

BLOCKCHAIN, SECURITIES MARKETS AND CENTRAL BANKING

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ABSTRACT

Distributed ledger technology, a variant of which is blockchain technology, represents one of the most important innovations of the fintech revolution. Academics, policymakers and market participants are experimenting with the technology with the aim of enhancing the functioning of financial markets. Industry consortia are being formed by the biggest financial institutions in the world seeking to leverage the use of the technology, in order to improve the clearing and settlement process. Furthermore, central banks in advanced and developing economies are examining the potential of using the technology in market infrastructures operated by central banks and are even exploring the possibility of issuing digital base money. Nevertheless, the widespread adoption of distributed ledger technology as envisioned by its ardent supporters encounters considerable legal obstacles, including the numerous new regulations imposed on financial markets and market participants in the aftermath of the financial crisis. The present paper will seek to disentangle the myths from the realities of the so-called distributed ledger technology or blockchain revolution and discuss how the legal regime can act both as an impediment and a catalyst to the widespread adoption of the technology.

INTRODUCTION

On September 15, 2008 Lehman Brothers filed for bankruptcy unleashing the most severe economic crisis since the Great Depression.¹ The bankruptcy of Lehman

¹ For an excellent account of the financial crisis see ANDREW ROSS SORKIN, *TOO BIG TO FAIL* (2010) & G. Gordon & A. Metrick, *Securitized Banking and the Run on Repo*, 104 *JOURNAL OF FINANCIAL ECONOMICS* 425 (2012).

Brothers was followed by the dry-up of liquidity in financial markets and the simultaneous distress of multiple systemically important financial institutions. In their quest to avert an economic calamity, governments and central banks around the world decided to massively intervene in financial markets and expend vast sums of taxpayer money, in order to bailout failing financial institutions, and stabilize the financial system. Shortly after Lehman's bankruptcy, in November 2008, Satoshi Nakamoto, whose real identity remains unknown, driven in part by anger over the financial crisis, published a proposal for a peer-to-peer electronic cash system.² The proposal formed the basis for the launch, in January 2009, of Bitcoin, the world's first decentralized digital currency. Despite the initial enthusiasm surrounding Bitcoin and its potential to bypass the banking system and displace sovereign fiat currencies, the cryptocurrency has witnessed limited success due to its high volatility, its increasing use to facilitate criminal activities and its vulnerability to hacking attacks and thefts.³

While the hype around Bitcoin is already starting to fade away, financial industry participants, regulators and central bankers have turned their attention to Bitcoin's underlying technology, the blockchain, and its variants, collectively referred to as distributed ledger technologies. Distributed ledger technologies have been touted as a panacea for resolving the inefficiencies of the current system for trading financial assets. For instance, in a rare case of industry-wide cooperation, over 80 of the world's most prominent financial institutions and regulators have formed a consortium led by financial technology company R3.⁴ The aim of the consortium is the development of commercial applications of distributed ledger technologies for the financial industry and the promotion of industry-wide standards. What is more, central banks in both developed and developing countries are examining potential applications of distributed ledger technology in order to more effectively carry out their tasks. Andy Haldane, Chief Economist of the Bank of England, was the first central banker to publicly

² Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN PROJECT, <http://bitcoin.org/bitcoin.pdf> [<https://perma.cc/GXZ8-6SDR>].

³ David Yermack, *Is Bitcoin a Real Currency? An Economic Appraisal* (Nat'l Bureau of Econ. Research, Working Paper No. 19747, 2013), available at <http://www.nber.org/papers/w19747>.

⁴ Jenima Kelly, *Blockchain Platform Developed by Banks to be Open-Source*, REUTERS, October 20, 2016, available at <http://uk.reuters.com/article/us-banks-blockchain-r3-exclusive-idUKKCN12K17E>

acknowledge the central role that the technology can play in supporting the future issuance of central bank digital currency.⁵

Nonetheless, the widespread adoption of the technology faces considerable legal hurdles, including the numerous new regulations imposed on financial markets and market participants in the aftermath of the financial crisis. In a recent speech, Abigail Johnson, CEO of Fidelity Investments, cited regulatory issues as a major obstacle to broader adoption of distributed ledger technology.⁶ The aim of this paper is to disentangle the myths from the realities of the so-called distributed ledger technology or blockchain revolution and discuss how the legal regime can act both as an impediment and a catalyst to the widespread adoption of the technology.

Part I offers an introduction to distributed ledger technologies and seeks to demystify them. Part II examines the potential application of distributed ledger technologies to securities markets and central banking. Finally, Part III discusses the role of law in the development of distributed ledger technology and its widespread adoption. On the one hand, numerous legal hurdles hinder the adoption of the technology. On the other hand, tweaks in the legal rules can act as a catalyst for its application. The Delaware Blockchain Initiative and the French Government's initiative to authorize the use of distributed ledger technology for the issuance and transfer of mini-bonds serve as examples of changes to the regulatory regime, which can act as a catalyst for the application of distributed ledger technology to securities markets.

I. DEMISTIFYING DISTRIBUTED LEDGER TECHNOLOGIES

The term distributed ledger essentially refers to a database, which is shared across a network. Distributed ledgers can be used to transfer, store and maintain ownership records of digital assets or digital representations of assets. Distributed ledger

⁵ Andy Haldane, Speech Given at the Portadown Chamber of Commerce, Northern Ireland: How Low Can You Go? (September 18, 2015).

⁶ Sarah Krouse, *Bitcoin's Unlikely Evangelist: Fidelity CEO Abigail Johnson*, WALL ST. J., May 23, 2017, available at <https://www.wsj.com/articles/fidelity-ceo-bringing-blockchain-to-the-masses-harder-than-it-seemed-1495548000>

technology allows users, which do not necessarily trust each other, to share the responsibility of database management without recourse to a central validation authority.⁷ The technology was first used for the transfer of Bitcoin and other digital currencies. The transfer process and recordkeeping of assets is supported by certain innovative elements of distributed ledger technology.⁸ Peer-to-peer networking and distributed data storage allow for the sharing of a single ledger across participants in the network with participants having a shared history of transactions. Another innovative feature of the technology is the extensive use of cryptography to securely transmit and store assets and validly initiate a transaction. Moreover, consensus algorithms are utilized for the confirmation and addition of transactions to the ledger.

The most famous variant of distributed ledger technology is the blockchain, the technology underlying Bitcoin and other digital currencies. The blockchain records transactions in a sequential archive. All individual transactions are stored in blocks, which are attached to each other in chronological sequence using cryptographic techniques (hashing), creating thus a long chain.⁹ The chain forms a record of transactions. Another variant of distributed ledger technology are consensus ledgers. In contrast to blockchain technology, which groups and chains transactions, only the balance of accounts of participants is updated in validation rounds by users. Finally, synchronized bilateral ledgers allow counterparties to update the information that pertains to their reciprocal activity and display that information to a broader range of users.

Depending on who can access the ledger and become a member of the network, distributed ledger technologies are divided into restricted and unrestricted systems.¹⁰ In an unrestricted system any unknown entity can access the database and play any role, such as proposing updates to the ledger and contributing to the validation of transactions. The blockchain is an example of an unrestricted system. Any entity can

⁷ Andrea Pinna & Wiebe Ruttenberg, *Distributed Ledger Technologies in Securities Post-Trading: Revolution or Evolution?*, 6 (ECB, Occasional Paper No 172, April 2016).

⁸ Lael Brainard, Speech at the Institute of International Finance Blockchain Roundtable, Washington, D.C., The Use of Distributed Ledger Technologies in Payment, Clearing and Settlement (April 14, 2016).

⁹ For an excellent technical analysis of blockchain technology see David Yermack, *Corporate Governance and Blockchains* (Nat'l Bureau of Econ. Research, Working Paper No. 21802, 2015).

¹⁰ See BANK OF INTERNATIONAL SETTLEMENTS COMMITTEE ON PAYMENTS AND MARKET INFRASTRUCTURES, *DISTRIBUTED LEDGER TECHNOLOGIES IN PAYMENT, CLEARING AND SETTLEMENT: AN ANALYTICAL FRAMEWORK 7-9* (FEBRUARY 2017) & EUROPEAN CENTRAL BANK, *DISTRIBUTED LEDGER TECHNOLOGY 2* (2016).

access the network and contribute to the validation of transactions through a process called mining. Participants on the network, known as miners, add new records by solving complex cryptographical problems. The participant who first solves the problem and inserts new records on the ledger is rewarded with Bitcoins. Users are identified solely by a cryptographic public key, which is not necessarily linked to their real identity.

In contrast, in restricted systems membership in the network is limited. Only identified entities can participate in the network. One can further distinguish between restricted egalitarian and tiered systems. On the one hand, in restricted egalitarian systems, the identified entities, which participate in the network can assume any role, such as contributing to the validation of transactions. On the other hand, restricted tiered systems impose restrictions not only on which entities can become members of the network but also on the roles that these entities can assume once they have joined the network. For instance, only certain authorized entities may be allowed to validate transactions.

Smart contracts are another technology that can be combined with and leverage the potential of distributed ledger technology. Pursuant to Szabo, a smart contract can be defined as “a computerized protocol that executes the terms of a contract”.¹¹ In essence, the terms of the contracts are written in computer language. Smart contracts seek to assure the fulfillment of the promises of a party to a contract. Their promise lies in their potential to drastically reduce the costs of verification, mediation and enforcement.¹² It should be noted that the concept of smart contracts predates the current digital revolution. An example of a smart contract is the vending machine. In the context of a distributed ledger, smart contracts can be used to transpose the contractual obligations of parties to a transaction into the ledger and transfer assets

¹¹ 8 Nick Szabo, *A Formal Language for Analyzing Contracts*, NICK SZABO’S ESSAYS, PAPERS, & CONCISE TUTORIALS (2002) Numerous other authors have offered alternative definitions of smart contracts. See e.g. Max Raskin *The Law and Legality of Smart Contracts*, 1 *Georgetown Law Technology Review* 304, 309-310 (2017) (“A smart contract is an agreement whose execution is automated. This automated execution is often effected through a computer running code that has translated legal prose into an executable program. This program has control over the physical and digital objects needed to effect execution.”) & Christopher D. Clack et al., *Smart Contract Templates: Foundations, Design Landscape and Research Directions* 2 (Aug. 4, 2016) (unpublished manuscript), <http://arxiv.org/pdf/1608.00771v2.pdf> [<https://perma.cc/8Z5P-QRM9>] (“A smart contract is an agreement whose execution is both automatable and enforceable. Automatable by computer, although some parts may require human input and control. Enforceable by either legal enforcement of rights and obligations or tamper-proof execution.”).

¹² Raskin, *supra* note 11, at 320.

pursuant to contractual terms via automated procedures when specified events occur either inside or outside the ledger.¹³

Distributed ledger technologies offer numerous advantages over proprietary ledgers. Most notably, a distributed ledger network dispenses with the necessity of relying on a central validation authority. Instead of relying on a single authoritative “golden” ledger, multiple copies of the ledger are spread across a network of users with each user having its own copy. As a result, the network is resilient against the failure of a single network node or a cyberattack. In addition, tampering with the ledger becomes prohibitively difficult, since users are able to observe changes to the data recorded on the ledger. Furthermore, distributed ledger technology guarantees transaction permanence and immutability by making retroactive editing of the ledger extremely onerous. Moreover, distributed ledgers provide a solution to the double-spending problem, common in other digital cash schemes.

Furthermore, distributed ledger technologies can be applied to the transfer and storage of a wide array of financial assets. As a result, market participants can leverage the potential of the technology at various stages of the trading cycle across numerous asset classes. Finally, distributed ledger technologies combined with smart contracts can lead to the creation of a new form of organization called the decentralized autonomous organization.¹⁴ These organizations operate pursuant to rules and procedures specified in smart contracts. An example was the DAO, a venture capital fund governed by its investors and operating on Ethereum, Bitcoin blockchain’s main rival blockchain platform. The DAO, which had managed to raise more than 150 million worth in cryptocurrency, was attacked by hackers which were able to siphon more than 50 million of digital money.¹⁵

¹³ Pinna & Ruttenberg, *supra* note 7, at 18.

¹⁴ For an overview of the concept of decentralized autonomous organizations see Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia* 15 (March 10, 2015), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664.

¹⁵ Nathaniel Popper, *A Hacking of More than 50 Million Dashes Hopes in the World of Virtual Currency*, N.Y. TIMES, June 17, 2016, available at https://www.nytimes.com/2016/06/18/business/dealbook/hacker-may-have-removed-more-than-50-million-from-experimental-cybercurrency-project.html?_r=0

II. DISTRIBUTED LEDGER TECHNOLOGIES, SECURITIES MARKETS AND CENTRAL BANKING

The potential of distributed ledger technologies has not gone unnoticed by market participants and policymakers in both the developed and the developing world. Numerous financial centers are engaging in a race to the top seeking to position themselves at the forefront of the distributed ledger revolution.¹⁶ The world's largest financial institutions, including household names such as Morgan Stanley, Goldman Sachs and Bank of China, are forming consortia or bankrolling projects, in order to develop applications of the technology in the financial sector.¹⁷ Furthermore, central banks of the world's major economies, namely the Federal Reserve, the European Central Bank, the Bank of Japan and the Reserve Bank of India and the Bank of England, are exploring the possibility of using the technology in market infrastructures operated by central banks and are even exploring the possibility of issuing digital base money.¹⁸ Finally, financial supervisory and regulatory authorities, such as the Financial Conduct Authority in the UK (hereinafter "FCA") and the European Securities Market Authority (hereinafter "ESMA") are examining the risks posed and the opportunities offered by distributed ledger technology and are considering the implications of the use of the technology for the existing regulatory framework.

A. *Distributed Ledger Technologies and Securities Markets*

Exploitation of the distributed ledger technology in securities markets is still in its infancy. Financial markets participants and supervisory and regulatory authorities are carefully examining the potential benefits and risks of the technology and the

¹⁶ See Nikhil Lohade, *Dubai Aims to be a City Built on Blockchain*, WALL ST. J., April 24, 2017, available at <https://www.wsj.com/articles/dubai-aims-to-be-a-city-built-on-blockchain-1493086080>

¹⁷ See Telis Demos, *Banks Test Blockchain Network to Share Trade Data*, WALL ST. J., September 20, 2016, available at <https://www.wsj.com/articles/banks-test-blockchain-network-to-share-trade-data-1474379893>

¹⁸ See Payment and Settlement Systems Department Bank of Japan, ECB and the Bank of Japan launch a joint research project on distributed ledger technology, New Release, available at https://www.boj.or.jp/en/announcements/release_2016/rel161207a.htm/ & John Sindreu, *The Central Bankers' Bold New Idea Print Bitcoin*, WALL ST. J., July 19, 2016 available at <https://www.wsj.com/articles/the-central-bankers-bold-new-idea-print-bitcoins-1468936751>

implications that its adoption would entail for the financial system. Proponents of the technology claim that it can streamline complex financial processes and save costs. The technology has the potential to radically alter the role played by financial intermediaries in trading, clearing and settlement.¹⁹ In the extreme scenario, distributed ledger technology could completely change the current market structure allowing financial market participants to directly transact with each other and exchange assets and funds instantaneously without the involvement of financial intermediaries.²⁰ The promise of the technology is such that over 80 of the world's largest financial institutions, in a rare case of industry wide cooperation, decided to form a consortium led by R3, a fintech company.²¹ The efforts of the consortium have resulted in the creation of an open-source distributed ledger platform, named Codra, which is designed to record financial events and execute smart contracts.

The issuance and trading of securities on a distributed ledger could result in greater transparency and faster clearing and settlement. The issuance of securities on a distributed ledger platform may facilitate the recording and tracking of ownership of the securities.²² For instance, shareholders of a company would have a complete view of the record of ownership of the securities and would be able to instantaneously identify changes in ownership. The implications for securities markets and corporate governance would be profound. Shareholders would be able to observe the trades of managers in real time. As a result, managers would be more closely monitored by outside shareholders. Furthermore, managers' ability to engage in insider trading would be severely curtailed. Moreover, managers would be prevented from backdating financial instruments, such as stock option awards and stock option exercises, since entries on certain distributed ledger platforms, such as blockchain platforms, are time-stamped and cannot be changed retroactively.²³ Numerous financial institutions are already experimenting with the use of the technology for securities issuance. Nasdaq's blockchain platform, called Linq, is designed for private companies issuing debt and

¹⁹ Brainard, *supra* note 8.

²⁰ *Id.*

²¹ Paul Vigna, *Blockchain Firm R3 Raises 107 Million*, WALL ST. J., May 23, 2017, available at <https://www.wsj.com/articles/blockchain-firm-r3-raises-107-million-1495548641>

²² Yermack, *supra* note 9, at 15-16.

²³ For an analysis of the practice of backdating by managers see Jesse Fried, *Option Backdating and Its Implication*, 65 WASHINGTON AND LEE LAW REVIEW 853 (2008) & Cicero, David C., 2009, *The Manipulation of Executive Stock Option Exercise Strategies: Information Timing and Backdating*, 64 JOURNAL OF FINANCE 2627-2663

stock.²⁴ Furthermore, in December 2016 online retailer Overstock completed the issuance of digital securities on a proprietary blockchain platform.²⁵

Moreover, distributed ledger technology can radically alter the current clearing and settlement cycle. The technology can lead to the reduction of costs and the shortening of the time required for clearing and settling securities transactions. According to proponents of distributed ledger technology, the application of the technology in securities markets could result in faster clearing and settlement of transactions.²⁶ In theory, clearing and settlement could be combined in a single step and become (almost) instantaneous. Generally, securities trades require three business days for settlement in the US and two business days in Europe. Numerous intermediaries are involved before settlement occurs and ownership moves formally from seller to buyer.²⁷

The adoption of distributed ledger technology has the potential to dispense with a number of intermediaries and make the reconciliation process more efficient. Since all participants in the distributed ledger network would have access to copies of a single authoritative ledger, the need for reconciling duplicative, and at times conflicting, records would be eliminated. Shorter settlement cycles would mitigate counterparty risk, since each party would be exposed for a shorter time period to the default risk of its counterparty. Distributed ledger technology could even eliminate counterparty risk and remove the need for clearing if settlement becomes instantaneous. However, it should be noted that the elimination of counterparty risk is possible only in case of cash spot transactions. In contrast to spot transactions where a single settlement extinguishes the obligations of the parties to the transactions, term transactions, most notably derivatives, create obligations throughout the life of the contract. In case of derivative transactions, there is a need to reduce counterparty risk throughout the life of the contract. Consequently, distributed ledger technology is unlikely to lead to an

²⁴ Paul Vigna, *Nasdaq Blockchain Based Securities Platform Records First Transaction*, WALL ST. J., December 30, 2015 available at <https://blogs.wsj.com/moneybeat/2015/12/30/nasdaqs-blockchain-based-securities-platform-records-first-transaction/#> =

²⁵ Michael Del Castillo, *Overstock Raises 10.9 Million in First Blockchain Stock Issuance*, COINDESK, December 15, 2016, available at <http://www.coindesk.com/overstock-first-blockchain-stock-issuance/>

²⁶ EUROPEAN SECURITIES MARKETS AUTHORITY, *THE DISTRIBUTED LEDGER TECHNOLOGY APPLIED TO FINANCIAL MARKETS* 10 (2 JUNE 2016).

²⁷ For an overview of the current state of equity post-trade processes see WORLD ECONOMIC FORUM, *REPORT ON THE FUTURE OF FINANCIAL INFRASTRUCTURE: AN AMBITIOUS LOOK AT HOW BLOCKCHAIN CAN RESHAPE FINANCIAL SERVICES* 121-123 (AUGUST 2016).

elimination of counterparty risk with clearing retaining its importance for derivative transactions. What is more, faster settlement would lower the amount of collateral posted for hedging counterparty risk. Finally, the reduction in costs and the compression of the settlement cycle could result in an increase in liquidity.

Smart contracts have numerous applications in the field of corporate finance and securities markets. Their use has the potential to reduce costs and improve the efficiency of post-trade processes. Smart contracts allow for the automatic execution of transactions to take place in the ledger based upon simple events, such as the passage of time, specific corporate actions or market events.²⁸ As a result, numerous transactions, including the payment of coupons or dividends, the transfer of collateral in case of default, the issuance of margin calls and the exchange of margin for derivatives, netting and the exercise of options embedded in derivatives, can become fully automated.²⁹

Distributed ledger technologies can also greatly facilitate the collection and sharing of data for supervisory purposes. Regulators can be granted special access to the distributed ledger platform in order to retrieve data from the platform, such as the exposures or the transactions made by a financial institution. Hence, regulators will have direct and immediate access to valuable information, which will allow them to monitor the buildup of systemic risk in the financial system. Nonetheless, granting access to regulators is not without its risks. As ESMA notes, direct access may entail reputational risks for regulators, since it might result in a sharing of responsibility between regulated institutions and regulators.³⁰ Moreover, the ability of distributed ledger platforms to process transactions 24/7 has the potential to promote the globalization of securities markets.

Nonetheless, it should be stressed that the widespread adoption of the technology and the radical transformation of securities markets as envisioned by its utopian proponents faces considerable obstacles. For instance, shorter settlement cycles will reduce or even eliminate netting. In addition, a shift to near real-time settlement will lead to profound changes in business processes with parties to a transaction having

²⁸ ECB, *supra* note 7, at 18.

²⁹ Yermack, *supra* note 9, at 33 & OLIVERY WYMAN, BLOCKCHAIN IN CAPITAL MARKETS: THE PRIZE AND THE JOURNEY 10-11 (February 2016)

³⁰ EUROPEAN SECURITIES AND MARKETS AUTHORITY, REPORT ON THE DISTRIBUTED LEDGER TECHNOLOGY APPLIED TO SECURITIES MARKETS 6 (FEBRUARY 2017).

to hold securities or cash prior to trade.³¹ Moreover, the challenge of replacing existing legacy systems and changing incumbent business processes should not be underestimated. The adoption of the technology hinges on a careful analysis of on the one hand the benefits of the technology in terms of cost reduction and improvements in efficiency and on the other hand the cost of investment in the technology and operational changes.³²

Furthermore, since it is highly unlikely that only a single distributed ledger arrangement will be deployed in financial markets, interoperability across different distributed ledger arrangements will be a crucial factor in determining the extent of the application of the technology. Under the most plausible scenario, certain legacy systems will continue to exist. Consequently, market participants seeking to adopt the technology must also ensure the interoperability between distributed ledger arrangements and legacy systems. Finally, significant doubts remain on whether distributed ledger technology can be scalable to high-volume markets, such as the US stock market.

With regard to what the future may look like, one can discern three alternative scenarios concerning the adoption of the technology: a) individual financial market participants apply the technology in order to improve internal efficiency without a major impact on the financial ecosystem b) a group of core market players embrace a shared distributed ledger making some other players redundant c) a peer-to-peer world without financial intermediaries where issuers and investors are able to transact directly on the ledger.³³ Real world applications of the technology predominantly revolve around the first and second scenarios.³⁴

B. Distributed Ledger Technology and Central Banking

³¹ Michael Mainelli & Alistair Milne, *The Impact and Potential of Blockchain on the Securities Transaction Lifecycle* 28 (SWIFT INSTITUTE WORKING PAPER NO. 007, 2015).

³² David Mills et al., *Distributed Ledger Technology in Payments, Clearing and Settlement* 22 (Finance and Economics Discussion Series Divisions of Research & Statistics and Monetary Affairs No 095, 2016).

³³ Yves Mersch, Member of the Executive Board EC, Speech at 22nd Handelsblatt Annual Conference Banken-Technologie, Distributed Ledger Technology: Role and Relevance of the ECB (December 6, 2016), available at <https://www.ecb.europa.eu/press/key/date/2016/html/sp161206.en.html>

³⁴ *Id.*

The advent of Bitcoin spurred discussions regarding the potential of cryptocurrencies to become viable competitors to fiat money. Bitcoin and imitator digital currencies were designed in order to bypass the modern central banking system. Proponents of Bitcoin touted the currency's algorithmic growth rate and deterministic supply, which make it immune to manipulation by central banks or any other government authority. Nevertheless, Bitcoin has not managed to establish itself as a viable alternative to central bank fiat money with the total value of all Bitcoins in circulation standing at around 40 billion US dollars,³⁵ a fraction of the approximately 1.5 trillion of dollars in circulation.³⁶ Thus, the attention of central bankers has turned to distributed ledger technology. The interest of central banks in distributed ledger technology stems from their role in defining and implementing monetary policy, promoting financial stability, supervising financial institutions, issuing physical currency, overseeing payment systems and operating financial market infrastructures for the settlement of payments and securities.³⁷

Central banks in developed and developing economies are examining the potential of using the technology in market infrastructures operated by central banks and are even exploring the possibility of issuing central bank issued digital currency. For instance, the European Central Bank and the Bank of Japan have recently announced the launch of joint research program into the possible use of distributed ledger technology for market infrastructures,³⁸ while the Bank of England is undertaking a multiyear research program into the implications of a central bank issued digital currency and has recently launched a fintech accelerator seeking to harness innovations for central banking.³⁹

³⁵ *Bitcoin Price Sprints to (New) All-Time High \$2,450, Market Cap > \$40 Billion*, BITCOINNEWS, available at <http://www.btcbitcoinnews.com/news/169866/Bitcoin-Price-Sprints-to-New-All-Time-High-2-450-Market-Cap-40-Billion>

³⁶ Board of Governors of the Federal Reserve System, *Currency in Circulation, Value*, available at https://www.federalreserve.gov/paymentsystems/coin_currircvalue.htm.

³⁷ BANK OF INTERNATIONAL SETTLEMENTS COMMITTEE ON PAYMENTS AND MARKET INFRASTRUCTURES, *DIGITAL CURRENCIES 13* (NOVEMBER 2015).

³⁸ Payment and Settlement Systems Department Bank of Japan, ECB and the Bank of Japan launch a joint research project on distributed ledger technology, *New Release*, available at https://www.boj.or.jp/en/announcements/release_2016/rel161207a.htm/

³⁹ Mark Carney, Governor of the Bank of England, *Speech at International FinTech Conference 2017, Old Billingsgate: Building the Infrastructure to Realize Fintech Potential* (April 12, 2017).

In fulfilling their tasks as operators and overseers of payment systems and other financial market infrastructures and as catalysts for financial market development and integration, central banks are responsible for the safe and efficient functioning of financial market infrastructures. The safe and efficient functioning of financial market infrastructures is of utmost importance for maintaining price stability, conducting monetary policy and safeguarding financial stability. Numerous central banks around the world are operators of financial market infrastructures with the most prominent example being the European Central Bank.

In its quest to promote financial market integration, the European Central Bank has developed two significant innovations in the field of payment and settlement systems: TARGET2 and TARGET2-Securities. TARGET2 is the real-time gross settlement system for the euro, while TARGET2-Securities is a single Pan-European platform for securities settlement in central bank money. Central banks, including the European Central Bank, have openly acknowledged that they are examining the possibility of moving the market infrastructure operated by them on a distributed ledger platform. Despite the promise of distributed ledger technology in terms of cost reduction, speed and efficiency, central bank officials have determined that distributed ledger technology is not yet ready for mass adoption and is not capable of meeting central banks' safety and efficiency standards.⁴⁰

The use of distributed ledger technology as a platform on which central banks might launch a digital currency has become by far the most hotly debated topic among central bankers.⁴¹ It should be noted that central bank digital currency already exists in the form of deposits at the central bank held by commercial banks.⁴² The recent discussion revolves around whether nonbank institutions, including households, should be allowed to directly open accounts at the central bank instead of depositing their funds at a traditional banking institution. Due to the enormous complexity and volume of

⁴⁰ Mersch, *supra* note 33.

⁴¹ In a recent study, researchers at the Bank of England find that the issuance of central bank digital currency could, under certain conditions, permanently increase by as much as 3% due to reductions in real interest rates, monetary transaction costs and discretionary taxes. See John Barrdear & Michael Kumhof, *The Macroeconomics of Central Bank Issued Digital Currencies* (Bank of England, Staff Working Paper, No. 605, July 2016).

⁴² Yves Mersch, Member of the Executive Board ECB, Speech at the Farewell Ceremony for Pentti Hakarrainen, Deputy Governor of Finland's Bank: Digital Base Money: An Assessment from the ECB's Perspective (January 16, 2017), available at <https://www.ecb.europa.eu/press/key/date/2017/html/sp170116.en.html>

required record-keeping and customer support, central banks have traditionally shied away from allowing the public to open accounts and deposit funds.⁴³ Digital technologies, most notably distributed ledger technology, might prove a solution to this problem. Central banks could operate their own distributed ledger platform on which they would issue digital currency. Depositors at the central bank would transfer digital currency over the ledger to other accountholders. The distributed ledger platform operated by the central bank would differ from distributed ledger technologies that do not rely on a trusted third party, such as blockchain. The central bank would assume the role of a trusted gatekeeper adding and modifying entries.

According to proponents of allowing the public to deposit funds at the central banks, a central bank issued digital currency would eliminate the shortcomings of fractional reserve banking. The central bank would not be subject to bank runs and the government could end the explicit and implicit guarantees offered to the banking system, such as deposit insurance, lender of last resort facilities and bailouts.⁴⁴ Furthermore, a central bank issued digital currency would greatly simplify the conduct of monetary policy. The central bank could bypass the banking system as a transmission channel of monetary policy and directly manipulate accountholder balances. As Andy Haldane has noted, a digital currency could solve the lower bound problem allowing the central bank to reduce interest rates on deposits at below zero, in order to spur consumption and investment.⁴⁵

Moreover, on a macroeconomic level, the government would be able to implement its desired economic policy in a more precise manner. For instance, it could directly credit funds to citizens of an underdeveloped geographic region that it wishes to support. Nevertheless, a major drawback of the issuance of central bank digital currency is that it would drain deposits from banks, a major source of their funding. In response, banks might severely reduce their lending activities leading to adverse consequences for the real economy.⁴⁶

⁴³ WINKLER, ROBIN, FEDCOIN: HOW BANKS CAN SURVIVE BLOCKCHAINS, DEUTSCHE BANK RESEARCH HOUSE KONZEPT 6-7 (2015).

⁴⁴ Max Raskin & David Yermack, *Digital Currencies, Decentralized Ledgers, And the Future of Central Banking* 12 (Nat'l Bureau of Econ. Research, Working Paper No. 22238 2016).

⁴⁵ Haldane, *supra* note 5.

⁴⁶ Raskin & Yermack, *supra* note 44, at 13.

III. The Role of Regulation

Despite the promise offered by distributed ledger technology, considerable regulatory obstacles create uncertainty regarding its widespread adoption in financial markets. The widespread adoption of distributed ledger technology depends on its ability to comply with the existing regulatory framework, including the numerous new regulations imposed on financial markets and market participants in the aftermath of the financial crisis. The existing regulatory framework is largely built upon the current financial market architecture, which is comprised of a network of financial institutions performing distinct functions and regulated and overseen by different supervisors. As a result, the development and widespread adoption of distributed ledger technology hinges on changes to the existing regulatory regime. The regulatory regime can thus serve as a catalyst for the further development and application of the technology in financial markets. Two notable examples are the Delaware Blockchain Initiative, which is a comprehensive program to provide an enabling regulatory and legal environment for the development of distributed ledger technology, and the initiative of the French government to spur the application of distributed ledger technology in the issuance and trading of mini-bonds.

A. Regulation as an Impediment to the Evolution of Distributed Ledger Technologies.

Financial markets and financial market participants are subject to stringent regulation, which is premised on the need to protect investors, safeguard financial stability and promote transparent and fair financial markets. Indeed, the financial crisis and the flaws exposed in the previous regulatory framework led to a radical overhaul and strengthening of financial market regulation. Apart from the regulatory framework applicable to financial markets and their participants, distributed ledger technologies are also subject to numerous other regulations, such as the regulatory framework governing data protection.

The promise of distributed ledgers lies in their ability to create a record of information that is updated and shared by participants. The reliability of the record as source of the underlying obligations and the enforceability of these obligations must therefore be guaranteed. Thus, the legal basis for these records is of utmost importance for the widespread adoption of distributed ledger technology. Where the legal regime cannot assure the reliability of the records, existing laws must be changed to accommodate recordkeeping on a distributed ledger. What is more, uncertainty from a legal point of view remains concerning the ownership rights and obligations associated with digital representation of assets and digital assets, such as digital shares or bonds.⁴⁷ The legal validity of financial instruments issued on a distributed ledger must be assured regulators and supervisors.

Furthermore, significant uncertainty remains regarding the legal nature of smart contracts. Smart contracts can be considered either an enforceable contractual agreement or just tools that execute a contractual agreement.⁴⁸ In order for smart contracts to be considered as enforceable contractual agreements, they must abide by the basic principles of contract law, including the rules regarding contract formation, amendment and termination. Some aspects of smart contracts are in contradiction with doctrines of contract law. For instance, the automatic execution of smart contracts contravenes with the doctrine of amendment of contracts due to changed circumstances.⁴⁹ Moreover, commentators have questioned the ability of the current technology to accurately encode the terms of a complex natural language contract. Significant challenges may also arise with regard to their enforceability. There may be no central administering authority to settle disputes between the parties forcing them to resort to courts. Nonetheless, in numerous cases, such as in case of operational defects resulting in nonperformance of the smart contract, there may be no obvious defendant against whom legal action may be brought.⁵⁰

⁴⁷ Mills et al, *supra* note 32, at 28.

⁴⁸ See also R3 & NORTON ROSE, CAN SMART CONTRACTS BE LEGALLY BINDING CONTRACTS? 13 (NOVEMBER 2016) discussing the spectrum of possibilities of what a smart contract could be. On the one extreme, the code is contract school of thought considers that the code that the code constitutes the entirety of the terms of a contract, and a running program referring to that code is a complete contract undergoing performance. On the other end of the spectrum, smart contracts could simply be the digitized performance of business logic.

⁴⁹ Mills et al., *supra* note 32, at 29.

⁵⁰ R3 & Norton Rose, *supra* note 48, at 18.

Taking into account that distributed ledger technologies are, at the moment, primarily explored for post-trading activities, such as clearing, settlement and securities servicing, the technologies are further subject to the numerous regulations governing these activities. For instance, regulations adopted in the aftermath of the financial crisis, require the clearing of derivative transactions through central counterparties (“CCP”). As a result, a distributed ledger network created, in order to clear derivatives would still need to comply with these requirements, namely that a central counterparty would be needed.

In addition, an important concept in financial markets is settlement finality. Settlement finality is a legally defined moment and refers to the point at which an order becomes irrevocable in relation to counterparties and when those parties have discharged their contractual obligations.⁵¹ The definition and timing of finality is crucial for the parties to a transaction and the intermediaries involved in the process when updating their ledger to settle the transaction and ascertain ownership rights concerning the assets involved in the transaction. Nonetheless, certain distributed ledger arrangements utilize consensus methods, which are probabilistic. Multiple participants are allowed to contribute to the updating of the ledger through the consensus process, whereby participants agree on the status of the ledger. The likelihood that a transaction will be reversed is reduced the longer the participants consider the transaction settled. Thus, a clear and transparent moment of finality does not exist. What is more, settlement finality is complicated in cases where the transaction has two legs, namely delivery of an asset versus payment, and the two legs are not occurring on the same ledger. As a result, there may be a need to introduce a new legal concept of finality for distributed ledger arrangements, in order to define when settlement takes place.⁵²

Moreover, market participants are obliged to comply with stringent anti-money laundering, counter-terrorist financing and know-your-customer rules. In restricted systems participants can be held accountable for their illegal activity in the ledger. In contrast, unrestricted systems do not provide the tools for allocating accountability. Thus, their operators may be held responsible for illegal activity in the ledger. Finally,

⁵¹ Andrea Pinna, *Distributed Ledger Technologies in Financial Markets? An Introduction and Some Point of Interest for Legal Analysis*, ESCB Legal Conference Paper 128 (January 2017).

⁵² *Id* at 129.

data protection issues loom large. More specifically, sharing a ledger among users of a network poses data privacy risks. In financial markets, the identity of parties to a transaction is not usually public except when regulations require disclosure. In addition, in case of distributed ledgers with immutable records, the right to be forgotten under European data protection law is excluded.⁵³

B. Regulation as a Catalyst to the Evolution of Distributed Ledger Technology

The State of Delaware in the US is the preferred state of incorporation for the overwhelming majority of US companies. Delaware's competitive advantages include an adaptive and business-friendly legal framework, a highly specialized judiciary in resolving corporate law disputes and responsiveness to the needs of its corporations.⁵⁴ As a result, Delaware corporate law serves as the foundation of American corporate finance. The Delaware Blockchain Initiative launched by the state's Governor to promote the adoption of distributed ledger technology in the private and public sectors. In the framework of this initiative, the Governor asked the Delaware State Bar Association's Corporation Law Council to examine whether changes should be made to the Delaware General Corporation Law to expressly authorize tracking of share issuances and transfers on a distributed ledger.

In March 2017, the Council released a set of proposed amendment to the Delaware General Corporation Law, which if enacted, would allow corporations incorporated in Delaware to authorize and issue so-called "Distributed Ledger Shares" that could be authorized, issued, transferred, redeemed on a distributed ledger.⁵⁵

⁵³See FINANCIAL CONDUCT AUTHORITY, DISCUSSION PAPER ON DISTRIBUTED LEDGER TECHNOLOGY 26 (APRIL 2017) & Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (OJ L 119, 4.5.2016, p. 1).

⁵⁴ More than half of all US publicly-traded companies and 64% of Fortune 500 companies are incorporated in Delaware. See Christopher Wink, *64% of Fortune 500 Firms Are Delaware Incorporations: Here's Why*, TECHNICALLY DELAWARE, September 23, 2014, available at <https://technical.ly/delaware/2014/09/23/why-delaware-incorporation/>

⁵⁵ Andrea Tinianow, *Delaware Blockchain Initiative: Transforming the Foundational Infrastructure of Corporate Finance* HARV. L. SCH. F. ON CORP. GOVERNANCE & FIN. REG. (March 16, 2017) & COOLEY, NEWLY RELEASED DELAWARE CORPORATE LAW AMENDMENTS WOULD PERMIT BLOCKCHAIN SHARES (March 2017).

Delaware corporations are required to maintain a stock ledger, which lists the names and addresses of the corporation's record owners, and register the issuance and transfer of shares on the ledger. Stock ledgers are usually maintained by the corporate secretary or the corporation's transfer agent and are maintained and updated by individuals. Any transfer of record ownership must be notified to the corporation or its transfer agent, who must record the transfer on the corporation's stock ledger, in order for the transferee to become the record owner of the transferred share. Pursuant to the proposed amendments, corporations would be allowed to use distributed ledgers to create and administer corporate records, including the stock ledger, without the involvement of any intermediary. Furthermore, amendments to the Delaware General Corporation Law would enable to give notices through the use of distributed ledger technology. Thus, the proposed amendments pave the way for the electronic transmission of investor communication using a distributed ledger.⁵⁶

Another initiative seeking to promote the application of distributed ledger technology via changes to the legal framework is the initiative of the French government to authorize the use of distributed ledger technology for the issuance and the recording of transfers of financial instruments termed "mini-bonds". Mini-bonds are obligations to reimburse, issued by companies to investors, in exchange for a loan.⁵⁷ The term of the loan is generally one to five years. At the end of the term, investors receive the principal amount and interest at a rate fixed at the beginning of the loan. Mini-bonds, which have been traditionally issued by SMEs, are particularly attractive for crowdfunding. They are used to circumvent regulatory requirements, which allow only physical persons to lend via crowdfunding platforms and which limit the amount of the loan to 2000 euros for each project.⁵⁸

As part of the French government's initiative, a government order was adopted, which explicitly permits the issuance and transfer of mini-bonds on a blockchain platform under certain conditions. The registration of the transfer of mini-bonds on the blockchain will be considered as a transfer of ownership title.⁵⁹ Most notably, the

⁵⁶ Matthew J. O'Toole and Michael K. Reilly, *The First Block in the Chain: Proposed Amendments to the DGCL Pave the Way for Distributed Ledgers and Beyond* HARV. L. SCH. F. ON CORP. GOVERNANCE & FIN. REG. (MARCH 16, 2017).

⁵⁷ *La Blockchain*, REVUE TRIMESTRIELLE DE DROIT COMMERCIAL 830, 831 (October-December 2016).

⁵⁸ *Id.*

⁵⁹ Art. 2, sec. 2, Ordonnance No 2016-520 du 28 Avril 2016 Relative Aux Bons des Caisse.

government order gives a legal definition of blockchain defining it as a “shared electronic recording system allowing for authentication”.⁶⁰ Following the initiative of the French government, the securities division of BNP Paribas announced that it is expanding its blockchain platform for private stocks to help private companies issue minibonds via crowdfunding platforms.⁶¹

IV. Conclusion

The present paper has sought to disentangle the myths from the realities of the so-called distributed ledger technology or blockchain revolution and discuss how the legal regime can act both as an impediment and a catalyst to the widespread adoption of the technology. Despite the hype surrounding distributed ledger technology, regulatory obstacles can act as an impediment to the widespread adoption of the technology in financial markets. Nonetheless, as experimentation with the technology continues and its potential benefits for financial markets are revealed, policymakers are starting to foster the development of the technology. The Delaware Blockchain Initiative and the French government’s initiative to authorize the issuance and transfer of mini-bonds are examples of changes to the regulatory regime, which can act as a catalyst for the application of distributed ledger technology to securities markets.

⁶⁰ *Id.*

⁶¹ BNP Paribas, BNP Paribas Securities Services Expands its Blockchain Platform for Private Stocks, PRESS RELEASE, September 2016, *available at* <https://group.bnpparibas/en/press-release/bnp-paribas-securities-services-expands-blockchain-platform-private-stocks>

