connected to general meetings given their small stake and impact in the company.[120] Hence, for them, it makes sense to only be interested in dividends and leave the decision-making to those more informed. However, a new architecture that would not only store the records and provide for information-sharing and voting, but would also encompass incentive mechanisms for those actively involved (as the nodes in a Bitcoin) could drastically alter the system.

Blockchain could serve as a viable substitute for the archaic mail voting or corporate proxy voting system that continues to be present and utilized in the majority of global jurisdictions today. It might not necessarily be welcomed by all parties involved, but it could contribute to greater

117. *See supra* Part I.A.

118. *See, e.g.*, John C. Coffee, *Law and the Market: The Impact of Enforcement*, 156 U. PA. L. REV. 229, 294 (2007); James D. Cox et al., *Public and Private Enforcement of Securities Laws: Have Things Changed Since Enron?* 80 NOTRE DAME L. REV. 893 (2005).

119. Yaron Nili & Kobi Kastiel, *In Search of "Absent" Shareholders: A New Solution to Retail Investors' Apathy*, 41 DEL. J. CORP. L. 55, 57 (2016).

120. *See* Dirk Zetzsche, *Shareholders Passivity, Cross-Border Voting and the Shareholder Rights Directive*, 8 J. CORP. L. STUD. 289, 296 (2008). *Cf.* Joan MacLeod Heminway & Adam J. Sulkowski, *Blockchains, Corporate Governance, and the Lawyer's Role*, 65 WAYNE L. REV. 17, 26–27 (2019).

transparency in decision-making. In several countries, electronic voting has been introduced,[121] but it has not proved to be a true solution for shareholder apathy.[122] According to Professor Dirk Zetsche, the number of active shareholders has not substantially changed.[123] Shareholders continue to be disinterested and apathetic towards voting on general meetings if they do not own a substantial stock of shares.[124] This suggests that the issue of inactive shareholders and the dominance of major shareholders is a phenomenon not based on the inability to physically participate, but rather due to the awareness of one's limited power and the cost-benefit analysis previously discussed. However, what if the system did not only resolve the digital versus analogue voting debate, but was rather a system designed to facilitate and incentivize shareholder participation? These incentives could perhaps take the form of higher dividends, additional tokens, or some other rights.[125] Blockchain itself is an incentive-based architecture. Moreover, blockchain is compatible with mobile platforms, which could also have a positive impact on voting since access to voting on a mobile phone could increase the convenience of exercising one's voting right.[126]

C. Shareholder's Vote: Proxy & Correct Calculations

Another reality of today's corporate world is the existing voting mechanism. Previously, shareholders were voting in person at the meeting, but nowadays, the majority of shareholders cast their votes through a **proxy**. The proxy system is present not only in the U.S., but in a majority of jurisdictions around the world.[127] This voting arrangement is a result of a sys-

121. *See* Zetzsche, *supra* note 120.
122. *Id.* at 335.
123. *Id.*
124. *Id.* at 293.
125. A token is a unit of value that represents an asset or utility in digital form. At the simplest level, tokens can be divided into utility tokens and security tokens. A utility token is a "coin" backed by a specific project. However, in the context of voting and corporate governance, the use of security tokens would be more appropriate. A security token represents a share in the company that issued the token. It represents a financial security in a digitalized form. They perform the same function and include the same rights as the securities that they represent. Yet, they are easier to transfer because it can all be done in digitized form. The security tokens are much more regulated than the utility tokens. *See* Toshendra Kumar Sharma, *Security Tokens vs. Utility Tokens: A Concise Guide*, BLOCKCHAIN COUNCIL, (Sept. 6, 2019), https://www.blockchain-council.org/blockchain/security-tokens-vs-utility-tokens-a-concise-guide/ [https://perma.cc/82NT-SHEN].
126. Erik Kuebler, *Making Voting, Elections Both Secure and Accessible with Blockchain Technology*, BITCOIN MAG. (Jan. 11, 2018), https://bitcoinmagazine.com/articles/making-voting-elections-both-secure-and-accessible-blockchain-technology [https://perma.cc/BQ48-2CEA].
127. For an overview of the European proxy market, see *Discussion Paper: An Overview of the Proxy Advisory Industry: Considerations on Possible Policy Options*, EUR. SEC. & MKT. AUTHORITY 5 (2012), https://www.esma.europa.eu/sites/default/files/library/2015/11/2012-212.pdf [https://perma.cc/Z53M-XA6Z] (providing an overview of the functioning of the proxy advisory industry in Europe). *See generally* Peter Cziraki et al., *Shareholder Activism Through Proxy Proposals: The European Perspective*, 16 EUR. FIN.

tem where shares are usually held by diverse intermediaries such as banks, brokers, or investment companies on behalf of their owners—the shareholders. The system of intermediaries is often endless because it needs an array of additional third parties, including: brokers, custodians, securities depositories, transfer agents, proxy service provides, proxy advisory firms, proxy solicitors, and vote tabulators.[128] Each of these parties brings into the relationships their own interests, additional costs, and more opportunities for mistakes. In order to understand the machinery, in 2018, 482 billion share proxies were handed in within 4,108 shareholder meetings in the U.S.[129] The Depository Trust and Clearing Corporation (DTCC), according to their data from 2018, provided custody and asset services to more than 130 countries making over $57 trillion.[130] Although this system has been facilitating the trading, clearing, and settlement of securities for many decades, these benefits come at the cost of substantially obstructing shareholder voting rights.[131]

Given that the majority of shareholders keep their shares through diverse intermediaries, these intermediaries are ultimately the ones who cast the votes.[132] In addition, these intermediaries are also entitled to communicate with each other about the performance of management, and discuss mergers and acquisitions without the fear of liability for improper solicitation of proxies.[133] Institutional investors view their voting as part of their strategy rather than as a representation of the shareholders' interests.[134] As mentioned, the representation of shareholders' interests by forms of proxies is universal. The European Commission has also been

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MGMT. 738 (2010) (analyzing various corporate governance issues that have been caused by newly initiated proxy proposals across corporations in Europe).

128. *See* Concept Release on the U.S. Proxy System, Exchange Act Release No. 34-62495, Investment Advisers Act Release No. 3052, Investment Company Act Release No. 29340, 98 SEC docket 3027, at 8 (July 14, 2010), *available at* https://www.sec.gov/rules/concept/2010/34-62495.pdf [https://perma.cc/M69Y-H384] [hereinafter Concept Release on the U.S. Proxy System].

129. *2018 Proxy Season Key Statistics and Performance Rating*, BROADRIDGE (2018), https://www.broadridge.com/_assets/pdf/broadridge-proxy-season-stats.pdf [https://perma.cc/3L58-FH2B].

130. *Our Capabilities*, DEPOSITORY TR. & CLEARING CORP. (2018), http://www.dtcc.com/~/media/Files/Downloads/About/DTCC_Capabilities.pdf [https://perma.cc/2C3D-TMQJ].

131. For more on the proxy system, see Spencer J. Nord, *Blockchain Plumbing: A Potential Solution for Shareholder Voting?*, 21 U. PA. J. BUS. L. 706, 710–18 (2019); R. Franklin Balotti & J. Travis Laster, *Professor Coates Is Right. Now Please Study Stockholder Voting*, 54 U. MIAMI L. REV. 819, 833–837 (2000). *See generally* Jill E. Fisch, *From Legitimacy to Logic: Reconstructing Proxy Regulation*, 46 VAND. L. REV. 1129 (1993) (describing the geographic dispersion as a tool for limiting shareholders' voting).

132. In a majority of institutional investors, there are specialized proxy departments and teams that are responsible for implementing the proxy voting and engagement guidelines.

133. Commission Interpretation and Guidance Regarding the Applicability of the Proxy Rules to Proxy Voting Advice, Exchange Act Release No. 34-86721, 84 Fed. Reg. 47416 (Sept. 10, 2019).

134. *Cf.* Edward B. Rock, *Institutional Investors in Corporate Governance*, *in* THE OXFORD HANDBOOK OF CORPORATE LAW AND GOVERNANCE 363, 374 (Jeffrey N. Gordon & Wolf-Georg Ringe eds., Oxford Univ. Press 2018).

frustrated by shareholder apathy and aims to address the lack of shareholder engagement.[135] Hence, looking at the existing voting mechanism, we can surely conclude that individual shareholders truly lack any power over decision-making.

With blockchain technology, the entire system could be completely reformed and made "more responsive."[136] It would be the shareholders who would cast the vote instead of other intermediaries with their own incentives. Individual shareholders could communicate directly and securely among themselves and with the Board. "Votes could be instantaneously recorded on a blockchain, making elections" simple and accessible.[137] Meetings could be done virtually, live-streamed with active interactions, and with less control from institutional investors.[138] "Requisite votes could be entered remotely, using a blockchain as a secure data store, and subsequently tallied in real-time in a trusted way."[139] Technology "could make corporations more dynamic" and transparent.[140] Existing restrictions, direct or indirect, could be lessened and shareholders' individual voices could be heard. This could have a substantial effect on their activism and involvement as well as provide a platform for legitimate shareholder concerns and interests. Blockchain could bring more efficient coordination to shared resource pools and enable new models of nonhierarchical governance that are present in Nordic countries, and thus allow equitable division of power and profit in the future. Blockchain has already been presented by several institutions as a platform for voting in various types of elections.[141] Could this be the tool for greater shareholder democracy?

Some might claim that the current system works and that the system is secured by several gatekeepers on the market. But studies and news reports are showing otherwise. Marcel Kahan and Edward Rock have documented the many problems of existing corporate elections, which includes an **inexact voter (shareholder) list.**[142] This would be easily

135. The European Commission has submitted a proposal to amend the Shareholder Rights Directive. *See Proposal for a Directive of the European Parliament and of the Council Amending Directive 2007/36/EC as Regards the Encouragement of Long-Term Shareholder Engagement and Directive 2013/34/EU as Regards Certain Elements of the Corporate Governance Statement*, COM (2014) 213 final (Apr. 9, 2014).

136. Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SOC. SCI. RES. NETWORK 1, 37 (2015), https://www.ssrn.com/abstract=2580664 [https://perma.cc/DZ46-XM5K].

137. *Id.*

138. *Id.*

139. *Id.*

140. *Id.*

141. Stock exchanges, as well as custodian intermediaries, have been outlining their vision for blockchain infrastructure. "During the 'Open Day 2015' IT Conference, Deutshe Börse Group presented its corporate voting proxy prototype." *See* Anne Lafarre & Christoph Van der Elst, *Blockchain Technology for Corporate Governance and Shareholder Activism* 20 (Eur. Corp. Governance Inst., Working Paper No. 390, 2018). Nasdaq, the Australian Stock Exchange, the Japan Exchange Group, the London Stock Exchange, and the Moscow Exchange have been working on similar projects. *Id.* at 20, n.72.

142. *See* Kahan & Rock, *supra* note 99, at 1254–55.

solved if shareholder ownership was recorded on blockchain. The speed of blockchain would provide an exact overview of the shareholders.[143] The list of problems with the current voting scheme continues. Incomplete distribution of ballots and **chaotic vote tabulation** are among the key concerns.[144] Once corporations receive votes, state laws in the U.S. require that a vote tabulator or an inspector of election is hired to officially collect and count both, proxy votes and votes delivered by shareholders in person at a shareholder meeting.[145] The tabulator is responsible for the accuracy of the voting, which continues to be problematic.

There have been various high profile controversies involving errors in vote tabulation,[146] including one in 2008 after a tense proxy fight for control of Yahoo! Inc.[147] In this case, an independent vote tabulator, which Yahoo had employed, had miscounted votes by "about 20% of the total vote, with roughly twice as many votes withheld from the chairman and the CEO as first reported."[148] This was not a rare case, at least not with regards to publicly traded companies that have thousands of hundreds of investors.[149] Even the Securities and Exchange Commission (SEC) acknowledged that it is unable to confirm whether the vote of a shareholder was cast as instructed.[150] In fall of 2018, the SEC held a roundtable focused on the U.S. proxy system, including the "mechanics and technology" of the system.[151] The SEC observed the major problems in the system, yet it has not found a solution that would address them efficiently.[152] The fact that in the twenty-first century, we are unable to address the accuracy of voting mechanism remains puzzling.

As Ken Bertsch, Executive Director of the Council of Institutional Investors, explained before the SEC Investor Advisory Committee, we are

143. *Id.* at 1235.

144. *Id.* at 1255.

145. *See* Nord, *supra* note 131, at 717.

146. These cases involve annual meetings and voting controversies of CSX Corp. in 2008, Washington Mutual in 2008, and Transkaryotic Therapies in 2005. *See* Richard W. Barrett, *Elephant in the Boardroom?: Counting the Vote in Corporate Elections*, 44 VAL. U. L. REV. 125, 126–27 (2009). Additional controversies occurred in the Procter and Gamble Co. proxy fight of 2017. Donald Pierce, *Protecting the Voice of Retail Investors: Implementation of a Blockchain Proxy Voting Platform*, RUTGERS BUS. L.J., 2018–2019, at 1, 7.

147. Barrett, *supra* note 146, at 125–26. After Yahoo's annual meeting, the company declared that CEO Jerry Yang had received 85.4% of the shares voted. *Id.* at 125.

148. *Id.* at 126. *See also* Benjamin Pimentel & Dan Gallagher, *Yahoo Board Vote Count Sharply Revised*, MARKETWATCH, (Aug. 5, 2008, 7:21 PM), https://www.marketwatch.com/story/votes-against-yahoo-board-much-higher-than-first-reported [https://perma.cc/8KVC-F8YT].

149. *See* Kahan & Rock, *supra* note 99, at 1279 ("Gil Sparks, a . . . Delaware lawyer, estimates that, in a contest that is closer than 55 to 45%, there is no verifia[bility]" of the election results.).

150. *See* Concept Release on the U.S. Proxy System, *supra* note 128, at 27 ("[I]t is not currently possible to match a particular investor's vote to a specific securities position held at a securities depository.").

151. *See Spotlight on Proxy Process*, SEC (Feb. 22, 2019) https://www.sec.gov/proxy-roundtable-2018 [https://perma.cc/SVD9-A5DS].

152. *Id.*

certainly at a pivotal time in the future of proxy voting.[153] Some scholars perceive blockchain as a tool to eliminate all the existing middlemen,[154] while others foresee that the roles of the intermediaries will simply change.[155] All these concerns can be addressed by blockchain architecture and by defining the roles of the existing intermediaries. Yet, irrespective of the structure, blockchain would substantially increase the transparency, efficiency, and possibly also the legitimacy of the corporate system.

D. Costs

Another factor that cannot be ignored is the costs of blockchain. For the time being, the costs continue to be substantial. To specify the costs of both public and private blockchain solutions, one would need specific inputs, including: (i) the transaction volume, (ii) the transaction size, (iii) the node-hosting method, and (iv) the consensus protocol.[156] To these, one would need to add management costs, executive training costs, system transitioning costs, and costs connected to the entire operation. Like any other technological solution, the costs of blockchain would include not only installation and setup, but would also include yearly maintenance, cloud space, and monitoring costs. Depending on the size of a solution and the additional add-ons, the cheapest solutions could cost from $500,000 to several millions of dollars.[157] Hence, the costs of a blockchain continue to be considerable. However, these costs will decrease once a greater demand hits the market.[158]

E. Transparency, Long-Term Incentive Plan, and Security

Shining more light onto corporate decision-making is necessary. We saw, during the 2008 financial crisis, that those in the position of power are not the most willing to share their power and the information that they

153. *See generally* Ken Bertsch, Executive Director, Council of Institutional Inv., Remarks Before the SEC Inv'r Advisory Comm. Council of Institutional Inv., (Dec. 8, 2016) (transcript available at https://www.sec.gov/comments/265-28/26528-272.pdf [https://perma.cc/PMS3-K6VY]).

154. *Id.* at 4.

155. *See* Wright & De Filippi, *supra* note 136, at 4–5.

156. *See Total Cost of Ownership for Blockchain Solutions: Amendment of Fundamental Cost of Ownership for Private Blockchain Solutions*, ERNST & YOUNG 5 (2019), https://www.ey.com/Publication/vwLUAssets/ey-total-cost-of-ownership-for-blockchain-solutions/$File/ey-total-cost-of-ownership-for-blockchain-solutions.pdf [https://perma.cc/3XLR-23DC].

157. *Id.*

158. Currently, there are alternatives, such as Hyperledger or Corda. Hyperledger fabric is an increasingly popular enterprise blockchain platform. IBM and Amazon already provide a blockchain platform, which is based on Hyperledger fabric. *Hyperledger Fabric (HVM)*, AMAZON WEB SERV., INC., https://aws.amazon.com/marketplace/pp/Code-Creator-Hyperledger-Fabric-HVM/B0797GK9YY [https://perma.cc/3H4S-KRWK]; *IBM Blockchain in Retail: Building Trust from Source to Consumer*, IBM, https://www.ibm.com/blockchain/industries/retail [https://perma.cc/VXJ8-QVRS]; Philipp Sandner, *Comparison of Ethereum, Hyperledger Fabric, and Corda*, MEDIUM (June 25, 2017), https://medium.com/@philippsandner/comparison-of-ethereum-hyperledger-fabric-and-corda-21c1bb9442f6 [https://perma.cc/5FN6-HX7Q].

hold.[159] There must be a law or a system that forces them to do so. **Transparency** was one of the key words during the financial crisis.[160] Yet, despite thousands of new pages of law and regulation, little has been done to render this word efficient. Therefore, one could argue that, aside from the law, we need a change in infrastructure. Blockchain could serve as the example. Increasing transparency in the records of owners, corporate decisions, information-sharing mechanisms, and voting mechanisms could have additional, remarkable effects on the behavior of the parties involved. With a technology such as blockchain, ownership—more specifically, management ownership—could become substantially more transparent. This would directly affect the transparency of their compensation, given that the directors' compensation is often a combination of salary and equity.[161]

Furthermore, blockchain could support a **long-term incentive plan** that provides incentives to both, Boards and shareholders. Those shareholders who own shares for longer periods of time could be provided with additional financial, or non-financial, incentives like more voting power, tokens, or dividends. Blockchain offers not only an infrastructure, but also self-executing add-ons, such as smart contracts. These could be connected to the registry of stocks and include the stock options or stock warrants. Considering the long-term incentive plans, incentive mechanisms could also be coded into the blockchain where the rights and obligations of specific shareholders would be subjected to other activities. Incentivizing people to actively participate in the life of a corporation would indisputably contribute to the quality of corporate governance.

In regard to the **security** of blockchain, "the algorithms that control the communication [between shareholders] use cryptography to ensure that only the proper computers are making the decisions, that the blockchain does not record any improper transactions, and that past transactions are safe from being corrupted."[162] Manipulation, like backdating the stocks' purchase or stock compensation, would become impossible because rewriting the transactions and their corresponding timestamps on the blockchain is almost impossible.

All of these new tweaks in the system would dramatically affect the division of power between shareholders and Boards. They would contrib-

159. *See, e.g.*, John C. Coffee, *Systemic Risk after Dodd-Frank: Contingent Capital and the Need for Regulatory Strategies Beyond Oversight*, 111 COLUM. L. REV. 795, 795 (2011); Andrew F. Tuch, *Financial Conglomerates and Information Barriers*, 39 J. CORP. L. 563, 586–87 (2014).

160. *See* Caroline Bradley, *Transparency is the New Opacity: Constructing Financial Regulation After the Crisis*, 1 AM. U. BUS. L. REV., 7, 7 (2011) (analyzing the necessary approach towards the reconstruction of financial regulation in the U.S., while strengthening the transparency mechanisms); *see also* Christine Kaufmann & Rolf H. Weber, *The Role of Transparency in Financial Regulation*, 13 J. INT'L ECON. L. 779, 780 (2010).

161. Lucian Bebchuk & Jesse M. Fried, *Pay Without Performance: Overview of the Issues* 6 (Harv. John M. Olin Ctr. for L., Econ. & Bus., Working Paper No. 528, 2005).

162. Steve Young, *Changing Governance Models by Applying Blockchain Computing*, CATH. U. J.L. & TECH., Spring 2018, at 53, 54. *See also* Ryan Surujnath, Note, *Off the Chain!: A Guide to Blockchain Derivatives Markets and the Implications on Systemic Risk*, 22 FORDHAM J. CORP. & FIN. L. 257, 280–82 (2017).

ute to greater transparency, and with the right architecture, they could change the values on which our corporations are built.

III. Blockchain for Publicly Traded Corporations: A Proposal

Blockchain represents a decentralized architecture that enables autonomous software programs to run as a result of the collaborative efforts of various parties around the world, all while not being controlled by a single party. By using smart contracts on blockchain, companies or shareholders can transfer data, documents, or votes thereby facilitating the possibility of reaching shareholder consensus. Blockchain, as a tool, can be easily translated into corporate governance and used by shareholders to achieve consensus and engage all relevant parties. If we think of shareholders as parties who have diverse incentives and are scattered around the world, but must nevertheless come to a decision—that is, they must achieve consensus on a number of issues—then, is not blockchain the ideal technology for corporate governance considering the values and objectives that blockchain offers? The use of blockchain as a corporate governance tool—for information-sharing, shareholder voting, or shareholder incentivizing —is further supported by the fact that blockchain technology includes transparent and tamper-resistant registries.[163] These registries can be used as registries of shares as well as registries of shareholder decisions. The form in which blockchain stores the data is unique and safe, which should support greater shareholder involvement while safeguarding the corporation's confidential information. In this section, I will elaborate on the possibility and practicability of using blockchain by a corporation.

A. What Form of a Blockchain?

When analyzing blockchain, it is important to understand that there are different forms in which blockchain can be operated and organized. There are two main types: public and private, which are further organized into consortium or Hyperledger fabric blockchains.[164] The original blockchains were public (e.g., Bitcoin or Ethereum). A public blockchain is open to everyone in the world. Anyone can read it, access it, send transactions through it, and expect to see those transactions included in their account if they are valid.[165] In a public blockchain, anyone can also participate in the consensus process.[166] However, this form of blockchain may

163. *Distributed Ledger Technology: Beyond Block Chain*, U.K. GOV'T OFF. SCI. 1, 23-25 (2016), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf [https://perma.cc/XK86-53QE].

164. *See* Lafarre & Van der Elst, *supra* note 141, at 4, 16, 21. For more on Hyperledger, see VIKRAM DHILLON ET AL., BLOCKCHAIN ENABLED APPLICATIONS: UNDERSTANDING THE BLOCKCHAIN ECOSYSTEM AND HOW TO MAKE IT WORK FOR YOU 139-49 (Apress 2017).

165. *See, e.g.*, IMRAN BASHIR, MASTERING BLOCKCHAIN: DISTRIBUTED LEDGER TECHNOLOGY, DECENTRALIZATION, AND SMART CONTRACTS EXPLAINED 26-30 (Packt Publ'g 2d ed. 2018)

166. *Id.*

not necessarily be the best for purposes of corporate architecture. "**Consortium blockchain** is a blockchain where the consensus process is controlled by a pre-selected set of nodes . . . ."[167] We talk about consortium blockchains if different companies operate a blockchain together while they are equally involved in the consensus and the decision-making processes on the chain (e.g., banks).[168] Access to the blockchain can vary. The blockchain may allow everyone or only some to access it, make decisions, or just "read" what is on the blockchain. The consortium blockchains can be regarded as "partially decentralized."[169] On the other end of the spectrum, are **private blockchains**, which are fully controlled by one organization and access can be limited to chosen participants.[170] This infrastructure can work well for database management, audit, and companies' internal infrastructure. Private blockchains are a way of taking advantage of blockchain technology by setting up groups and participants who can verify transactions internally; however, this means that there is one party that has full control over the blockchain. Nevertheless, there could be a combination of a consortium blockchain and a private blockchain, providing various parties with different sets of rights while ensuring that the right to add a block would not be centralized in the hands of one entity.

Due to the openness of a blockchain, permission-less, public blockchains would not be ideal for corporate governance work. A system where access is controlled would be more suitable, as specific parties—shareholders, stock exchanges, and governmental agencies—would be allowed access, but only a limited amount of information would be made available to the public. This controlled access could be provided by either a private blockchain, or a consortium blockchain (jointly referred to as "permissioned blockchains"). In a permissioned blockchain, there is usually a central authority or consortium that selects the parties who are allowed to engage on the blockchain, imposing limits on who can access or record information to the shared databases.[171] Permissioned blockchains

167. *See, e.g.*, Vitalik Buterin, *On Public and Private Blockchains*, ETHEREUM BLOG (Aug. 7, 2015), https://blog.ethereum.org/2015/08/07/on-public-and-private-blockchains/ [https://perma.cc/L5YG-RSD7] [hereinafter *On Public and Private Blockchains*]; Deborah Dobson, *The 4 Types of Blockchain Networks Explained*, INT'L LEGAL TECH. ASS'N. (Feb. 13, 2018, 10:41 AM), http://iltanet.org/blogs/deborah-dobson/2018/02/13/the-4-types-of-blockchain-networks-explained?ssopc=1 [https://perma.cc/7RBK-BXKJ] (explaining that consortium blockchains are sometimes also referred to as federated blockchains).

168. There are numerous examples of consortium blockchains, including those blockchains that are collaborating together to leverage blockchain technology for improved business processes, like Quorum, Hyperledger, and R3 Corda. *See* Darya Yafimava, *What Are Consortium Blockchains, and What Purpose Do They Serve?*, OPENLEDGER (Jan. 15, 2019), https://openledger.info/insights/consortium-blockchains/ [https://perma.cc/5H6Y-3AYL].

169. *See, e.g.*, *On Public and Private Blockchains*, *supra* note 167.

170. *Id.*; Dobson, *supra* note 167.

171. *See* Allison Berke, *How Safe Are Blockchains? It Depends*, HARV. BUS. REV. (Mar. 7, 2017), https://hbr.org/2017/03/how-safe-are-blockchains-it-depends [https://perma.cc/N4S6-CMNP]. "The right to read the blockchain may be public, or restricted to the participants, and there are also hybrid routes such as the root hashes of the blocks being public together with an API that allows members of the public to make a limited

are usually **purpose-driven**, which would be consistent with the ideas for share recordkeeping, information sustenance, and voting. Permissioned blockchains, besides being limited to a specific group, are also substantially **faster** than the permission-less ones, which would be yet another advantage.[172] They are also cheaper because only a limited number of nodes are needed to verify a completed block.[173] Since the permissioned blockchains are operated by a smaller number of pre-selected participants, they can implement alternative ways to validate and approve transactions faster.[174] Permissioned blockchains also have numerous benefits for "(i) data privacy,[175] (ii) transaction volume scalability, (iii) system responsiveness, [and] (iv) ease of protocol updatability. . . ."[176]

An alternative to the above could be a **sidechain blockchain**, where permissioned systems operate independently, but periodically connect with a public blockchain.[177] The point of the pegged sidechains was to "enable[ ] bitcoins and other ledger assets to be transferred between multiple blockchains," which would provide the "users with access to new . . . cryptocurrency systems using the assets they already own."[178] "These systems . . . [could then] easily interoperate with each other. . . ."[179] Even though the sidechain has been developed for cryptocurrency, its architecture could be used for a stock exchange system. In a stock exchange system, independent blockchains of publicly traded companies would coexist while being connected to the same sidechain that ultimately validates data from other blockchains. This sidechain would be governed by a stock exchange itself and would be operated as a public blockchain.

There are numerous technical solutions that could apply blockchain across the multifaceted relationships that are present within a corporation. This Article does not intend to provide a bulletproof, technical solution, but rather, offers diverse proposals that should be later developed with the help of blockchain developers. Nevertheless, while reviewing plausible technical solutions, the goal is to critically consider the added value of such systems. Would the fact that the blockchain would be more accurate, transparent, and immutable be sufficient to pursue this new technology

number of queries and get back" some information. *See On Public and Private Blockchains*, *supra* note 167.

172. *See, e.g.*, *On Public and Private Blockchains*, *supra* note 167.

173. *Id.*

174. *Id.*

175. The relationship between blockchain and data protection continues to develop. The analysis is still far from clear. For more information on the topic, see *Blockchain and the General Data Protection Regulation: Can Distributed Ledgers Be Squared with European Data Protection Law?*, EUR. PARLIAMENT (2019), https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU(2019)634445_EN.pdf [https://perma.cc/6GJ7-GGU9].

176. Omar Dib et al., *Consortium Blockchains: Overview, Application and Challenges*, 11 INT'L J. ADVANCES TELECOMM. 51, 52 (2018).

177. The concept of sidechain blockchain was originally introduced by Core Bitcoin Developers at Blockstream in their October 2014 White Paper. *See generally* ADAM BACK ET AL., ENABLING BLOCKCHAIN INNOVATIONS WITH PEGGED SIDECHAINS (2012).

178. *See id.* at 1.

179. *Id.*

despite many uncertainties? And are these attributes achievable to their full extent? I would argue yes. Particularly with regards to blockchains of individual, publicly traded companies, which should reflect on the contemporary governance model.

However, one key flaw of permissioned blockchains is a lack of **trust**.[180] "With permissioned blockchains, there is no guarantee that parties [(blockchain participants)] will not collude to tamper with the underlying blockchain in ways that may ultimately harm other network participants."[181] "If only a handful of parties can validate and record information to a blockchain, these parties . . . [will own the control]. . ., which could be compromised by technical failures, [fraud,] corruption, or hacking."[182] Still, the technicalities of the permissioned blockchain are not necessarily set in stone. Existing parties, including gatekeepers, will divide and share powers and liabilities, which can be enforced by implementing an incentive mechanism into the architecture. Gatekeepers have always played a "valuable role in capital markets as a mechanism for investor protection," and blockchain technology should enhance their efficiency.[183] In the following sections, I focus on the role of four key parties: a governmental (or enforcement) agency, a stock exchange, a corporation, and the shareholders. The division of rights is a balancing act that needs to be carefully considered.

B. Governmental Agency: A Developer and an Observer at the Same Time?

If blockchains attain a central role in corporate recordkeeping and sale of shares, as well as become a network for information disclosure, the maintenance and upgrading of blockchains themselves would have to be closely supervised, if not carried out directly by a governmental (enforcement) agency such as the SEC in the case of the U.S. One could imagine the entire corporate infrastructure system being "put" on a blockchain, or rather, on a group of various types of blockchains. Since blockchains are inherently decentralized systems, which consist of different actors who act depending on their incentives and on the information that is available to them, the codes and smart contracts, similar to the laws and rules, would be developed with the help of enforcement agencies. The SEC in the U.S. has already initiated talks about blockchain and the possibility of completely reconstructing the equity markets with distributed ledger technology involving certain layers of blockchain.[184]

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180. De Filippi & Wright, *supra* note 38, at 32.

181. *Id.*

182. *Id.*

183. On the role of Gatekeepers, see Jennifer Payne, *The Role of Gatekeepers*, *in* The Oxford Handbook of Financial Regulation 254, 255 (Niamh Moloney et al. eds., Oxford Univ. Press 2015).

184. Amanda Maine, *SEC Advisory Committee Members Endorse Universal Proxy, Encourage Blockchain in Corporate Elections*, Jim Hamilton Blog (Sept. 18, 2018, 8:44 AM), https://jimhamiltonblog.blogspot.com/2018/09/sec-advisory-committee-members-endorse.html [https://perma.cc/J2Z8-NXW2]. Several roundtables of stakeholders

One of the solutions could be a private (permissioned), or a semi-private, blockchain run by a central authority in collaboration with other gatekeepers—namely, the stock exchange—which would manage the blockchain's protocols, having full control over access to the blockchain and the rules governing the relationships. The agency would secure access to the blockchain to those shareholders who prove their ownership. Some of the governance tasks would be carried out by the stock exchange and some by the governmental agency itself. Yet, all the activities would be fully visible and transparent to everyone on the blockchain. With the removal of certain parties (e.g., brokers, or transfer agents), the SEC could expand its budget and require fees for maintaining the infrastructure, and thus support its activities and the quality of the oversight. A governmental agency would need to closely collaborate with software engineers, developers, and lawyers who would help translate law into code.

C. A New Role for Stock Exchanges?

Presently, governmental agencies share oversight and governance of markets with a number of gatekeepers, including the stock exchanges. As such, stock exchanges play two roles: (i) the role of a publicly traded company in competition with other publicly traded companies, and (ii) the role a Self-Regulatory Organization (SRO) that brings together various market participants.[185] They are thus responsible for regulating themselves and all the parties that carry out business with them. Therefore, in the case of a change of corporate and market architecture, they will continue to have an important role in governance and oversight.

Stock exchanges have already recognized the changing horizon and started to look and review their processes, taking into consideration the implementation of blockchain. The Australian Securities Exchange (ASX) is rebuilding its Clearing House Electronic Subregister System (or CHESS) with help from a distributed ledger start-up known as Digital Asset.[186] Similarly, "the Hong Kong Exchange and Clearing (HKEX) is working with Digital Asset and BNP Paribas to enhance its post-trade infrastruc-

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discussed the possibility of using blockchain for proxy voting systems (Bank Santander has already initiated a pilot program). *See* Sujha Sundararajan, *Santander Conducts Proxy Voting Blockchain Pilot at AGM*, COINDESK (May 18, 2018, 2:02 PM), https://www.coindesk.com/santander-conducts-proxy-voting-blockchain-pilot-at-agm [https://perma.cc/C5TA-J7AV].

185. On the role of stock exchanges, see generally Roberta S. Karmel, *Demutualization of Exchanges as a Strategy for Capital Market Regulatory Reform*, *in* FOCUS ON CAPITAL: NEW APPROACHES TO DEVELOPING LATIN AMERICAN CAPITAL MARKETS 269 (Kenroy Dowers & Pietro Masci eds., 2003); Andreas M. Fleckner, *Stock Exchanges at the Crossroads*, 74 FORDHAM L. REV. 2541 (2006); Paul G. Mahoney, *The Exchange as Regulator*, 83 VA. L. REV. 1453 (1997).

186. *See CHESS Replacement: ASX Is Replacing CHESS with Distributed Ledger Technology (DLT) Developed by Digital Asset*, ASX, https://www.asx.com.au/services/chess-replacement.htm [https://perma.cc/72MK-BWK2].

ture. . . ."[187] Numerous other stock exchanges are starting to move toward this direction, including Singapore and Gibraltar.[188] The London Stock Exchange Group (LSEG) joined forces with International Business Machines (IBM) in 2017 "to build a blockchain-based platform to digitally issue shares of small and medium size enterprises in Italy."[189] The project was tested by *Borsa Italiana*, which is a member of LSEG.[190] The main rationale for the blockchain-based platform was to allow SMEs to have a better and easier interaction with their shareholders and to provide greater transparency to investors on their ownership.[191] Additional benefits for the corporations to join the platform have been recently introduced by the Italian government with new tax incentives.[192]

At the beginning of 2016, Nasdaq announced that it would develop a blockchain-based e-voting service—to allow shareholders of companies listed on Nasdaq's Tallinn Stock Exchange to vote in shareholder meetings—as one of the pilot programs.[193] By early 2017, Nasdaq declared the pilot a success and stated that it created a "proof of concept [ ] with four

187. *Stock Exchanges in Asia Pacific Are Rising to the Challenge of Blockchain Adoption*, BNP PARIBAS (July 22, 2019), https://securities.bnpparibas.com/insights/stock-exchanges-blockchain.html [https://perma.cc/NC7N-2S4R] [hereinafter BNP PARIBAS].

188. *Id.*; *The Gibraltar Stock Exchange Set to Offer Digital Debt Securities and Funds*, GIB. STOCK EXCHANGE (Apr. 9, 2019), https://www.gsx.gi/article/9466/the-gibraltar-stock-exchange-set-to-offer-digital-debt-securities-and-funds [https://perma.cc/MH6T-D4BY] [hereinafter GIB. STOCK EXCHANGE] (announcing that the Gibraltar Stock Exchange (GSX) launched listings of blockchain-powered securities on its GSX Global Market on April 9, 2019).

189. *See Applications for Blockchain*, PRINCIPLES RESPONSIBLE INV. (Aug. 31, 2018), https://www.unpri.org/sustainable-financial-system/stock-exchange-innovation-applications-for-blockchain/3597.article [https://perma.cc/J6H6-RCS9] [hereinafter *Applications for Blockchain*]. *See also LSEG Links with IBM to Build Key Blockchain Solution for SME's,* LONDON STOCK EXCHANGE GRP. (July 18, 2017), https://www.lseg.com/resources/media-centre/news-and-insight/lseg-links-ibm-build-key-blockchain-solution-smes [https://perma.cc/WY2M-D2BK] [hereinafter LONDON STOCK EXCHANGE GRP.].

190. *Applications for Blockchain*, *supra* note 189.

191. Raffaele Jerusalmi, the CEO of Borsa Italiana stated: "Through our work with IBM on this blockchain solution, Borsa Italiania is taking the lead in transforming the way European SMEs can manage their shareholder data and at the same time expand credit access—all on a trusted digital platform." LONDON STOCK EXCHANGE GRP., *supra* note 189.

192. At the end of 2018, the Italian Parliament passed "the Budget Law for 2019, . . . which includes several provisions for digital growth." It binds the government to set up a fund of 45 million Euros for 2019–2021, with the aim of supporting companies that are developing blockchain, AI, and IOT solutions, relevant to Italy's competitiveness. *See* Francesco Bonichi & Elisa Cesetti, *Insight: Italy-New Tax Incentives for Digitalization and Innovation*, BLOOMBERG TAX (Mar. 21, 2019, 5:59 AM), https://news.bloombergtax.com/daily-tax-report-international/insight-italy-new-tax-incentives-for-digitalization-and-innovation [https://perma.cc/5BLA-CMJX].

193. *See* Press Release, Nat'l Ass'n of Sec. Dealers Automated Quotations, *Nasdaq's Blockchain Technology to Transform the Republic of Estonia's E-Residency Shareholder Participation* (Feb. 12, 2016) (available at http://ir.nasdaq.com/news-releases/news-release-details/nasdaqs-blockchain-technology-transform-republic-estonias-e [https://perma.cc/J3XT-S3AH]).

web-based user interfaces in Estonia."[194] They have also tested the solution with a Nasdaq Tallinn company LHV Group.[195] Although this all sounds extremely positive, there have been no news about this pilot, and its efficiency or effectiveness, since 2017.[196] On the contrary, according to a source who is familiar with Nasdaq, "the cost to fully adopt [blockchain technology] outweighed the benefits."[197] Supporting this view, large companies that have initiated thirty-three projects involving blockchain agree that "the technology has yet to deliver on its promise."[198] Yet, despite the challenge of limiting the cost of blockchain, the companies have not lost their faith. Facebook recently announced its new blockchain-based cryptocurrency, Libra, which will undoubtedly bring a lot more discussion and focus on blockchain.[199]

D. Corporations as the Trust-Holders: Risks & Incentives

If blockchains become the tool for corporate governance, the operation and maintenance of blockchain would raise additional governance, regulatory, and liability concerns. If a governmental agency is responsible for the operations, then the incentives to manipulate the code could be limited. However, one could argue that only corporations should have that authority because they know their governance rules best and should be enabled to react quickly in case of technical issues; therefore, they should be the ones authorized to update their code. But this would mean that the corporation—that is, the Board—will have the keys to the treasure, which would undermine some of the benefits of blockchain like transparency and trust.

Corporations themselves should only be entitled to a specific set of rights, which would still be overseen by third parties as is the case now. A blockchain corporate platform could give reading and writing privileges to the corporations in regard to their disclosure obligations. However, shareholder recordkeeping and voting management should be left to third parties. By publishing ownership records to the blockchain, it would enable

194. *See Is Blockchain the Answer to E-Voting? Nasdaq Believes So*, NASDAQ (Jan. 23, 2017, 8:00 AM), https://business.nasdaq.com/marketinsite/2017/Is-Blockchain-the-Answer-to-E-voting-Nasdaq-Believes-So.html [https://perma.cc/H9U8-RUQ8].

195. *See Nasdaq Calls Shareholder E-voting Tests Based on Blockchain Technology a Success*, BALTIC COURSE (Jan. 23, 2017), http://www.baltic-course.com/eng2/good_for_business/?doc=127087&output=D [https://perma.cc/R3LZ-CGKS].

196. The only published news has been a new collaboration between Nasdaq and South Africa's Central Securities Depository at the end of 2017. Their collaboration was to focus on "a new blockchain solution that would bring electronic voting to the South African capital markets," using the model from Estonia. *See* Press Release, Nat'l Ass'n of Sec. Dealers Automated Quotations, *Nasdaq to Deliver Blockchain E-Voting Solution to Strate*, (Nov. 22, 2017) (available at https://business.nasdaq.com/mediacenter/pressreleases/1648022/nasdaq-to-deliver-blockchain-e-voting-solution-to-strate [https://perma.cc/MVL4-35GL]).

197. *See* Anna Irrera & John McCrank, *Focus: Wall Street Finds Blockchain Hard to Tame After Early Euphoria*, REUTERS (July 16, 2019, 6:07 AM), https://www.reuters.com/article/us-blockchain-finance-focus/wall-street-finds-blockchain-hard-to-tame-after-early-euphoria-idUSKCN1UB0YV [https://perma.cc/8VQQ-VW93].

198. *Id.*

199. *See generally* LIBRA ASSOCIATION MEMBERS, WHITE PAPER (2019).

the timely and accurate determination of vote entitlement. During voting and general meetings, blockchain's transparent nature would facilitate instantaneous vote tabulations. This efficiency will provide shareholders with finality and also increase the legitimacy of the election.[200]

E. Shareholders: Miners or Readers?

There are a few entities that already operate on a blockchain, where shareholders have a greater role in the everyday decision-making and operations.[201] These shareholders are "tak[ing] a greater role in the management of their organizations, with innovations such as real time accounting, nearly instantaneous voting mechanism, and more efficient markets."[202] However, this will not be the *modus operandi* for the majority of publicly traded companies, as most shareholders might not necessarily be involved to such a great extent.

The key questions in regard to the shareholders are: what should their role on the blockchain be? To what extent should they be actively involved in mining the corporate blockchain, if at all? If all shareholders are able to mine, that might negatively affect the speed or even security of the blockchain, yet it would provide the blockchain with a higher level of trust. Alternatively, there could be a mechanism where only shareholders who (i) have a specific percentage of ownership,[203] or (ii) are regularly active would be provided with mining opportunities, within which they could also be incentivized with tokens. Other shareholders would only be provided with some kind of "reading" rights, where they can see what is happening on the blockchain but cannot mine.

In order to guarantee the security of a blockchain and create incentive mechanisms, a combination of proof-of-work and proof-of-stake algorithms could be applied. The proof-of-stake would keep the blockchain safe and the proof-of-work would enable the reward (or token) associated with completing a new block.[204] Peercoin was "the first alt-coin to use a hybrid Proof-of-Work and Proof-of-Stake algorithm to issue a new currency."[205] Tokens could represent an additional feature of the blockchain. These tokens could encapsulate an incentive mechanism where the number of

200. Lafarre & Van der Elst, *supra* note 141, at 16.

201. *See, e.g.*, CONSENSYS, https://consensys.net/about/ [https://perma.cc/EC2H-LQFG] (last visited May 26, 2020) (describing how ConsenSys gives shareholders a more powerful position, which enables business models to be built on blockchain).

202. *See* Wright & De Filippi, *supra* note 136, at 36.

203. The percentage could correlate with the existing regulation on minority shareholders, which varies between jurisdictions from 3% to 25%. Minority shareholders are usually provided with a greater set of rights in order to protect their position. *OECD Corporate Governance Factbook*, OECD 80 tbl.3.2 (June 8, 2019), http://www.oecd.org/corporate/Corporate-Governance-Factbook.pdf [https://perma.cc/NN8C-3Q8R].

204. Sunny King & Scott Nadal, *PPCoin: Peer-to-Peer Crypto-Currency with Proof-of-Stake,* PEERCOIN (Aug. 19, 2012), https://archive.org/details/peercoin-paper [https://perma.cc/QJ29-7S23].

205. ANDREAS M. ANTONOPOULOS, MASTERING BITCOIN: UNLOCKING DIGITAL CRYPTO-CURRENCIES 226 (Mike Loukides & Allyson MacDonald eds., O'Reilly Media 2014).

uses would enhance voting power or would increase the dividend. The code within the token could also have various features.

The blockchain platform should, at minimum, provide shareholders with reading privileges that would allow them to access corporate documents, observe the activities on the blockchain, store copies of the blockchain, and thereby help secure the system. It should also allow them to trace their past voting instructions and votes, as well as provide them with secure tools to communicate.

Corporations have, for a long time, relied on the separation of ownership and control, where Boards often govern a company with only very limited oversight from shareholders. Through the deployment of new and innovative blockchain technology, shareholders may take on a greater role in the management of their organizations, as discussed in Part II of this Article. In a world of decentralized, autonomous consensus, collective decision-making could take greater prominence, resulting in increased corporate governance and democratization of corporate power. Blockchain computing changes how consensus can be reached and will, therefore, change how any organization that applies blockchain technology serves its members.[206]

F. Additional Flaws

The inherent risks and flaws connected to blockchain will vary depending on the type of blockchain a corporation aims to implement. For instance, in the case of a public blockchain, there is a possibility of a "51% Attack."[207] But this is not really a concern in the case of private, consortium, or modified blockchains because the nodes' power is more limited than it would be in a public blockchain. Shareholder wallets are another concern that would need to be addressed. It must be determined who will be in control of the shareholders' wallets—that is, who is the trusted party? Is it a government or governmental agency that is responsible for keeping the identification information safe? Most presumably, yes. Furthermore, there would need to be processes in place in the event that a blockchain wallet is lost.

Another major concern that has already been mentioned is the cost of a blockchain, which ultimately will be borne by all the shareholders. An additional substantial flaw is the energy consumption. The digital consumption index continues to increase with the complexity of generating new blocks.[208] This is a concern not only because of the energy efficiency

206. Chris Hammerschmidt, *Consensus in Blockchain Systems. In Short.*, MEDIUM (Jan. 27, 2017), https://medium.com/@chrshmmmr/consensus-in-blockchain-systems-in-short-691fc7d1fefe [https://perma.cc/64XT-PC3A] (explaining how a consensus is reached in blockchain).

207. *See* discussion *supra* Section I.E.4. For more on blockchain security attacks, see JOSEPH HOLBROOK, ARCHITECTING ENTERPRISE BLOCKCHAIN SOLUTIONS 335–36 (John Wiley & Sons 2020).

208. Currently, according to Digiconomist, Bitcoin's energy footprint per transaction is 541.29 kWh. To better visualize the consumption of energy in the case of Bitcoin, 541.29 kWh is equivalent to the power consumption of an average U.S. household for

of corporations, but also in light of climate change, the need to limit carbon dioxide emissions, and electricity consumption at large.[209] Further concerns are connected to privacy. With a public or a semipublic blockchain, all transactions are visible.[210] Even with a permissioned blockchain, a shareholder owning only one share would have access to all of the information.[211] This might prove problematic and not truly efficient. Based on any economic theory, it is hard to assess to what extent this transparency is positive and to what extent it raises new economic behavior concerns.

These substantial limitations could potentially present too great of a risk to even undertake blockchain as a tool for corporate governance. Yet, the existing forms of blockchain continue to develop with new variations, which can "offer differing degrees of control and decentralization across a spectrum of options."[212]

Conclusion

Blockchain is a very promising technology, yet it is still emerging and thus immature in comparison to other technologies. It has a number of weaknesses, out of which its costs and electric consumption should be considered the most relevant. However, this situation, over the next years, can substantially change and a different mechanism of "proof" could be developed. The World Economic Forum predicts that by 2027, 10% of the world's gross domestic product will be stored on some form of blockchain technology.[213] Whether this is true or not, and whether blockchain represents a truly time-changing solution or just a fad that in a couple of years will evaporate, is the crucial question that corporations need to address. Nevertheless, according to TechCrunch, at least $1.3 billion was invested globally in 2018 into blockchain-developing companies.[214]

Many countries have already started to adopt changes to their regula-

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over 18.29 days. *Bitcoin Energy Consumption Index*, DIGICONOMIST (2020), https://digiconomist.net/bitcoin-energy-consumption [https://perma.cc/2UJ9-WWRL].

209. That being said, there are several operations that use alternative or renewable energy. In Iceland, its biggest Bitcoin operation is run on the renewable geothermal energy and arctic air cooling. *See* Nathaniel Popper, *Into the Bitcoin Mines*, N.Y. TIMES: DEALBOOK BLOG (Dec. 21, 2013, 1:42 PM), https://dealbook.nytimes.com/2013/12/21/into-the-bitcoin-mines/ [https://perma.cc/N8KH-HKN8].

210. *See* Sarah Meiklejohn, *The Limits of Anonymity in Bitcoin*, *in* ROUTLEDGE HANDBOOK OF CRIME SCIENCE 280, 280–81 (Richard Wortley et al. eds., Routledge 2018).

211. Permissioned, public blockchains "are a form of hybrid system that provide for situations where whitelisted access is required but all the transactions should be publicly viewable." *See* CATHERINE MULLIGAN ET AL., BLOCKCHAIN BEYOND THE HYPE: A PRACTICAL FRAMEWORK FOR BUSINESS LEADERS 5 (2018).

212. Alexander Daniels, *Blockchain & Shareholder Voting: A Hard Fork for 21st-Century Corporate Governance*, U. PA. J. BUS. L. 405, 431 (2018).

213. *Deep Shift: Technology Tipping Points and Societal Impact*, WORLD ECON. F. 1, 24 (2015), http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf [https://perma.cc/24JP-QTL7].

214. Jason Rowley, *With at Least $1.3 Billion Invested Globally in 2018, VC Funding for Blockchain Blows Past 2017 Totals*, TECHCRUNCH (May 20, 2018, 2:11 PM), https://techcrunch.com/2018/05/20/with-at-least-1-3-billion-invested-globally-in-2018-vc-funding-for-blockchain-blows-past-2017-totals/ [https://perma.cc/KD8U-8HNZ].

tory framework in order to support blockchain.[215] The global distribution of blockchain development activity encourages jurisdictional competition among regions. U.S. dominance of the early Internet industry produced major benefits, both economic and in terms of global soft power. Hoping to be the Silicon Valley of the crypto economy, countries ranging from tiny Gibraltar to giant Russia are creating new legal frameworks to attract blockchain start-ups, coin offerings, and other activities.[216] The early leader is the canton of Zug in Switzerland, which relies on a stable government, a central location in Europe, a welcoming environment for cryptocurrency companies, and very favorable tax policies.[217] Since 2016, it has been using blockchain technology to pay cantonal taxes.[218] There is no certainty that the U.S., or any other jurisdiction, will strike the appropriate balance between flexibility and protection in its regulatory approaches to blockchain-based systems. The debates over this technology have just begun. Overall, though, regulators who do nothing will be a greater threat to the development of the market than those who engage in thoughtful and evolving efforts to address public policy considerations.

Aside of all predictions, technology should not only be about the technology itself, but also about the purpose it serves. Therefore, the main concern for regulators and lawyers should be the added value of blockchain and whether this technology can further the policy goals of corporate governance, provide transparent overview of ownership, support easier access to information, provide more shareholders with the opportunity to vote and to be active owners, and support the ideas on which our markets have been built and which we have struggled to enforce.

As the technology matures and continues to be accepted by more jurisdictions, blockchain could accelerate a structural shift of power. As Professor Kevin Werbach has emphasized, blockchains "operate as mechanisms of law and governance."[219] Code-based rules and protocols governed by a blockchain-based network would provide greater transparency and efficiency. Code-based protocols and decisions related to their development would ultimately dictate how these systems work and shape our means of

215. The year 2019 substantially changed the regulatory scene. New regulations, or draft regulations, have been adopted in several jurisdictions across the world, including Switzerland, Liechtenstein, Malta, France, the U.K., Japan, Hong Kong, and several states of the U.S. *See, e.g.*, *Blockchain Laws and Regulations 2020*, GLI (Oct. 23, 2019), https://www.globallegalinsights.com/practice-areas/blockchain-laws-and-regulations [https://perma.cc/6J3L-VWS6].

216. *See* BNP PARIBAS, *supra* note 187; GIB. STOCK EXCHANGE, *supra* note 188. *Cf.* Kevin Helms, *Russian Official: Cryptocurrency Bill Completed– Effects on Payments, Exchanges, Miners*, BITCOIN NEWS (Apr. 3, 2020), https://news.bitcoin.com/russia-cryptocurrency/ [https://perma.cc/Y48Y-VCHL].

217. Dean Steinbeck, *Zug: The Crypto-Friendly Jurisdiction Where You Can Pay Taxes in Bitcoin*, CRYPTO L. INSIDER (Sept. 4, 2018), https://cryptolawinsider.com/zug-the-crypto-friendly-jurisdiction-where-you-can-pay-taxes-in-bitcoin/ [https://perma.cc/P7RH-9GVH].

218. *Id.*

219. KEVIN WERBACH, THE BLOCKCHAIN AND THE NEW ARCHITECTURE OF TRUST 10 (2018).

interaction, whether that be transfer of files, money, knowledge, or (possibly) votes.

Corporate governance could change in many ways through blockchain technology. Shareholders, institutional investors, and activist shareholders could benefit from being able to access shareholders' records, share information, and vote. Yet, I am slightly doubtful about whether there will be sufficient support for this change, and whether the Boards would have any incentive to bring more clarity and transparency to a system that is hard to understand for outsiders and regular shareholders. Information asymmetry, rational ignorance, and the overall sentiment on the value of the shareholder vote might support the existing system, where the power remains in the hands of few—namely, Boards and institutional investors. To change the existing structures, there would have to be a substantial push from shareholders, a scandal, or another financial crisis. If I was to be more optimistic, then I would conclude that the market will first decide whether blockchain innovations prove cost-effective and efficient, and only then would blockchains become the technological foundation of modern corporations.