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Nobody Puts Blockchain in a Corner: The Disruptive Role of Blockchain Technology in the Financial Services Industry and Current Regulatory Issues

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NOBODY PUTS BLOCKCHAIN IN A CORNER: THE DISRUPTIVE ROLE OF BLOCKCHAIN TECHNOLOGY IN THE FINANCIAL SERVICES INDUSTRY AND CURRENT REGULATORY ISSUES

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"Technology changes. Economy laws do not."[1]

INTRODUCTION

Recall the old VISA commercials portraying a modern consumer's synchronized and effortless credit card transactions undermined by the one Luddite with the audacity to bring the marketplace to a grinding halt by presenting cash (or worse, a check).[2] By visualizing faster and more efficient payments, consumers would transition to credit cards for their convenience, not because it was a safer or more secure option. Rather than emphasize the credit card itself, VISA's viscerally engaging and forward-looking advertisement allowed consumers to imagine heightened human experiences made possible *because of technology*. Fast-forwarding to our modern brave new world, our financial ecosystem and definition of "trust"[3] have rapidly changed.[4] People engage

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1 HAL R. VARIAN & CARL SHAPIRO, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY 1-2 (Har. Bus. Sch. Press 1999).

2 *See* Allen N. Berger et al., *The Economic Effects of Technological Progress: Evidence from the Banking Industry*, 35 J. OF MONEY, CREDIT AND BANKING 141, 149-50 (2002).

3 *See* OLIVER E. WILLIAMSON, THE MECHANISMS OF GOVERNANCE 256-57 (Oxford

socially,[5] take food from,[6] get into cars with,[7] and inhabit the homes of *strangers.*[8] The invention of the Internet, paired with the mass proliferation of mobile phones,[9] has transformed consumer financial conduct[10]and cultivated a

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Univ. Press 1996) (arguing that it is misleading to use of "the term 'trust' to describe commercial exchange for which cost-effective safeguards have been devised in support of more efficient exchange. Calculative trust is a contradiction in its terms … Trust is made more transparent and operational by treating calculated trust as a subset of calculated risk.").

4 *See* Somini Sengupta, *The Post-Cash, Post-Credit-Card Economy*, N.Y. TIMES (Apr. 28, 2012), http://www.nytimes.com/2012/04/29/sunday-review/the-post-cash-post-credit-card-economy.html.

5 Aaron Smith, *6 new facts about Facebook*, PEWRESEARCHCENTER (Feb. 3, 2014), http://www.pewresearch.org/fact-tank/2014/02/03/6-new-facts-about-facebook/.

6 Heather Haddon, *Grocers Feel Chill From Millennials*, WALL ST. J. (Oct. 27, 2016), https://www.wsj.com/articles/grocers-feel-chill-from-millennials-1477579072?mod=e2fb (identifying that millennials preference toward online grocery delivery services, including Instacart, Inc. suggests a "permanent shift in [consumer] shopping patterns").

7 *See From zero to seventy (billion)*, ECONOMIST (Sept. 3, 2016), http://www.economist.com/news/briefing/21706249-accelerated-life-and-times-worlds-most-valuable-startup-zero-seventy. The ride-hailing startup Uber carries a valuation close to $70 billion. *See From zero to seventy (billion)*, ECONOMIST (Sept. 3, 2016), http://www.economist.com/news/briefing/21706249-accelerated-life-and-times-worlds-most-valuable-startup-zero-seventy. "No technology firm in history has raised more money from private investors before going public." *From zero to seventy (billion)*, ECONOMIST (Sept. 3, 2016), http://www.economist.com/news/briefing/21706249-accelerated-life-and-times-worlds-most-valuable-startup-zero-seventy. Investor optimism is supported by Uber's position at the intersection of three linked disruptive trends: first, the emergence of asset-light business models; second, the shift to the sharing economy—for without which, the success of peer-to-peer service based business models would be non-existent; and third, consumers' willingness to pay for access to things is increasingly outweighing their will for outright ownership. *From zero to seventy (billion)*, ECONOMIST (Sept. 3, 2016), http://www.economist.com/news/briefing/21706249-accelerated-life-and-times-worlds-most-valuable-startup-zero-seventy.

8 Air BnB is an online marketplace for people to list, discover and book accommodations at any price point in more than 34,000 cities and 191 countries. *See about us*, AIRBNB, https://www.airbnb.com/about/about-us (last visited Nov. 11, 2016).

9 The steady increase in the adoption of smartphone users has resulted in the prevalence of services that allow consumers to obtain financial account information and conduct transactions with their financial institution ("mobile banking") and that allow consumers to make payments, transfer money, or pay for goods and services ("mobile payments"). *See* BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM, CONSUMERS AND MOBILE FINANCIAL SERVICES 11 (Mar. 2016), https://www.federalreserve.gov/econresdata/consumers-and-mobile-financial-services-report-201603.pdf; *see also* Hal Varian, *Intelligent Technology*, INTERNATIONAL MONETARY FUND 7 (Sept. 2016), http://www.imf.org/external/pubs/ft/fandd/2016/09/pdf/varian.pdf (acknowledging that computer mediation can impact economic activity through five channels: (1) data collection and analysis, (2) personalization and customization, (3) experimentation and continuous improvement, (4) contractual innovation, and (5) coordination and communication).

10 *See* BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM, CONSUMERS AND MOBILE FINANCIAL SERVICES 2016 (Mar. 2016).

societal expectation of progress as determined by the level of convenience.[11] Why? Companies are cognizant of the new peer-to-peer services ("P2P") code of the sharing economy:[12] get rich or adapt trying.[13]

Following the global financial crises of 2007-2009,[14] the world's trust in banks was at an all-time low.[15] Capitalizing on this time, Satoshi Nakamoto[16] (a person or an entity) pseudonymously released Bitcoin[17] to replace the traditional role of the banker[18] and provide a more transparent, equitable, and efficient payment system.[19] The range of Bitcoin's initial negative publicity, including price volatility,[20] hacking,[21] fraudulent investment schemes,[22] and black market

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11 Consumers cite that "convenience" is the most common reason motivating their adoption of mobile payment activity. *See* BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM, CONSUMERS AND MOBILE FINANCIAL SERVICES 2016 (Mar. 2016).

12 ARUN SUNDARARAJAN, THE SHARING ECONOMY: THE END OF EMPLOYMENT AND THE RISE OF CROWD-BASED CAPITALISM (2016). *See also* DON TAPSCOTT AND ANTHONY WILLIAMS, WIKINOMICS: HOW MASS COLLABORATION CHANGES EVERYTHING (2006).

13 CHRIS SKINNER, VALUEWEB 162 (2016) ("Apps and mobile are changing the retail experience; [Application Program Interfaces] are shifting the operations to real-time processing; and cloud, combined with data analytics are changing product and service."); *see also* David McBride, *General Corporation Laws: History and Economics*, LAW & CONTEMP. PROBS. 1, 9-10 (2010) (analyzing the economic evolutionary effects of how physical technologies, social technologies, and business organization interact and coevolve); ERIC BEINHOCKER, THE ORIGIN OF WEALTH: EVOLUTION, COMPLEXITY AND THE RADICAL REMAKING OF ECONOMICS 15 (2006) (recognizing "social technologies" as "ways of organizing people to do things").

14 *See* HAL SCOTT, CONNECTEDNESS AND CONTAGION (MIT Press 2016).

15 *See generally The origins of the financial crisis: Crash course*, ECONOMIST (Sept. 7, 2016), http://www.economist.com/news/schoolsbrief/21584534-effects-financial-crisis-are-still-being-felt-five-years-article (explaining how the dissolution of "trust, the ultimate glue of all financial systems" combined with central bankers and regulators failure to exercise proper oversight of financial institutions spread panic throughout the market and led to increased government intervention). *See also What causes financial crises?*, ECONOMIST (Sept. 8, 2016), http://www.economist.com/blogs/economist-explains/2016/09/economist-explains-economics-2.

16 It has been theorized that "the name might be a portmanteau of four technology companies: SAmsung, TOSHIba, NAKAmichi, and MOTOrola." DAVID LEE KUO CHUEN, HANDBOOK OF DIGITAL CURRENCY: BITCOIN, INNOVATION, FINANCIAL INSTRUMENTS, AND BIG DATA 11, n.1 (2015).

17 Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN 8 (2009), https://bitcoin.org/bitcoin.pdf. *See also History of Bitcoin: The World's First Decentralized Currency*, HISTORYOFBITCOIN, http:// historyofbitcoin.org/ (last visited Oct. 26, 2016) [hereinafter Bitcoin History].

18 BRIAN KELLY, THE BITCOIN BIG BANG 79 (2015).

19 DAVID LEE KUO CHUEN, HANDBOOK OF DIGITAL CURRENCY: BITCOIN, INNOVATION, FINANCIAL INSTRUMENTS, AND BIG DATA 12 (2015). The centralized core through which virtual currencies, like bitcoin., seeks to disrupt traditional legacy payment methods, including banknotes and bank-wires, checks, and all forms of card payments, credit. *See* RICHARD D. PORTER AND WADE ROUSSE., REINVENTING MONEY AND LENDING FOR THE DIGITAL AGE, *in* BANKING BEYOND BANKS AND MONEY 147 (PAOLO TASCA ET AL. eds., 2016).

20 Jonathan Todd Barker, *Why is Bitcoin's Value So Volatile*, INVESTOPEDIA, http://www.investopedia.com/articles/investing/052014/why-bitcoins-value-so-volatile.asp

for the deep web,[23] conditioned the public's perception of all cryptocurrencies with illicit purposes.[24] Despite bitcoin's "growing pains,"[25] venture capitalists,[26] software developers,[27] and technology start-up companies[28] continued to assert

(last visited Feb. 20, 2017).

21 Laura Shin, *Hackers Have Stolen Millions of Dollars in Bitcoin—Using Only Phone Numbers*, FORBES (Dec. 20, 2017), http://www.forbes.com/sites/laurashin/2016/12/20/hackers-have-stolen-millions-of-dollars-in-bitcoin-using-only-phone-numbers/#50df2f9222db.

22 *See also* SEC v. Shavers, Case No. 4:13-CV-416, 2013 WL 4028182, at *2 (E.D. Tex. Sept. 18, 2014).

23 The currency's association with Silk Road created the misconception that all bitcoin is linked to money launderers and terrorists.

24 Simon Taylor, *Blockchain: understanding the potential*, BARCLAYS 2 (July 2015), https://www.barclayscorporate.com/content/dam/corppublic/corporate/Documents/insight/blockchain_understanding_the_potential.pdf. "[A]longside … [Bitcoin's] hype, many clichés and misconceptions have grown up around the digital currency and its underlying technology. These misconceptions can hinder discussions about the future direction of development and the way in which initiatives are presented in the media." *Blockchain: Understandig The Potential*, CONTRACTSIT, http://contractsit.com/blockchain-understanding-the-potential/ (last visited Feb. 20, 2017).

25 Michael Casey and Paul Vigna, *Bitcoin and the Digital-Currency Revolution: For all bitcoin's growing pains, it represents the future of money and global finance*, WALL ST. J. (Jan. 23, 2015), https://www.wsj.com/articles/the-revolutionary-power-of-digital-currency-1422035061 (quoting former U.S. Treasury Secretary Lawrence Summers: "substantial inefficiencies" of an outdated financial system make it "ripe for disruption").

26 "Bitcoin represents not only the future of payments but also the future of governance." CHRIS SKINNER, VALUEWEB 99 (2016) (*quoting* Dee Hock, Founder of Visa). *See also* Marc Andreessen, *Why Bitcoin Matters*, N.Y. TIMES (Jan. 21, 2014), https://dealbook.nytimes.com/2014/01/21/why-bitcoin-matters/. The practical consequence of solving this problem is that Bitcoin gives us, for the first time, a way for one Internet user to transfer a unique piece of digital property to another Internet user, such that the transfer is guaranteed to be safe and secure, everyone knows that the transfer has taken place, and nobody can challenge the legitimacy of the transfer. The consequences of this breakthrough are hard to overstate.

27 *IBM Launches First Highly Secure Blockchain Services for Financial Services, Government and Healthcare on IBM Cloud*, IBM (Apr. 29, 2016), https://www-03.ibm.com/press/us/en/pressrelease/49632.wss (announcing a new framework for blockchain networks to operate securely in addition to meeting current regulatory and security requirements).

28 Edward Robinson and Matthew Leising, *Blythe Masters Tells Banks the Blockchain Changes Everything*, BLOOMBERG (Aug. 31, 2015), http://www.bloomberg.com/news/features/2015-09-01/blythe-masters-tells-banks-the-blockchain-changes-everything. Blythe Masters is the CEO of Digital Asset Holdings. *See* Edward Robinson and Matthew Leising, *Blythe Masters Tells Banks the Blockchain Changes Everything*, BLOOMBERG (Aug. 31, 2015), http://www.bloomberg.com/news/features/2015-09-01/blythe-masters-tells-banks-the-blockchain-changes-everything ("[Blockchain is] analogous to e-mail for money."). *See generally* Edward Robinson and Matthew Leising, *Blythe Masters Tells Banks the Blockchain Changes Everything*, BLOOMBERG (Aug. 31, 2015), http://www.bloomberg.com/news/features/2015-09-01/blythe-masters-tells-banks-the-

that the true value of Bitcoin is the blockchain,[29] the distributed ledger technology ("DLT") in which the bitcoin currency operates.[30] Previous discussions surrounding blockchain were initially constrained to educating others on how the technology worked and hype" over the potential applications that might be implemented in the distant future. [31] While it was previously speculated that the financial services and banking industries would have to wait five to ten years before the potential of blockchain technology was actually turned into a reality, IBM released a report stating that "2017 looks to be the year banking on blockchain's shifts from zero to sixty."[32] Accordingly, the global competition to service distributed ledger technology by incorporating it into the existing financial services industry is advancing in real time.[33] The World Economic Forum[34] estimates that more than 25 countries are investing in blockchain technology, filing more than 2,500 patents[35] and investing $1.3 billion.[36] Regu-

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blockchain-changes-everything.

29 Bitcoin's cryptographically secure blockchain protocol provides the ability to record and transfer value without intermediaries. See CHRIS SKINNER, VALUEWEB 190 (2016). At a high level, the blockchain "combin[es] peer-to-peer networks, cryptographic algorithms, distributed data storage, and a decentralized consensus mechanisms [sic]" to "provide[sic] a way for people to agree on a particular state of affairs and record that agreement in a secure and verifiable manner." Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SSRN 4–5, 5 & n.15 (Mar. 12, 2015), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664.

30 *See* Jeff John Roberts, *The Crisis in Bitcoin and the Rise of Blockchain*, FORTUNE (Mar. 4, 2016), http://fortune.com/2016/03/04/crisis-in-bitcoin-rise-of-blockchain/.

31 *See* Nicole Bullock, *Blockchain starts transition from hype to everyday use in markets*, FIN. TIMES (Oct. 10, 2016), https://www.ft.com/content/08d54cdc-74e2-11e6-bf48-b372cdb1043a; *How Coin Center Is Helping Define The 'Big Fuzzy Gray Area' Of Blockchain And Cryptocurrency Law*, TUNEIN (Oct. 18, 2016), http://tunein.com/embed/player/t109377177/ (discussing how one of the ways CoinCenter represents bitcoin blockchain technology, includes ensuring that policy makers "understand the technology and don't do anything stupid" by "mak[ing] easy to avoid mistakes").

32 Jemima Kelly, *Banks adopting blockchain 'dramatically faster' than expected: IBM*, REUTERS (Sept. 28, 2016), http://www.reuters.com/article/us-tech-blockchain-ibm-idUSKCN11Y28D.

33 J. Christopher Giancarlo, Commissioner, U.S. Commodity Futures Trading Comm'n, Address to the American Enterprise Institute, 21st Century Markets Need 21st Century Regulation (Sept. 29 2016), http://www.cftc.gov/PressRoom/SpeechesTestimony/opagiancarlo-17 (acknowledging that in comparison to international regulatory efforts that have been effected to address distributed ledger technology, the United States is "falling behind").

34 *Disruptive innovation in financial services: A Blueprint for Digital Identity*, WORLD ECONOMIC FORUM (Aug. 12, 2016), http://www3.weforum.org/docs/WEF_A_Blueprint_for_Digital_Identity.pdf.

35 *See* Megan M. La Belle & Heidi Mandanis Schooner, *Big Banks and Business Method Patents*, 16 U. PA. J. BUS. L. 431, 477-87 (2014) (discussing the underlying motivations and implications of increased big bank participation in the patent system). *See also* Bailey Reutzel, *The Looming War for Blockchain Patents*, COINDESK (Sept. 24, 2016), http://www.coindesk.com/looming-war-blockchain-patents/ (noting the scope and enforceability of bank's blockchain patents is currently unknown). For example, On November 15,

latory interest in financial technology ("FinTech")[37] in the United States represents a turning point,[38] in which the focus shifts from attempting to prevent the previous crises, to looking at how to support future market developments while maintaining financial stability. [39]

Blockchain technology has been frequently, and appropriately, analogized to the Internet Protocol.[40] The potential of each respective protocol is realized after the application of a new layer of services on top of the technology.[41] Similar to how the Internet fundamentally changed the way we share information, blockchain is an open source innovation that is going to revolutionize the transactions among individuals, governments, businesses, and machines.[42]

2015, Goldman Sachs filed a patent for "methods for settling securities in financial markets using distributed peer to peer and cryptographic techniques," using a proprietary coin called SETLcoin. DON TAPSCOTT & ALEX TAPSCOTT, BLOCKCHAIN REVOLUTION: HOW THE TECHNOLOGY BEHIND BITCOIN IS CHANGING MONEY, BUSINESS, AND THE WORLD 70 (2016).

36 Philip Stafford, *Banks struggle to make blockchain fast and secure*, WALL ST. J. (Sept. 26, 2016), http://www.ft.com/cms/s/2/e0a32840-4f68-11e6-8172-e39ecd3b86fc.html#axzz4LNglVau0. UBS, Deutsche Bank, Santander, BNY Mellon and interdealer broker ICAP pioneered a blockchain-based digital token, which they hope could form the industry standard to clear and settle trades. *See generally Disruptive innovation in financial services: A Blueprint for Digital Identity*, WORLD ECONOMIC FORUM (Aug. 12, 2016), http://www3.weforum.org/docs/WEF_A_Blueprint_for_Digital_Identity.pdf.

37 *See generally* J. Christopher Giancarlo, Commissioner, U.S. Commodity Futures Trading Comm'n, Address to the Cato Institute, Cryptocurrency: The Policy Challenges of a Decentralized Revolution (Apr. 12, 2016), http://www.cftc.gov/PressRoom/SpeechesTestimony/opagiancarlo-14#P35_11428 ("Regulation of DLT [distributed ledger technology] must indeed be coordinated on a multilateral level based on the principle of 'do no harm.' Just as many financial services firms are joining together in broad DLT consortiums, regulators must do the same."). *See generally* OFFICE OF THE COMPTROLLER OF THE CURRENCY, SUPPORTING RESPONSIBLE INNOVATION IN THE FEDERAL BANKING SYSTEM: AN OCC PERSPECTIVE (Mar. 2016).

38 DON TAPSCOTT & ALEX TAPSCOTT, BLOCKCHAIN REVOLUTION: HOW THE TECHNOLOGY BEHIND BITCOIN IS CHANGING MONEY, BUSINESS, AND THE WORLD 299 (2016).

39 *Id.*

40 *Beyond Silk Road: Potential Risks, Threats, and Promises of Virtual Currencies: Hearing Before the S. Comm. On Homeland Sec. and Gov't Aff.*, 113th Con. 5 (2013) (Statement of Patrick Murck, General Counsel, The Bitcoin Foundation). "Bitcoin is a protocol. It is like TCP/IP, which enables all the different uses people around the globe invented for the Internet. And it is like HTML, which enables all the different uses people invented for the World Wide Web without having to ask anyone's permission. We envision Bitcoin as a driver of global change that rivals these other protocols in terms of the benefits it delivers to humankind across the globe." *Beyond Silk Road: Potential Risks, Threats, and Promises of Virtual Currencies: Hearing Before the S. Comm. On Homeland Sec. and Gov't Aff.*, 113th Con. 5 (2013) (Statement of Patrick Murck, General Counsel, The Bitcoin Foundation).

41 *See* KELLY, *supra* note 18, at 77. Services include social engagement, (Facebook), entertainment (iTunes), information (Google) and marketplace (Amazon).

42 *See* Perianne Boring, *The Beauty Of The Blockchain*, FORBES (Jun. 17, 2016),

This Note proceeds in three parts. Part I identifies the tripartite characteristics of Bitcoin: the blockchain, the protocol, and the currency. It examines the processes within the Bitcoin ecosystem and demonstrates how a bitcoin transaction operates and explains the layout of the blockchain ecosystem in terms of the transaction, recording, and verification. Part II addresses how blockchain technology will disrupt the financial services industry. First, it addresses the digitization of the banking industry. Second, it identifies the need for collaboration between banks and FinTechs. It explores what precautions need to be taken to ensure consumer protection and security of one's digital identity and why it is in the government's best interest to endorse blockchain technology. Third, it examines the regulatory challenges that banks and FinTechs face prior to the implementation and widespread adoption of blockchain technology can take place. Part III evaluates the legal and regulatory issues that may arise as a result of blockchain's disruptive role in the financial services industry. First, it identifies the current state of regulation for the application of distributed ledger technology as a virtual currency. Second, it analyzes how a disjointed regulatory emphasis on virtual currencies and failure to endorse blockchain technology in the financial services industry directly threatens to stifle innovation, capital formation, consumer protection, and national cybersecurity. Third, it compares the rules-based regulatory approach to money licensing regimes in the United States with the United Kingdom's principles-based regulatory sandbox. Fourth, it argues why a national FinTech charter would be possible to implement in the United States and how it would correspond with joint proposed rule by the Office of the Comptroller, Department of Treasury and Federal Deposit Insurance Corporation for cybersecurity standards.

I. IT'S ALL ABOUT THE BLOCKCHAIN

Bitcoin is the first and largest cryptocurrency.[43] A cryptocurrency is a peer-to-peer ("P2P") version of electronic cash that allows payments to be sent directly from one party to another without the need of an intermediary.[44] There are three phases of the global financial technological revolution: Blockchain 1.0 emphasizes virtual currency,[45] Blockchain 2.0 isolates technology and pro-

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http://www.forbes.com/sites/perianneboring/2016/06/17/the-beauty-of-the-blockchain/#499aa2af4489.

43 For a list of other cryptocurrencies to data, *see Crypto-Currency Market Capitalizations*, COINMARKETCAP, https://coinmarketcap.com/ (last visited Nov. 6, 2016).

44 DAVID LEE KUO CHUEN, HANDBOOK OF DIGITAL CURRENCY: BITCOIN, INNOVATION, FINANCIAL INSTRUMENTS, AND BIG DATA 16 (2015).

45 Melanie Swan, *Decentralized Money: Bitcoin 1.0, 2.0, and 3.0*, INSTITUTE FOR ETHICS AND EMERGING TECHNOLOGIES (Nov. 10, 2014), http://ieet.org/index.php/IEET/more/swan20141110. The deployment of cryptocurrencies in applications related to cash, such as currency transfer, remittance, and digital payment sys-

tocol applications as to contracts,[46] and Blockchain 3.0 is the expansion of the technological applications beyond finance and markets.[47] This Note is limited to addressing the transition between Blockchain 1.0 to Blockchain 2.0. First, this Section answers the question, "What is the difference between bitcoin and blockchain?" by explaining the properties of the blockchain ecosystem. It accentuates the special properties of this technology and how it can be applied in the financial services industry. Finally, it analyzes why the application of blockchain technology will disrupt the financial services industry.

A. Bitcoin Ecosystem: Blockchain, Protocol, and Currency

Blockchain technology enables secure electronic transactions of bitcoin through the Bitcoin protocol, which employs cryptography to validate transactions before recording them on a decentralized[48] public ledger.[49] The ledger in which all network transactions are displayed is the *blockchain*.[50] Bitcoin is trustless technology[51] that exists through a decentralized peer-to-peer ("P2P")[52] consensus network of Bitcoin clients (also known as *nodes)*.[53] The Bitcoin pro-

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tems.

46 *Id.* Blockchain 2.0 space can include Bitcoin 2.0 protocols, smart contracts, smart property, Dapps (decentralized applications), DAOs (decentralized autonomous organizations), and DACs (decentralized autonomous corporations). Melanie Swan, *Decentralized Money: Bitcoin 1.0, 2.0, and 3.0*, INSTITUTE FOR ETHICS AND EMERGING TECHNOLOGIES (Nov. 10, 2014), http://ieet.org/index.php/IEET/more/swan20141110.

47 *See id.*

48 GARETH W. PETERS AND EFSTATHIOS PANAYI, UNDERSTANDING MODERN BANKING LEDGERS THROUGH BLOCKCHAIN TECHNOLOGIES: FUTURE OF TRANSACTION PROCESSING AND SMART CONTRACTS ON THE INTERNET OF MONEY 4 (2015). "Decentralization" describes conditions under which the actions of many agents cohere and are effective despite the fact that they do not rely on reducing the number of people whose will counts to direct effective action.

49 *Id.* at 3-4. The word "ledger" refers to a book or set of records.

50 *Id.* at 4; *see also* Bruno Campenon, *Fintech and the future of securities services*, 8 J. SEC. OPERATIONS & CUSTODY 107, 111 (2016) ("[B]itcoin acts as a decentrali[z]ed depositary, messaging system and settlement platform rolled into one.")

51 Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN.ORG (Nov. 8 2008), https://bitcoin.org/bitcoin.pdf.

52 A P2P network is a "network of personal computers, each of which acts as both client and server, so that each can exchange files . . . with every other computer on the network." *Peer-to-peer Network Definition*, DICTIONARY.COM, http://dictionary.reference.com/browse/peer-to-peer%20network (last visited Sept. 30, 2016).

53 Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SSRN 4 (2015), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664. *See* Andreas M. Antonopoulos, *Mastering Bitcoin*, Chapter 2 (2015), http://chimera.labs.oreilly.com/books/1234000001802/index.html ("Nodes in a peer-to-peer

tocol employs public-key cryptography[54] to verify and secure bitcoin transactions.[55] As a publically distributed ledger, the blockchain ensures that all computers in the "Bitcoin network"[56] have an updated and verified record of transactions within the network.[57] Thus, the transparent nature of transactions in the Bitcoin network that are recorded on the blockchain prevents fraud and the "double-spending" problem[58] by ensuring that every cryptocurrency can be spent only once.[59]

1. Public Cryptographic Key

Bitcoin's decentralized public ledger is the blockchain.[60] The blockchain is a "chronological database"[61] of all transactions that have been validated by

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network both provide and consume services at the same time with reciprocity acting as the incentive for participation.").

54 The word "cryptography" is derived from the Greek words *kryptos* (hidden) and *graphein* (writing). Monica Pawlan, *Cryptography: The Ancient Art of Secret Messages*, PAWLAN (Feb. 1998), http://www.pawlan.com/monica/articles/crypto. Cryptography is "the scientific study of techniques for securing digital information, transactions, and distributed computations." JONATHAN KATZ & YEHUDA LINDELL, INTRODUCTION TO MODERN CRYPTOGRAPHY: PRINCIPLES AND PROCOCOLS 3 (2007).

55 *See* KELLY, *supra* note 18, at 23.

56 Andreas M. Antonopoulos, *Mastering Bitcoin*, Chapter 2 (2015), http://chimera.labs.oreilly.com/books/1234000001802/index.html (referring to the "bitcoin network" as the collection of notes running through the bitcoin P2P protocol).

57 JERRY BRITO & ANDREA CASTILLO, BITCOIN: A PRIMER FOR POLICYMAKERS 7 (2nd ed. 2016) (detailing the life cycle of a bitcoin transaction).

58 SATOSHI NAKAMOTO, BITCOIN: A PEER-TO-PEER ELECTRONIC CASH SYSTEM 8 (2009), https://bitcoin.org/bitcoin.pdf [https://perma.cc/4HCA-UUSR]. The double spending problem is also called the "Byzantine Generals problem" – generals who are circling the enemy need to either simultaneously launch their attack or retreat; some attackers may be traitors, spread misinformation and effectively foil the attack. *See* Leslie Lamert et al., THE BYZANTINE GENERALS PROBLEM, 4 ACM Transactions on Programming Languages and Systems 382-401 (1982) (addressing reliability concerns computer communications). Satoshi Nakamoto's "Bitcoin solution" to this Byzantine Generals Problem" cannot be understated – it is simply revolutionary." KELLY, *supra* note 18, at 57.

59 ANDREAS M. ANTONOPOULOS, MASTERING BITCOIN, LOC. Chapter 1 (2015) (ebook), http://chimera.labs.oreilly.com/books/1234000001802/index.html. *See also* KUO CHUEN, *supra* note 44, at 12 (detailing the technical aspects of a bitcoin transaction). *See generally* KELLY, *supra* note 18, at 23 (earliest known banking ledgers date to 9000 BCE when transactions were literally written in stone).

60 *See also* Paul H. Farmer, Jr., Note & Comment, *Speculative Tech: The Bitcoin Legal Quagmire & the Need for Legal Innovation*, 9 J. BUS. & TECH. L. 85, 88–89 (2014) ("The Bitcoin peer-to-peer network that allows for miners to generate Bitcoins also serves as a public ledger for all Bitcoin transactions . . . The full record of transactions [within the network] is called a block chain, a sequence of records composing a virtual ledger." (footnotes omitted)).

61 Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SSRN 6 (Mar. 10, 2015),

Bitcoin network participants.[62] Each block[63] that is added onto the blockchain represents a transaction between two network users that manifested their intent to transact by exchanging a minimum amount of public information, and is verified by network participants, who compete to the decrypt puzzle of transaction consisting of private information.[64] Once computers in the network reach a consensus on the transaction's validity, it is recorded and timestamped[65] as a new block on blockchain.[66]

Network users are given[67] one public key, also known as a "public address" that is shared to the network, like a social media profile page, and one private key, the content of which is kept secret, like a password.[68] The address informs network participants where to transfer value.[69]

In order for bitcoin transactions between Bitcoin network users to appear on the blockchain, parties must first manifest their intent to transact through the exchange of their public key. In a bitcoin transaction, an individual proves authentication of bitcoin ownership through their private key and transfers the value to the new owner's address though the public key.[70] Transactional securi-

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http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664.

62 KUO CHUEN, *supra* note 44, at 16.

63 *Blockchain*, BITCOIN, https://en.bitcoin.it/wiki/Block_chain (last visited Oct. 31, 2016), (providing that "[a] block chain is a transaction database shared by all nodes" on a network).

64 *Mining Bitcoin Has Become A Ruthlessly Competitive Business*, BUSINESS INSIDER (Jan. 11, 2015), http://www.businessinsider.com/mining-bitcoin-is-a-competitive-business-2015-1 (providing that the cryptography competition ends when one node decrypts the transacting parties puzzle –the decrypted puzzle verifies that the public identify of the parties corresponds with private information of the deal, namely the sufficiency of funds between the parties which underlies the parties transaction); JERRY BRITO & ANDREA CASTILLO, BITCOIN: A PRIMER FOR POLICYMAKERS 8 (2nd ed. 2016 (explaining that mining involves the search is to find a sequence of data that produces a particular pattern when the Bitcoin "hash" algorithm is applied to the data").

65 *See* Joseph Bonneau et al., *Research Perspectives and Challenges for Bitcoin and Cryptocurrencies*, IEEE SECURITY AND PRIVACY (forthcoming May 2015), http://www.jbonneau.com/doc/BMCNKF15-IEEESP-bitcoin.pdf.

66 KUO CHUEN, *supra* note 44, at 22. *See also* GARETH W. PETERS & EFSTATHIOS PANAYI, UNDERSTANDING MODERN BANKING LEDGERS THROUGH BLOCKCHAIN TECHNOLOGIES: FUTURE OF TRANSACTION PROCESSING AND SMART CONTRACTS ON THE INTERNET OF MONEY, *in* BANKING BEYOND BANKS AND MONEY 239, 243 (Paolo Tasca et al eds., Springer Int'l. Pub., 2016) (describing how final hash functions combine to form a new published block).

67 Bitcoin uses the public-cryptographic keys to maintain the "creation, use, and transfer of digital value." KEVIN C. TAYLOR, FINTECH LAW: A GUIDE TO TECHNOLOGY LAW IN THE FINANCIAL SERVICES INDUSTRY 12-2 (2014).

68 JERRY BRITO & ANDREA CASTILLO, BITCOIN: A PRIMER FOR POLICYMAKERS 7 (2nd ed. 2016) (detailing the life cycle of a bitcoin transaction).

69 *See* KEVIN C. TAYLOR, FINTECH LAW: A GUIDE TO TECHNOLOGY LAW IN THE FINANCIAL SERVICES INDUSTRY 12-2, (2014).

70 KEVIN C. TAYLOR, FINTECH LAW: A GUIDE TO TECHNOLOGY LAW IN THE FINANCIAL SERVICES INDUSTRY 12-2, (2014).

ty on the blockchain is afforded through the combination of a cryptographic hash.[71] Bitcoin solves the double-spending problem and provides transactional security wherein each transaction has a digital signature and contains a cryptographic hash[72] that allows for easy tamper detection.[73] Thus, the two parties' exchange of public keys initiates a bitcoin transaction because it effectively requests computers on Bitcoin Network to validate the transaction to decrypt, through the public key's information, the content of the private.[74]

2. Blockchain Protocol and Consensus-Based Transaction Mechanisms
Consensus

Bitcoin exists through a peer-to-peer network ("P2P")[75] of Bitcoin users who have access to all transactions. As a distributed public ledger,[76] Bitcoin requires that all transactions be publically announced to all computers on the Bitcoin network, called *nodes*. [77] If Alice wants to transact with Bob, Alice initiates this process by broadcasting to the network "I, Alice, give Bob one bitcoin" by signing off the transaction with her private key (i.e., her signature). Before Bitcoin network users can view transactions on the blockchain ledger, miners must first reach a consensus[78] to validate the transaction.[79] Users that providing

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71 *See* PETERS & PANAYI, *supra* note 66, at 243.

72 *See* SATOSHI NAKAMOTO, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN (2009), https://bitcoin.org/bitcoin.pdf. *See also* PETERS & PANAYI, *supra* note 66, at 243 (evaluating how second-generation contract-based developments of blockchain technology can be applied to data integrity protocols in the banking industry to achieve varying degrees of "permissioning, data integrity, and data security.").

73 KUO CHUEN, *supra* note 44, at 16.

74 *See* Larissa Lee, *New Kids on the Blockchain: How Bitcoin's Technology Could Reinvent the Stock Market*, 12 HASTINGS BUS. L.J. 81, 98 (2016).

75 *Peer-to-peer Network Definition*, DICTIONARY.COM, http://dictionary.reference.com/browse/peer-to-peer%20network (last visited Feb. 10, 2017) (a P2P network is a "network of personal computers, each of which acts as both client and server, so that each can exchange files . . . with every other computer on the network").

76 Private or permissioned blockchains are also known as shared or distributed ledgers. Gideon Greenspan, *Payment and Exchange Transactions in Shared Ledgers*, 10 J. PAYMENTS STRATEGY & SYS. 172, 172 (2016) (identifying what characteristics distinguish distributed ledgers from centralized ledgers, as well as bitcoin-style blockchain from etherum-style blockchain).

77 *See* SATOSHI NAKAMOTO, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN (2009), https://bitcoin.org/bitcoin.pdf.

78 *See* Joseph Bonneau et al., *Research Perspectives and Challenges for Bitcoin and Cryptocurrencies*, IEEE SECURITY AND PRIVACY (forthcoming May 2015), http://www.jbonneau.com/doc/BMCNKF15-IEEESP-bitcoin.pdf (noting that the implications of Bitcoin's consensus protocol includes "self-enforcing ("smart") contracts, decentralized markets and order books, and distributed autonomous agents").

79 *See* Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SSRN 7 (Mar. 10, 2015), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664.

computing power to log and reconcile transactions on the ledger are called *miners*.[80] Miners compete to be the first to validate the transaction through computationally intense process, known as "proof-of-work," in which they determine the legitimacy of the transaction.[81] Once a consensus has been reached as to the transaction's legitimacy, it is recorded, time-stamped, and displayed in one "block" of the blockchain.[82]

3. Proof of Work

A "block"[83] of data will be added to the blockchain once computers on the Bitcoin network[84] reach a consensus as to the transaction's validity.[85] The mechanism in which transactions are validated is through the computationally intensive "proof-of-work" of all transactions that constitute the blockchain and depends upon the amount of computing processing power being contributed to the network. [86] Mining is integral in the issuance of new bitcoins and is a necessary process for transactions to be added onto the blockchain and subsequently verified. [87] The mining process in which transactions are verified is computationally intensive to ensure that only legitimate transactions are verified and recorded onto the blockchain. [88]

B. The Evolution of Financial Intermediaries and the Application of

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80 JERRY BRITO AND ANDREA CASTILLO, BITCOIN: A PRIMER FOR POLICYMAKERS 7 (2nd ed. 2016).

81 KUO CHUEN, *supra* note 44, at 16.

82 JERRY BRITO AND ANDREA CASTILLO, BITCOIN: A PRIMER FOR POLICYMAKERS 7 (2nd ed. 2016).

83 Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SSRN 48-49 (Mar. 12, 2015) http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664 (citing Blockchain, BITCOIN FOUNDATION WIKI, https://en.bitcoin.it/wiki/Block_chain (last accessed Mar. 21, 2017) ("Every block contains information about a certain number of transactions, a reference to the preceding block in the blockchain, as well as an answer to a complex mathematical puzzle, which is used to validate the data associated with that block.")

84 Computers in the Bitcoin network are "nodes." *See Bitcoin Glossary*, COINDESK, http://www.coindesk.com/information/bitcoin-glossary/#n (last visited Mar. 21, 2017) (defining "nodes" as "[a] computer connected to the bitcoin network using a client that relays transactions to others").

85 PETERS & PANAYI, *supra* note 66, at 242 (manuscript at 4); Gareth Peters et al., *Trends in crypto-currencies and blockchain technologies: a monetary theory and regulation perspective*, SSRN 2 (Aug. 15, 2015), http://ssrn.com/abstract=2646618.

86 NATHANIEL POPPER, DIGITAL GOLD: BITCOIN AND THE INSIDE STORY OF THE MISFITS AND MILLIONAIRES TRYING TO REINVENT MONEY 23 (2016).

87 KUO CHUEN, *supra* note 44, at 19.

88 *Id.*

Blockchain Technology

The distributed leger technology of Bitcoin's blockchain can virtually incorporate the contractual process in "anything that can be digitally identified."[89] Consequently, blockchain technology enables the creation and execution of digital "smart contracts," [90] a term Nick Szabo first introduced in 1996. [91] The development of FinTech, blockchain technology, and associated smart contracts, has the potential to reshape transaction costs in the financial system. It is significant to note, however, that smart contracts are *automation*, not law.[92] Smart contracts are modules of computer code than run on blockchains.[93] They are permissioned[94] and cryptographically verifiable self-executing programs[95] that are dependent on certain triggering conditions to transfer digital assets on the blockchain.[96] Smart contract protocol can specify, as computer code, the terms under which certain obligations are fulfilled and can execute actions like sending a payment or deactivating a file once there is evidence of the contract's terms' fulfillment.[97]

The evolution of financial institutions is arguably shaped by the relationship between varying levels of trust and differences in transaction costs. Specifically, it is argued that the application of distributed ledger technology will disrupt traditional financial service institutions because it revolutionizes the role of the

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89 KELLY, *supra* note 18, at 153.

90 KELLY, *supra* note 18, at 154; *see also* MELANIE SWAN, BLOCKCHAIN: BLUEPRINT FOR A NEW ECONOMY 21 (2015); *see also* Pavel Maltsev, *A Next Generation Smart Contract & Decentralized Application Platform*, GITHUB (Jan. 5, 2015), https://github.com/ethereum/wiki/wiki/White-Paper.

91 *See* Michael Gord, *Smart Contracts Described by Nick Szabo 20 Years Ago Now Becoming Reality*, BITCOIN MAGAZINE (Apr. 26, 2016), https://bitcoinmagazine.com/articles/smart-contracts-described-by-nick-szabo-years-ago-now-becoming-reality-1461693751/ (conceiving the idea of digital "smart" contracts); *but see* Allan I. Mendelowitz &Willi Brammertz, *Smart Contracts Were Around Long Before Cryptocurrency*, AM. BANKER (Nov. 17, 2016), http://www.americanbanker.com/bankthink/smart-contracts-were-around-long-before-cryptocurrency-1092463-1.html (noting that banks have imperfectly implemented smart contracts into their business for three decades, as exemplified by transaction processing systems and data warehouses).

92 JAMES HAZARD ET AL, ARE TRANSACTIONS COSTS DRIVERS OF FINANCIAL INSTITUTIONS? CONTRACTS MADE IN HEAVEN, HELL, AND THE CLOUD IN BETWEEN, *in* BANKING BEYOND BANKS AND MONEY 226 (PAOLO TASCA ET AL. eds., 2016) (emphasis in original).

93 *See Id;* KELLY, *supra* note 18, at 150 (identifying smart contracts as legal documents attached to a bitcoin transaction).

94 Permissioned, in this context, means shared among the parties involved in a transaction.

95 HAZARD ET AL, *supra* note 92, at 225.

96 Joshua A.T. Fairfield, *Smart Contracts, Bitcoin Bots, and Consumer Protection*, 71 WASH. & LEE L. REV. ONLINE 36, 38 (2014).

97 ARUN SUNDARARAJAN, THE SHARING ECONOMY: THE END OF EMPLOYMENT AND THE RISE OF CROWD-BASED CAPITALISM 93 (2016).

intermediary. The three dimensions of transaction costs, which are (1) definition and manufacturing, (2) monitoring, and (3) enforcement of contracts, resemble the stages of financial banking intermediation, which involve (1) underwriting and manufacturing of financial instruments, (2) monitoring and screening credit and market risks to the value of contracts, and (3) enforcement/execution of financial contracts.[98] Banks' business model of operating through the *centralization* of control has not significantly changed from Italian banks of the 1400's and commercial banks of the 1930's.[99] However, the geographical expansion of what diverse and complex services and transactions banks could provide clients has resulted in the association of financial intermediaries with an increase in transaction costs. Blockchain technology, therefore, has been recognized as the most "truly disruptive technological advancements to the practice of law since the invention of the printing press"[100] because smart contracts can facilitate the replacement of banking financial intermediaries. The role of banks in intermediation, initially established to solidify trust among contract counterparties and promote transparency, depreciates in the presence of a trustless technology that accomplishes the same functions.[101]

A smart contract is self-executing software that is able to autonomously and precisely determine each payment required by the contract.[102] To be put differently, a smart financial contract represents the black-letter legal obligations contained in a natural language contract.[103] The risks posed by smart contracts are reduced because they are autonomous, self-sufficient, and decentralized.[104] Smart contracts resemble the design of Bitcoin in that they "subsist inde-

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98 HAZARD ET AL, *supra* note 92, at 218.

99 Jacob H. Gutwillg, Note, *Glass Versus Steagall: The Fight Over Federalism and American Banking*, 100 VA. L. REV. 771, 775 (2014).

100 Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SSRN 12-13 (Mar. 15, 2015), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664.

101 Anil Awasthi, *'Revolutionary' Smart Contracts Automate Trust*, PAYMENTS SOURCE (Sept. 8, 2016) https://www.paymentssource.com/opinion/revolutionary-smart-contracts-automate-trust.

102 *See* Allan I. Mendelowitz & Willi Brammertz, *Smart Contracts Were Around Long Before Cryptocurrency*, AM. BANKER (Nov. 17, 2016) http://www.americanbanker.com/bankthink/smart-contracts-were-around-long-before-cryptocurrency-1092463-1.html (recognizing that banks have imperfectly implemented smart contracts into their business for three decades, as exemplified by transaction processing systems ("TPS"), data warehouses ("DW")).

103 Allan I. Mendelowitz & Willi Brammertz, *Smart Contracts Were Around Long Before Cryptocurrency*, AM. BANKER (Nov. 17, 2016) http://www.americanbanker.com/bankthink/smart-contracts-were-around-long-before-cryptocurrency-1092463-1.html.

104 SUNDARARAJAN, *supra* note 97, at 93.

pendently of any moral or legal entity."[105] Smart contract codes define and manage ownership rights.[106] Due to the immutability of a decentralized and distributed ledger, the smart contract codes do not make any assumptions about the assignment of rights, nor can they arbitrarily seize, divest or transfer these rights.[107] Smart contract code is jurisdictionally neutral and therefore allows "borderless" enforceability, no longer restricted by the jurisprudential reliance of political borders. With smart contracts, it is the *code* that is the law.[108] As a result, the trustless blockchain provides a faster, more efficient, and secure means of transacting and contracting, and the reduction of transaction costs will increase the amount of market participants.

In conclusion, decentralized and autonomous applications of blockchain will disrupt the traditional role of intermediaries. The implementation of smart financial contracts in an open source dynamic will result in the optimization of contracting and transacting. The impact of distributed ledger technology and the application of smart contracts in the financial services industry will be discussed in the next Section.

II. DISRUPTION: THE ROLE OF FINTECH SERVICES IN TRADITIONAL BANKING

The disruptive role that blockchain will have on banking is clear – banking financial intermediaries operate through a centralized control of authority and the autonomous, self-serving, and decentralized applications of blockchain replace the intermediaries.[109] This section analyzes how blockchain technology will disrupt the financial services and banking industry. It emphasizes the economics of blockchain in terms of how disintermediation[110] and decentralization will likely shift the economic organization of banking.[111]

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105 Primavera de Filippi, *Tomorrow's Apps Will Come from Brilliant (and Risky) Bitcoin Code*, WIRED (Mar. 8, 2014, 6:30 AM), http://www.wired.com/2014/03/decentralized-applications-built-bitcoin-great-except-whos-responsible-outcomes/.

106 *See* TAPSCOTT & TAPSCOTT, *supra* note 38, at 142 (explaining how smart contracts eliminate the need for a bureaucracy to define ownership and generate wealth).

107 *Id.* at 143 (2016) (describing how the functionality of the code would replace the need for a centralized ledger).

108 *See* LAWRENCE LESSIG, CODE VERSION 2.0 4 (2d ed. 2006) (arguing "[c]ode is law" and that within the realm of cyberspace, the invisible hand, pushed by government and by commerce, highly efficient regulation is possible).

109 *See generally* SUNDARARAJAN, *supra* note 97, at 93.

110 Disintermediation refers "to the general process of designing transactions that remove the need for a trusted intermediary." *See* Joseph Bonneau et al., *Research Perspectives and Challenges for Bitcoin and Cryptocurrencies*, IEEE SECURITY AND PRIVACY (forthcoming May 2015), http://www.jbonneau.com/doc/BMCNKF15-IEEESP-bitcoin.pdf.

111 TRENT J. MACDONALD, ET AL., BLOCKCHAINS AND THE BOUNDARIES OF SELF-ORGANIZED ECONOMIES: PREDICTIONS FOR THE FUTURE OF BANKING, *in* BANKING BEYOND

A. Why the Financial Services Industry is Ripe for Disruption

The general function of blockchain technology is that it eliminates the role of a financial intermediary. Thus, financial services is the most "obvious industry" [112] for initial "blockchain marketplace development"[113] and disruption for a number of reasons.[114] Consider the three factors that define a bank:[115] (1) by its legal form; (2) by the services it offers; and (3) economic function to society.[116] Its economic function to society is categorized by its role in financial intermediation[117] and transaction services.[118] Banks have dominated the payment system.[119] Historically, a common feature of payment systems[120] was that payment service providers, traditionally banks, were at the same time standard-setters and owners of the infrastructure.[121]

Traditional legacy bank structures continue to dominate.[122] Card networks, money transmissions and counterparty connectivity enable banks, merchants,

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BANKS AND MONEY 279, 284 (PAOLO TASCA ET AL. eds., 2016).

112 KELLY, *supra* note 18, at 57.

113 SUNDARARAJAN, *supra* note 97, at 91.

114 RICHARD SCOTT CARNELL ET AL., THE LAW OF FINANCIAL INSTITUTIONS 54 (5th ed. 2013).

115 *Id.* at 56-57 (quoting United States v. Phil. Nat'l Bank, 374 U.S. 321, 326 (1963) ("Banks are unique among financial institutions in that they are alone permitted by law to accept demand deposits. This distinctive power … gives banking a key role in the national economy. For banks do not merely deal in, by are actually a source of, money and credit…Furthermore, the power to accept demand deposits makes banks the intermediaries in most financial transactions (*since transfers of substantial moneys are almost always by check rather than by cash*) and concomitantly, the repositories of very substantial individual and corporate money. The banks use this money is conditioned by the fast that their working capital consists largely of demand deposits, which makes liquidity the *guiding* principle of bank lending and investing policies; this it is that banks are the chief source of the country's short-term business credit")).

116 *Id.* at 38-46 (emphasis in original).

117 *Id.* at 39-40 (explaining that the benefits that financial intermediaries provide include (1) offering diversification, (2) enable investors to enjoy economies of scale, (3) offer expertise, (4) convert illiquid investments into liquid ones).

118 *Id.* at 39-40.

119 *Id.* at 54 (5th ed. 2013).

120 A "payment system" is an organized arrangement for transferring value between its participants. GEOFFREY P. MILLER & FABRIZIO CAFAGGI, THE GOVERNANCE AND REGULATION OF INTERNATIONAL FINANCE 118-19 (2013) citing ANDREW G. HALDANE ET AL., THE FUTURE PAYMENTS SYSTEM 2 (2008). A "payment service" is the function of intermedition between the payer and the payee in a market transaction. GEOFFREY P. MILLER & FABRIZIO CAFAGGI, THE GOVERNANCE AND REGULATION OF INTERNATIONAL FINANCE 117 (2013).

121 GEOFFREY P. MILLER & FABRIZIO CAFAGGI, THE GOVERNANCE AND REGULATION OF INTERNATIONAL FINANCE 119 (2013).

122 For example, the Visa, MasterCard, SWIFT, EBA, CHIPS, Fedwire, RTGS, and ACH, all of which have a relationship with traditional banking, dominate the market. CHRIS SKINNER, VALUEWEB: HOW FINTECH FIRMS ARE USING BITCOIN BLOCKCHAIN AND MOBILE TECHNOLOGIES TO CREATE THE INTERNET OF VALUE 155 (2016).

corporates, and institutions to interoperate with trust and security.[123] However, as a consequence of the technological revolution, banks' monopoly position as a payment services provider has been jeopardized[124] by FinTechs that target "narrow financial services."[125] The goal of these narrow financial services is the unbundling of banking through the offering of banking components.[126]

Looking at the evolution of the banking technology[127] in the United States, disintermediation[128] and the concept of digitalization being disruptive are not new.[129] What is revolutionary, however, is that the blockchain democratizes value in the same way the Internet of Things democratized information.[130]

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123 CHRIS SKINNER, VALUEWEB: HOW FINTECH FIRMS ARE USING BITCOIN BLOCKCHAIN AND MOBILE TECHNOLOGIES TO CREATE THE INTERNET OF VALUE 155-56 (2016).

124 MILLER & CAFAGGI, *supra* note 121, at 119

125 *See* SKINNER, *supra* note 123, at 13 (discussing how technology is changing the structures built in the past for paper distribution).

126 *See id*. For example, the peer-to-peer payment application Venmo, owned by PayPal, provides an instantaneous monetary-transfer service. *See e.g.*, Steve Lohr, *A Financial Industry Scramble As More Pay by Smartphone*, N.Y. TIMES, JAN. 19, 2016, at A-1 (recognizing that the millennial-led shift toward digital financial services, like Venmo, threatens to permanently depriving to permanently deprive the consumer banking industry of one of its sectors).

127 Technology has catalyzed the evolution of the consumer financial marketplace in the United States with the advent of new products and services. Throughout the 1950s, bank-issued credit cards for general use were introduced and they have changed the way consumers spend and borrow. The 1960's brought Automated Teller Machines, ("ATM's), which enabled consumers to conduct basic banking transactions on their own time. The Automated Clearing House (ACH) network was established in the 1970s and has become one of the largest payment networks in the world. *What Is ACH?: Quick Facts About the Automated Clearing House (ACH) Network*, NACHA (Oct. 1, 2015), https://www.nacha.org/news/what-ach-quick-facts-about-automated- clearing-house-ach-network; *see also Automated Clearinghouse Services: About*, BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM, http://www.federalreserve.gov/paymentsystems/fedach_about.htm (last visited Feb. 21, 2017). In the 1990s, online banking increased consumer convenience and financial autonomy. Allen N. Berger, *The Economic Effects of Technological Progress: Evidence from the Banking Industry*, 35 J. OF MONEY, CREDIT AND BANKING (forthcoming 2003).

128 The removal of intermediaries is not a revolutionary concept, or one that banks are unfamiliar, given the expansion of the computer placed mainframe computing power on the desktop for personal use and the personalization of online banking, made possible by the Internet. Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, SSRN 48-49 (Mar. 12, 2015) http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664.

129 *See* SUNDARARAJAN, *supra* note 97, at 54-56 (discussing how digital forces sustained crowd-based capatialism); *see also* SKINNER, *supra* note 123, at 159; *see also* Joseph L. Bower & Clayton M. Christensen, *Disruptive Technologies: Catching the Wave*, HARV. BUS. R. (1995), https://hbr.org/1995/01/disruptive-technologies-catching-the-wave (recognizing that one of the determinative factors that contributes to a business's failure, success, or market domination is its ability to develop and commercialize new technologies that adequately address the next-generation performance needs of their customers).

130 TAPSCOTT & TAPSCOTT, *supra* note 38, at 299.

Blockchain operates a decentralized[131] public ledger of transactions that no one person or company owns or controls.[132] In the "Internet of Value" [133] the blockchain is referred to as the "value exchange network" because it is an exchange platform for digital value on the Internet and the programmability of its bitcoin has the ability to trigger efficient, fast, and secure actions directly wired into the real world.[134] Similar to how the Internet of Things fundamentally changed the way we share information,[135] blockchain is an open source innovation that is going to revolutionize the transactions amongst individuals, governments,[136] businesses, and machines.[137]

As a part of the P2P sharing economy, the role of banks has expanded from profit and trade to include community and social interaction.[138] In an effort to

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131 *See* YOCHAI BENKLER, THE WEALTH OF NETWORKS 62 (2006) (defining democratization as "conditions under which the actions of many agents cohere and are effective despite the fact that they do not rely on reducing the number of people whose will counts to direct effective action").

132 Mihaela Ulieru, *Blockchain: what it is, how it really can change the world*, WORLD ECONOMIC FORUM (June 23, 2016), https://www.weforum.org/agenda/2016/06/the-blockchain (last visited Sept. 24, 2016); *see also* WILLIAM MOUGAYAR, THE BUSINESS BLOCKCHAIN: PROMISE, PRACTICE, AND APPLICATION OF THE NEXT INTERNET TECHNOLOGY 90 (2016); *see also* CRAIG K. ELWELL ET AL., CONG. RESEARCH SERV., R43339, BITCOIN: QUESTIONS, ANSWERS, AND ANALYSIS OF LEGAL ISSUES 1, 6 (2015).

133 *See* SUNDARARAJAN, *supra* note 97, at 56 (noting that the Internet of Things is transitioning from the early internet's consumerization of the digital and onto the digitalization of the physical).

134 *See* MOUGAYAR, *supra* note 132, at 155 (giving an example, that trust components are stored on the blockchain (identity, rights, membership, ownership, and time stamping), services where a contractual component is executed on the blockchain (proof of service and proof of compliance), on decentralized peer-to-peer market (e.g., OpenBazaar or La'Zooz), through a Distributed Autonomous Organization (whose governance and operations run on the blockchain)).

135 Perianne Boring, *The Beauty Of The Blockchain*, FORBES (June 17, 2016), http://www.forbes.com/sites/perianneboring/2016/06/17/the-beauty-of-the-blockchain/#2bf379194489; s*ee also* Jacob Morgan, *A Simple Explanation Of 'The Internet Of Things'*, FORBES (May 13, 2014), http://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#1b4567d46828 (defining the Internet of Things as "the concept of basically connecting any device
with an on and off switch to the Internet (and/or to each other)").

136 *See* Bart van Liebergen et al., *Regtech in Financial Services: Solutions for Compliance and Reporting*, INST. OF INT'L FIN. 2 (Mar. 22, 2016), https://www.iif.com/publication/research-note/regtech-financial-services-solutions-compliance-and-reporting (defining "regtech" as "the use of new technologies to solve regulatory and compliance requirements more effectively and efficiently").

137 Perianne Boring, *The Beauty Of The Blockchain*, FORBES (June 17, 2016), http://www.forbes.com/sites/perianneboring/2016/06/17/the-beauty-of-the-blockchain/#499aa2af4489.

138 *See* SKINNER, *supra* note 123, at 77 (discussing how banks are adapting to mobile opportunities). There are three categories of start-applications: wrappers, replacesrs, and

maintain and acquire customers that prioritize the digital components of banking, banks have been leading in the market of mobile innovation.[139] The increase of startup banking applications which merely "wrap" themselves around a bank's mobile ecosystem do not pose a threat to the bank's own innovations.[140] However, given the rate at which technological payment innovations have moved from mobile and onto taking payments in "connected 'internet of things' devices," the traditional payment infrastructure has struggled to keep up.[141] This shortcoming reveals a differential feature between banks' and FinTechs'[142] respective market advantages and institutional strengths: whereas banks' stop-gap strategy has been to layer new technological solutions *on top* of legacy systems, FinTechs are already digital at their core.[143] Notably, banks and FinTechs each possess something that the other is likely unable to acquire within the immediate future: banks have the market expertise, regulatory familiarity, trusted brand name, and most importantly, a banking license, and FinTechs innovate with digital embedded in their culture.[144]

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reformers. Wrappers wrap themselves around old financial marketplace and their goal is to reduce friction (e.g., ApplePay). The goal of replacers is to replace core banking services with software and servers (e.g., Prosper and Lenging Club). Reformers utilize mobile and digital currency technology to transform financial services.

139 *See id*; *see also Episode #134: Blockchain is essential to the Fintech revolution*, SoundCloud: BreakingBank$ (Mar. 3, 2016) available at https://soundcloud.com/breakingbanks/blockchain-essential-fintech (recognizing that the "digital" consumer no longer evaluates their satisfaction with banks according to a standard of friendliness).

140 *See* SKINNER, *supra* note 123, at 228 (proposing that human behavior will forward the next technological issues of the future).

141 Hannah Kuchler, *Payments networks battle new breed of criminals in cyber attacks*, FIN. TIMES (Sept. 28, 2016), https://www.ft.com/content/44340cda-4ff5-11e6-8172-e39ecd3b86fc (providing that banks in competition with fintechs must perform cost benefit analysis to determine whether the risk of fraud outweighs a less convenient user experience).

142 The label "fintech" may be affixed "to almost any start-up that is trying to use technology to solve some financial problem, and that can mean everything from insurance brokering to data analytics to budgeting software." *Ranking the Top Fintech Companies*, N.Y. TIMES (Apr. 6, 2016), http://www.nytimes.com/interactive/2016/04/07/business/dealbook/The-Fintech-Power-Grab.html?_r=0; FinTech is comprised of five areas: (1) finance/investment, (2) operations/risk management, (3) payments/infrastructure, (4) data security monetization and (5) customer interface. *See* DOUGLAS W. ARNER ET AL., THE EVOLUTION OF FINTECH: A NEW POST-CRISIS PARADIGM? 18 (2015) (unpublished manuscript) (on file with the University of New South Wales Law Research Series) *available at* http://ssrn.com/abstract=2676553.

143 *See* SKINNER, *supra* note 123, at 227 (discussing the emergence of Banco Original in Brazil); *see also* Robert Barba, *B of A's Bessant on AI, Blockchain, Patents and Swift*, AM. BANKER (June 8, 2016) http://www.americanbanker.com/news/bank-technology/b-of-as-bessant-on-ai-blockchain-patents-and-swift-1081389-1.html (noting banks that use technology cannot afford to be pure fintech companies because customers have much higher expectations of reliability).

144 *See* SKINNER, *supra* note 123, at 229-231(discussing the difference between tradition-

The proliferation of smartphones has resulted in a rapid increase in the growth of "mobile wallets,"[145] which enable consumers to make payments via their mobile phones.[146] Despite millennial assertions that privacy is a priority, the relinquishment of their private data to third parties suggests the significance of the need to enhance privacy protections to safeguard personal identity information stored in digital wallets.[147] Any device that has an IP address and is connected to the Internet of Things is a vulnerability.[148] When considering the type[149] and value of data secured by banks[150] that is made accessible to its customers through the Internet,[151] potential unknown vulnerabilities in current mobile banking software risk open source software breaches.[152] With the understanding that payment systems are only as trustworthy as their weakest link, the message to central banks and FinTechs alike is if you can't beat them, join a consortium.[153]

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al banks and FinTechs).

145 *See, e.g.*, Erin F. Fonté, *Mobile Payments in the United States: How Disintermediation May Affect Delivery of Payment Functions, Financial Inclusion and Anti-Money Laundering Issues*, 8 WASH. J .L. TECH. & ARTS 419, 421-22 (2013) ("Mobile payments technology is poised to create a globally dramatic shift in how individuals pay for goods and services, track spending, and manage personal finances.").

146 BNY MELLON, INNOVATION IN PAYMENTS: THE FUTURE IS FINTECH 1 (2015), https://www.bnymellon.com/_global-assets/pdf/our-thinking/innovation-in-payments-the-future-is-fintech.pdf (acknowledging that the "era of fintech" is before us and bank's mindfulness is insufficient; banks must establish a clear plan "to adapt to and benefit from fintech-fuelled changes.").

147 Susan Athey et al., *Escaping from Government and Corporate Surveillance. Evidence from the MIT Digital Currency Experiment*, FTC 1 (Oct. 3, 2016), https://www.ftc.gov/system/files/documents/public_comments/2016/10/00071-129190.pdf.

148 Penny Crosman, *Can Banks Protect Against the Threat of Everyday Devices?*, AM. BANKER (Oct. 27, 2016), http://www.americanbanker.com/news/bank-technology/can-banks-protect-against-the-threat-of-everyday-devices-1092148-1.html (quoting Austin Berglas, head of cyber defense at the consulting firm K2 Intelligence and former head of the FBI's New York cyber branch).

149 *See id.*

150 *See id.*

151 *See id* (acknowledging that "[p]eople have become a little too cavalier about internet-connected devices.").

152 *See* David E. Sanger & Nicole Perloth, *A New Era of Internet Attacks Powered by Everyday Devices*, N.Y. TIMES (Oct. 22, 2016), http://www.nytimes.com/2016/10/23/us/politics/a-new-era-of-internet-attacks-powered-by-everyday-devices.html (discussing new malware that exploits vulnerabilities in cameras and other cheap devices).

153 *See* Jane Wild, *Central banks explore blockchain to create digital currencies*, WALL ST. J. (Nov. 2, 2016), https://www.ft.com/content/f15d3ab6-750d-11e6-bf48-b372cdb1043a (recognizing that as worldwide central bank experimentation with blockchain progresses, cross-border cooperation will be necessary to address regulating developments in digital currency).

B. How Will Blockchain Technology Change Financial Institutions

The FinTech competition to incorporate distributed ledger technology into the financial services industry has gone global. To date, the greatest challenge that FinTech companies face in developing what will comprise the new core of the blockchain banking industry is developing a ledger that properly[154] balances transparency to financial markets with protecting consumers' financial and identity information.[155] In attempting to achieve this balance, the crux of the competition, that divides FinTech and blockchain banking initiatives[156] alike, is whether the best interests of the industry will be served/achieved through a *permissionless*, distributed public ledger or a *permissioned*, distributed private ledger.[157]

Distinguishable from Bitcoin's permissionless, or public, blockchain that enables a universal market to access to all information, "permissioned," or private, blockchains are those in which only known, trusted entities can participate.[158] Through a permissioned distributed ledger, sensitive information would never be published.[159] It is highly likely that more financial institutions will opt for a permissioned distributed ledger that will limit the sharing of information

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154 *See* JOHN CASSIDY, HOW MARKETS FAIL: THE LOGIC OF ECONOMIC CALAMITIES 87 (2009) (explaining the efficient market theory and monetary policy).

155 The notable banking blockchain competitors include R3, Symbiont, Digital Asset Holdings, and CitiGroup. Compare Digital Asset Holdings' private distributed ledger model which is anchored in a "need-to know" basis model ("Shared ledgers should contain the bare minimum information, interpretable only by those with a need and right to know, to permit notification, synchronization and confirmation.") with Symbiont. Tanaya Macheel, *Banks' Privacy Concerns Shaping Blockchain Vendors' Strategies*, AM. BANKER (July 26, 2016), http://www.americanbanker.com/news/bank-technology/banks-privacy-concerns-shaping-blockchain-vendors-strategies-1090411-1.html.

156 As an open source innovation for financial disintermediation, the Bitcoin blockchain was designed with an "all or nothing" approach to transact, validate and access transactions publically. The sensitive information should never be published; some say all data should be published, even if some of it must be concealed. Addleshaw Goddard LLP, *Blockchain – Public or Private*, LEXOLOGY (Nov. 17, 2016), http://www.lexology.com/library/detail.aspx?g=a381bb8a-3494-4f8d-9655-7f469cfddb23.

157 *See* Gideon Greenspan, *Payment and Exchange Transactions in Shared Ledgers*, 10 J. PAYMENTS STRATEGY & SYS. 172, 172-77 (2016) (identifying what characteristics distinguish distributed ledgers from centralized ledgers, as well as Bitcoin-style blockchain from Etherum-style blockchain).

158 For a more technical understanding of the difference between permissioned and permissionless ledgers, *see* TIM SWANSON, CONSENSUS-AS-A-SERVICE: A BRIEF REPORT ON THE EMERGENCE OF PERMISSIONED,
DISTRIBUTED LEDGER SYSTEMS 5 (2015).

159 *See* Tanaya Macheel, *Banks' Privacy Concerns Shaping Blockchain Vendors' Strategies,*
AM. BANKER (July 26, 2016), http://www.americanbanker.com/news/bank-technology/banks-privacy-concerns-shaping-blockchain-vendors-strategies-1090411-1.html (recognizing consumer confidentiality concerns).

with the parties on a need-to-know basis while improving upon the quality of the consumer, business, or regulatory relationship. As financial institutions incorporate distributed ledger technology, a balance must be struck between maximizing efficiency and minimizing transaction costs, without sacrificing market stability, and consumer protection must take into consideration how cybersecurity risks will be mitigated.[160]

C. Advantages of Incorporating Blockchain Technology in Banks

The primary characteristics of distributed ledger technology are its immutability, transparency, and autonomy.[161] The autonomous execution capabilities of blockchain technology – both FinTech and regulatory technology ("RegTech") would enable compartmentalized access to financial information that provides immutable and real-time updates that facilitate automated review. Blockchain technologies have the potential to transform financial and industrial markets, challenge corporate boundaries,[162] and add transparency to the public sector.[163] The benefits of blockchain technology include reduction in transaction costs, [164] increase in regulatory compliance, instantaneous settlement,

160 *See* Max N. Helveston, *Consumer Protection in the Age of Big Data*, 93 WASH. U. L. REV. 859, 873-74 (2016) (discussing how the Big Data movement increases the risk to consumer personal information, either through intentional sharing with insufficient privacy protections for individual information or the data-possessing entity's failure to implement safeguards that would prevent a third-party breach of information); *see also* Justin Brookman, *Protecting Privacy in an Era of Weakening Regulation*, 9 HARV. L. & POL'Y REV. 355, 356-57 (2015) (detailing how the weak legal privacy protections afforded to consumers in the United States requires consumer initiative to protect their data).

161 *Disruptive innovation in financial services: A Blueprint for Digital Identity*, WORLD ECON. F. 60 (Aug. 12, 2016), http://www3.weforum.org/docs/WEF_A_Blueprint_for_Digital_Identity.pdf.

162 *See e.g.*, *The Great Chain of Being Sure About Things*, ECONOMIST (Oct. 31 2015), http://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable ("Ledgers that no longer need to be maintained by a company—or a government—may in time spur new changes in how companies and governments work, in what is expected of them and in what can be done without them").

163 Bitcoin 2.0 Protocol Projects include: *Ripple* (gateway, payment, exchange, remittance network, smart contract system); *Counterparty* (overlay protocol for currency issuance and exchange); Mastercoin (financial derivatives); *NXT* (altcoin mined with proof of stake consensus model); *BitShares* (decentralized crypto-equity share exchange); *Colored Coins* (Bitcoin assert marking for digital/physical assets). MELANIE SWAN, BLOCKCHAIN: BLUEPRINT FOR A NEW ECONOMY 18 (Tim McGovern eds., 2015).

164 *See* Nicole Bullock, *Blockchain starts transition from hype to everyday use in markets*, FIN. TIMES (Oct. 10, 2016), https://www.ft.com/content/08d54cdc-74e2-11e6-bf48-b372cdb1043a (discussing how costs such as cross-border payments, securities trading, and regulatory compliance charges could be reduced by technology).

increased security,[165] and streamlined international trade finance through global interoperability.[166] To date, the areas in which DLT is thought to be most impactful include the financial markets in payments, banking, securities settlement,[167] and the trade of digital and financial assets.[168] Accordingly, the advantages of incorporating blockchain technology as it applies to regulatory compliance functions include: compliance software that utilizes artificial intelligence to monitor trading activity by automatically learning patterns to detect illegal activity; recording derivative trades; monitoring the risk national banks are exposed; and programming mobile applications to notify and report suspicious account activity to bank managers in real-time.[169] As a consequence, traditional legacy banks will experience fundamental shifts in their organizational boundaries, with many transactions currently governed through hierarchy, relational contracting, or market transactions that will shift to the blockchain as an outworking of economic efficiency over transaction costs.[170]

The political economy of blockchains challenges the legacy of banking, financial organizations, and market structure. Blockchains are apt to outcompete hierarchical organizations such as banks, and relational market contracting, which are transactions requiring trust.[171] Therefore, the redistribution of value amongst financial institutions that have or have not adapted to DLT will be inevitable, and consequently, will warrant the recalibration of banking as an institution.[172] To date, a majority of financial institutions that are at the forefront of the global financial technological revolution are those Too-Big-To-Miss-Out – either, they were recognized as institutionally worthy enough to join a consortium or were capable of financing their own in-house FinTech

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165 TAPSCOTT & TAPSCOTT, *supra* note 38, at 71.

166 *Id.*

167 *See* Stan Higgins, *8 R3 Banks Test Intel Blockchain Platform*, COINDESK (Sept. 26, 2016), http://www.coindesk.com/8-r3-banks-test-intel-blockchain-platform/ (discussing how banks took part in blockchain technology tests performed by Intel); *see also* Michael Mainelli & Alistair Milne, *The Impact and Potential of Blockchain on Securities Transaction Lifecycle* 4 (SWIFT Inst., Working Paper No. 2015-007, 2016) (explaining how Bitcoin blockchain is being compared to complex messaging in securities settlements).

168 *See* MELANIE SWAN, BLOCKCHAIN: BLUEPRINT FOR A NEW ECONOMY 15 (2015), http://w2.blockchain-tec.net/blockchain/blockchain-by-melanie-swan.pdf ("Blockchain based smart property contemplates the possibility of widespread decentralized trustless asset management systems as well as cryptographically activated assets."); *see also* SUNDARARAJAN, *supra* note 97, at 91 (explaining that centralized institutions "increase costs, freezes innovative potential, and needs layers of reconciliation." Adam Ludwin, CEO of Chain identified blockchain at the "new database technology, purpose-built for trading assets.").

169 DIANA C. BIGGS, HOW NON-BANKS ARE BOOSTING FINANCIAL INCLUSION AND REMITTANCE, *in* BANKING BEYOND BANKS AND MONEY: A GUIDE TO BANKING SERVICES IN THE TWENTY-FIRST CENTURY 190 (Paolo Tasca et al. eds., 2016).

170 MACDONALD ET AL, supra note 111, at 279.

171 *Id.*

172 *Id.*

experimentation.

Regardless of whether financial institutions adopt a permissioned or permissionless distributed ledger, a shared repository with real-time access to data will facilitate transparency between regulators and regulated entities.[173] Reporting activities through smart contracts will enable the automation of compliance activities. In conclusion, the characteristics distributed ledger technology allows for the adaptability to a rapidly changing marketplace demands and enables efficient responsiveness to and growing regulatory constraints.

PART III: REGULATION

"You will not find a solution to political problems in cryptography."[174]

A. History of Federal Regulation of Digital Currencies, Money Service Businesses, and Money Transmission in the United States

Regulators have chosen to regulate cryptocurrency businesses under the payments regulatory framework.[175] Accordingly, the current regulatory approach to decentralized virtual currencies mirrors that of financial regulation in general, a hybrid of "ex ante and ex post regulation to mitigate systemic risk in the financial system."[176] This Section will outline the current regulations of virtual currency, the absence of legislation addressing distributed ledger technology, and the effect proposed cybersecurity standards will have on the future of global financial technology.

To date, the Department of the Treasury Financial Crimes Enforcement Network ("FinCEN") and the New York Department of Financial Services ("NYDFS") are the most notable examples of virtual currency proactive regulation. Under the Bank Secrecy Act (BSA),[177] banks and other financial institutions are subject to various registration and recordkeeping requirements.[178] The Department of the Treasury requires all "money service businesses" to register

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173 *A Blueprint for Digital Identity The Role of Financial Institution in Building Digital Identity*, WORLD ECON. F. 91 (Aug. 12, 2016), http://www3.weforum.org/docs/WEF_A_Blueprint_for_Digital_Identity.pdf.

174 TAPSCOTT & TAPSCOTT, *supra* note 38, at 263.

175 Joshua A.T. Fairfield, *BitProperty*, 88 S. CAL. L. REV. 805, 831 (2015).

176 Carla L. Reyes, Article, *Moving Beyond Bitcoin to an Endogenous Theory of Decentralized Ledger Technology Regulation: An Initial Proposal*, 61 VILL. L. REV. 191, 211 (2016).

177 Bank Secrecy Act of 1970, 12 U.S.C. §§ 1829b, 1951–59 (2012).

178 Courtney J. Linn, *Redefining the Bank Secrecy Act: Currency Reporting and the Crime of Structuring*, 50 SANTA CLARA L. REV. 407, 412–21 (2010) (describing the recordkeeping requirements of banks and other "money transmitters").

and develop both anti-money-laundering and customer identification programs. In March 2013, FinCen issued guidance on the application of the Bank Secrecy Act and its implementing regulations to virtual currencies ("Virtual Currency Guidance").[179]

The Virtual Currency Guidance outlines the applicability of the existing federal anti-money laundering (AML) regime to convertible virtual currencies and includes decentralized virtual currencies. Virtual Currency Guidance thereby declared that "exchangers"[180] and "administrators"[181] of such currencies are subject to the AML requirements to the extent that they transmit decentralized virtual currency or legal tender from one user to another, or from one location to another.[182] Additionally, it concluded that although a "virtual currency" would not be deemed a "currency" under regulations implementing the BSA, certain virtual currency businesses would nevertheless be money transmitters under the BSA, subject to regulation as money services businesses ("MSB").[183] In 2014, FinCen attempted to clarify how the Virtual Currency Guidance applied to different decentralized technology business models and issued administrative guidance to address the regulation of virtual currency miners,[184] soft-

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179 U.S. DEP'T OF TREASURY, FIN-2013-G001, APPLICATION OF FINCEN'S REGULATIONS TO PERSONS ADMINISTERING, EXCHANGING, OR USING VIRTUAL CURRENCIES 5 (2013).

180 U.S. DEP'T OF TREASURY, FIN-2013-G001, GUIDANCE: APPLICATION OF FINCEN'S REGULATIONS TO PERSONS ADMINISTERING, EXCHANGING, OR USING VIRTUAL CURRENCIES 2 (Mar. 18, 2013) ("An *exchanger* is a person engaged as a business in the exchange of virtual currency for real currency, funds, or other virtual currency.").

181 *Id.* at 2 ("An *administrator* is a person engaged as a business in issuing (putting into circulation) a virtual currency, and who has the authority to redeem (to withdraw from circulation) such virtual currency.").

182 *Id.* at 4.

183 *In re* Coinflip, Inc. d/b/a Derividan, and Francisco Riordan, CFTC Docket No. 15-29, at 2 n.2, Order Instituting Proceedings Pursuant to Sections 6(c) and 6(d) of the Commodity Exchange Act, Making Findings and Imposing Remedial Sanctions, (Sept. 17, 2015); For other definitions of virtual currency, *see* U.S. DEP'T OF TREASURY, FIN-2013-G001, GUIDANCE: APPLICATION OF FINCEN'S REGULATIONS TO PERSONS ADMINISTERING, EXCHANGING, OR USING VIRTUAL CURRENCIES 1 (Mar. 18, 2013) (defining "virtual currency" as "a medium of exchange that operates like a currency in some environments, but does not have all the attributes of real currency"); 23 N.Y. COMP. CODES R. & REGS. § 200.2 (2015) (defining "virtual currency" as "any type of digital unit that is used as a medium of exchange or a form of digitally stored value. Virtual Currency shall be broadly construed to include digital units of exchange that (i) have a centralized repository or administrator; (ii) are decentralized and have no centralized repository or administrator; or (iii) may be created or obtained by computing or manufacturing effort."); *see also* U.S. DEP'T OF TREASURY, FIN-2013-G001, GUIDANCE: APPLICATION OF FINCEN'S REGULATIONS TO PERSONS ADMINISTERING, EXCHANGING, OR USING VIRTUAL CURRENCIES 1 (Mar. 18, 2013) (quoting 31 C.F.R. § 1010.100(m), which defines "real currency" as "the coin and paper money of the United States or of any other country that (i) is designated as legal tender and that (ii) circulates and (iii) is customarily used and accepted as a medium of exchange in the country of issuance.").

184 *See* U.S. DEP'T OF TREASURY, FIN-2014-R007, GUIDANCE: APPLICATION OF MONEY

ware development and investment activities,[185] virtual currency trading platforms, [186] and virtual currency payment systems.[187] Despite FinCen's numerous attempts to provide clarity in the scope of its guidance through administrative rulings, the significant risk of harm posed by ongoing issues vagueness and a lack of clarity is particularly problematic in the arena of digital currency innovations; the USA Patriot Act made noncompliance with state money license rules a federal crime whether or not a business is aware of the violation.[188]

In June 2015, NYDFS promulgated its final "BitLicense" framework for regulating "virtual currency businesses."[189] Under NYDFS's BitLicense framework, "virtual currency business activities" are categorized into five major prongs: (1) transmitting virtual currency;[190] (2) holding virtual currency on behalf of others; (3) buying and selling virtual currency as a customer business; (4) providing exchange services as a customer business; and (5) controlling, administering, or issuing virtual currency.[191] Distinguishable from NYDFS's strict BitLicense regime, North Carolina is the only state that has proposed a bill that would adopt a lenient, regulatory sandbox approach to money transmitter licensing.[192]

The Financial Stability Oversight Council (FSOC) was established by the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act).[193] FSOC's 2016 Annual Report acknowledged that "a considerable degree of coordination among regulators may be required to effectively identify

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SERVICES BUSINESS REGULATIONS TO THE RENTAL OF COMPUTER SYSTEMS FOR MINING VIRTUAL CURRENCY 3 (Apr. 29, 2014).

185 *See* U.S. DEP'T OF TREASURY, FIN-2014-R011, GUIDANCE: APPLICATION OF FINCEN'S REGULATIONS TO VIRTUAL CURRENCY SOFTWARE DEVELOPMENT AND CERTAIN INVESTMENT ACTIVITY 2-3 (Jan. 30, 2014).

186 *See* U.S. DEP'T OF TREASURY, FIN-2014-R011, REQUEST FOR ADMINISTRATIVE RULING ON THE APPLICATION OF FINCEN REGULATIONS TO A VIRTUAL CURRENCY TRADING PLATFORM 2-3 (Oct. 27, 2014).

187 *See* U.S. DEP'T OF TREASURY, FIN-2013-G001, GUIDANCE: APPLICATION OF FINCEN'S REGULATIONS TO PERSONS ADMINISTERING, EXCHANGING, OR USING VIRTUAL CURRENCIES 2-3 (Oct. 27, 2014).

188 Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism (USA Patriot Act) Act of 2001, Pub. L. No. 107-56, 115 Stat. 272 (2001).

189 23 N.Y. COMP. CODES R. & REGS. § 200.2(p) (2015).

190 23 N.Y. COMP. CODES R. & REGS. § 200.02(o) (2015) (defining "transmitting virtual currency" as "the transfer, by or through a third party, of Virtual Currency from a Person to a Person.").

191 23 N.Y. COMP. CODES R. & REGS. § 200.02(q)(1)–(5) (2015).

192 H.B. 289, 2016-17 Gen. Assemb. (N.C. 2015).

193 *See* Hilary J. Allen, *Putting the "Financial Stability" In Financial Stability Oversight Council*, 76 OHIO ST. L. J. 1087, 1088 (2015) (arguing that "both the FSOC's structure and its mandate are flawed in ways that increase the susceptibility of financial stability regulation to the vagaries of political economy.").

and address risks associated with distributed ledger systems." [194] FSOC is the only agency that has a mandate to "identify risks to the financial stability of the United States" and to "respond to emerging threats to the stability of the United States financial system."[195] Unfortunately, the effectiveness of the mandate is reduced because Dodd-Frank does not provide definition for the term "financial stability."

B. The Repercussions of Deficient Regulatory Action Towards Blockchain Technology

Present alternative regulatory proposals primarily focus on "ex ante measures followed by ex post supplemental enforcement actions as necessary."[196] Financial globalization establishes a "regulator[y] dilemma" for regulators who would like to benefit from international exchange but are wary of compromising their financial systems.[197] Accordingly, there is a gap in current distributed ledger technology policy recommendations between the policy concerns presently voiced by regulators and the frustration of many decentralized industry participants who want a limited national FinTechs charter.

Businesses that have monetary transmission licenses that even remotely engage with distributed ledger technology are potentially subject to federal monetary, anti-money laundering, investment, and consumer protection regimes, in addition to any of the 50 different state money transmitter licensing regimes[198] in which their businesses engage. Federal authorities' policy priorities have shifted from a concentrated focus on money-laundering, terrorist financing, and identity verification towards a more complex payments-related issues, including privacy and security, tax compliance, and the potential for use of unfair and deceptive businesses practices in the industry."[199] State regulatory activity also added new policy concerns to the mix, with a primary focus on consumer protection.[200]

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194 FINANCIAL STABILITY OVERSIGHT COUNCIL, ANNUAL REPORT 127 (2016).

195 Dodd-Frank Wall Street Reform and Consumer Protection Act, 15 U.S.C. § 5301.

196 Reyes, *supra* note 176, at 221 (highlighting the "overwhelming[] emphasis on the payments applications of decentralized ledger technologies, curbing illicit uses of such payments applications, reducing the perceived extreme level of anonymity afforded to use of such payments applications, [and] protecting consumers from financial loss.").

197 Iman Anabtawi & Steven L. Schwarcz, *Regulating Ex Post: How Law Can Address the Inevitability of Financial Failure*, 92 TEX. L. REV. 75, 100–01 (2013).

198 *See generally* CONF. OF STATE BANK SUPERVISORS, MODEL STATE CONSUMER AND INVESTOR GUIDANCE ON VIRTUAL CURRENCY 3 (Apr. 23, 2014), https://www.csbs.org/legislative/testimony/Documents/ModelConsumerGuidance—Virtual%20Currencies.pdf. *See* Reyes, *supra* note 176, 208 n. 96 (identifying the ten states that have released consumer guidance in accordance with the CSBS model).

199 Reyes, *supra* note 176, at 210.

200 *Id.*

Therefore, the Uniform Law Commission is working to draft the Virtual Currency Businesses Act.[201] The Commission stated mission is to "harmonize" state-level regulation of virtual currencies "[i]n the absence of an overarching federal payments regulatory framework."[202] Due to the lack of clarity in FinCen digital currency regulations as it applies to distributed ledger technology, digital asset companies involved in MSB activities are being denied access to banking services without appropriate initial due diligence oriented towards understanding the actual business model.[203] As a result of anti-money laundering, terrorist financing, and potential use for illicit-purposes risks that virtual currencies pose,[204] licensed money transmitters [205] are fearful that activities associated with blockchain distributed ledger technology will threaten their licenses and relationships with regulators. Besides being subject to disjointed federal and state money transmission and money services business regimes,[206] entities engaged in transmitting money likely must comply with OFAC requirements,[207] consumer protection obligations, as well as the CFPB's Remittance Rule.[208]

The trajectory of federal regulation of decentralized virtual currency is marked by an emphasis on ex ante attempts to prevent financial harm and ex post prosecutions of harmful activity that are a consequence of the former regulations' incongruity with newly emerging technological applications.[209] This has resulted in a financial technology "law lag," which refers to the circumstances in which "existing legal provisions are inadequate to deal with a social, cultural or commercial context created by rapid advances in information and communication technology . . . ."[210] By falling behind in the global financial

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201 *See generally* NAT'L CONF. OF COMM'RS ON UNIF. STATE LAWS, REGULATION OF VIRTUAL CURRENCIES ACT (draft), 6 (2015).

202 *Regulation of Virtual Currencies*, UNIF. L. COMM'N (Feb. 9, 2017), http://www.uniformlawcommission.com/Committee.aspx?title=Regulation%20of%20Virtual%20Currencies.

203 *See* PRATIN VALLABHANENI ET AL., OVERCOMING OBSTACLES TO BANKING VIRTUAL CURRENCY BUSINESSES, COIN CENTER REPORT 11 (May 2016).

204 FINANCIAL ACTION TASK FORCE, VIRTUAL CURRENCIES: KEY DEFINITIONS AND POTENTIAL AML/CFT RISKS, 3 (June 2014).

205 John L. Douglas, *New Wine into Old Bottles: Fintech Meets the Bank Regulatory World*, 20 N.C. BANKING INST. 17, 43 (Mar. 1, 2016).

206 Bank Secrecy Act, 31 U.S.C. §§ 5311-5330 (2012).

207 JAMES SIVON ET AL., UNDERSTANDING FINTECH AND BANKING LAW: A PRACTICAL GUIDE 63 (2014).

208 Electronic Fund Transfers (Regulation E), 12 C.F.R. § 1005 (2012).

209 Reyes, *supra* note 176, at 212.

210 Jeremy Pitt & Ada Diaconescu, *The Algorithmic Governance of Common-Pool Resources*, *in* FROM BITCOIN TO BURNING MAN AND BEYOND: THE QUEST FOR IDENTITY AND AUTONOMY IN A DIGITAL SOCIETY 130, 137–38 (John H. Clippinger & David Bollier eds., 2014).

technological revolution, overly broad regulations and vague administrative guidance that do not directly address blockchain technology stifle innovation, and economic growth will decrease financial institutional capabilities to combat cybersecurity threats.[211] The OCC, CFTC, and SEC have been consistent in their acknowledgement of the potential of distributed ledger technology, their encouragement for collaboration between regulated financial institutions, and expression of caution to the operational and systematic risks posed by the new technology.[212]

In conclusion, a lack of uniformity between states' often vague and conflicting AML/BSA regimes, and the absence of a national limited FinTechs charter, have effectively stopped collaborative efforts between FinTechs and financial institutions. The absence of a national charter therefore jeopardizes American institutions' relevance in the development of the future global financial system by creating an environment that is inhospitable to innovators. Given the absence of any incentives for banks to collaborate with FinTechs, it is arguable that there will be an increase in cybersecurity threats posed to financial institutions who do not update their cyber risk protocol. Thus, financial stability will not be attained under current virtual currency regulations and in turn, threatens the privacy of financial and personal identifiable information.

C. Comparing International Regulatory Actions Towards Payment Innovation

With the increased use of technology within the financial services industry, regulatory bodies have the opportunity to access a level of granularity in risk assessments that did not previously exist. The autonomous, self-sufficient, and decentralized nature of blockchain technology suggests that a rule-based, as opposed to principle-based, approach to regulation is better suited for blockchain technology because it would be difficult for computers to understand the nuances and spirit of the laws in which the rules have been promulgated.[213] FinTech firms have suggested that the OCC create a limited purpose FinTechs charter [214] that resembles the principles-based regulation of the United King-

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[211] Hillary J. Allen, *$=€=Bitcoin?,* SUFFOLK U. LAW SCHOOL RESEARCH PAPER NO. 15-33 (May 18, 2016); Reyes, *supra* note 176, at 211.

[212] Mary Jo White, Chairman, SEC, Opening Statements at the Fintech Forum (Nov. 14, 2016); Thomas J. Curry, Comptroller of the Currency, Remarks at the Chatham House 'City Series' Conference, "The Banking Revolution: Innovation, Regulation and Consumer Choice (Nov. 3, 2016).

[213] *See* JANOS BARBERIS AND DOUGLAS W. ARNER., FINTECH IN CHINA: FROM SHADOW BANKING TO P2P LENDING, *in* BANKING BEYOND BANKS AND MONEY 89-90 (Paolo Tasca et al. eds., 2016).

[214] Lalita Clozel, *Fintech firms press OCC for specialized charter*, BLOOMBERG (June 16, 2016), https://www.bloomberg.com/enterprise/blog/fintech-firms-press-occ-for-specialized-charter/.

dom and Japan that would provide FinTechs with a "passport" across several states.[215] The OCC could create a risk-mitigating limited federal charter for FinTech firms which only authorizes FinTech firms to engage in *some* of the core activities of banks.[216] Specifically, FinTech firms would possess the benefits of federal regulation, preemption of state law, and access to the payments system, but would not participate in risk-generating activities.[217]

The United Kingdom's financial regulatory system consists of the U.K.'s Financial Conduct Authority ("FCA"), Prudential Regulation Authority ("PRA") and HM Treasury.[218] In May 2016, the FCA launched *Project Innovate*, a regulatory sandbox for market entrants and incumbent financial institutions for the purpose of promoting competition through disruptive innovation to foster innovation in the U.K. financial services market.[219] As a result of the U.K.'s principle-based approach to regulating payment innovations, it has experienced burgeoning success with payments experimentation and is "light-years ahead" of the United States in providing licensing options.[220] In contrast with the United States' state-by-state licensing regime, the European Union provides members with "passport regulation" which provides FinTech firms with licenses to make digital transfers across borders.[221] The eligibility criteria include the firm's activity intent to be within the scope of FCA regulations, genuinely innovative product or service that provides a consumer benefit, genuine need for the sandbox, and preparedness for testing in a live environment.[222] The U.K. has four levels of licensing for nonbank payments providers

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215 *See e.g.*, Telis Demos, *Brexit Leaves Europe's fintech Firms in the Lurch*, WALL. ST. J. (June 27, 2016), https://www.wsj.com/articles/brexit-leaves-europes-fintech-firms-in-the-lurch-1467019802 (recognizing that if a FinTech firm is regulated in the United Kingdom's FCA, it is regulated across the European Union).

216 Peter Van Valkenburgh & Jerry Brito, Comments to the Office of the Comptroller of the Currency on Supporting Responsible Innovation (May 27, 2016).

217 *Id.*

218 CHARTERED INS. INST., POLICY BRIEFING: THE UK'S NEW FINANCIAL SERVICES REGULATORY LANDSCAPE 2 (Apr. 2013), http://www.cii.co.uk/media/4372607/regulatory_landscape_update_april_2013_vfonline.pdf .

219 Alex Davis, *FCA Launches 'Regulatory Sandbox' For Financial Products*, LAW360 (May 9, 2016), https://www.law360.com/articles/793933/fca-launches-regulatory-sandbox-for-financial-products.

220 Telis Demos, *Brexit Leaves Europe's fintech Firms in the Lurch*, WALL. ST. J. (June 27, 2016), https://www.wsj.com/articles/brexit-leaves-europes-fintech-firms-in-the-lurch-1467019802.

221 *See e.g.*, *id.* (recognizing that if a FinTech firm is regulated in the United Kingdom's FCA, it is regulated across the European Union).

222 *Regulatory Sandbox*, FINANCIAL CONDUCT AUTHORITY, https://www.fca.org.uk/firms/project-innovate-innovation-hub/regulatory-sandbox (last updated Nov. 21, 2016).

which adapt to the characteristics and business models of the requesting entity: (1) E-Money Institutions ("EMI"), (2) small EMI licenses, (3) Authorized Payment Institutions ("API"), and (4) small API licenses.[223]

The Office of the Comptroller of the Currency (OCC), released a white paper in March 2016 entitled "Supporting Responsible Innovation in the Federal Banking System."[224] In its paper, the OCC extended its support for innovation in the financial services industry that it views as "consistent with safety and soundness, compliant with applicable laws and regulations, and protective of consumer's rights."[225] Additionally, it emphasizes the need to "support responsible innovation"[226] and business cultures "receptive to responsible innovation."[227] In October 2016, the OCC issued that, as a part of its responsible innovation framework, it will establish the Office of Innovation to facilitate regulatory interagency coordination and serve as a technical assistance program for banks and non-banks.[228] To date, the OCC has not yet decided to grant a national FinTech charter. However, Commissioner Thomas J. Curry of the OCC remarked in November 2016 that "if the OCC decides to grant a national charter …, the institution will be held to the same high standards of safety, soundness, and fairness that other federally chartered institutions must meet."[229] The Commissioner recognized that opposition to a limited purpose FinTech charter includes dispute over the scope of the charter, Congress being the more appropriate vessel to enact the charter, and concerns that states will be preempted from providing individualistic protections to its consumers. [230] Correspondingly, Commissioner Curry asserted that while the OCC does have the authority to

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223 Judith Rinearson, *U.S. Regulators Losing Out to U.K., EU on Innovation*, AMERICAN BANKER (Dec. 28, 2015), https://www.americanbanker.com/opinion/us-regulators-losing-out-to-uk-eu-on-innovation.

224 OFF. OF THE COMPTROLLER OF THE CURRENCY, SUPPORTING RESPONSIBLE INNOVATION IN THE FEDERAL BANKING SYSTEM: AN OCC PERSPECTIVE 5 (2016), http://www.occ.gov/publications/publicationsbytype/otherpublicationsreports/pubresponsibleinnovationbankingsystemoccperspective.pdf.

225 *Id.*

226 In to describe this process of using new or improved products, services, and processes to meet the evolving needs of consumers, businesses, and communities in a way that is safe, sound, and fair, and aligned with banks' strategies.

227 OFFICE OF THE COMPTROLLER OF THE CURRENCY, SUPPORTING RESPONSIBLE INNOVATION IN THE FEDERAL BANKING SYSTEM: AN OCC PERSPECTIVE 2 (2016), http://www.occ.gov/publications/publicationsbytype/otherpublicationsreports/pubresponsibleinnovationbankingsystemoccperspective.pdf.

228 Press Release, Office of the Comptroller of the Currency, OCC Issues Responsible Innovation Framework,
(Oct. 26, 2016) (on file with author).

229 Thomas J. Curry, Commissioner, Comptroller of the Currency, Remarks at the Chatham House 'City Series' Conference, "The Banking Revolution: Innovation, Regulation and Consumer Choice," (Nov. 3, 2016).

230 *Id.*

issue a charter to companies that engage in at least one of three core banking functions—taking deposits, paying checks, or lending money – the OCC has never waived consumer protection compliance requirements because it does not have the authority to do so.

D. The Feasibility of a FinTech Federal Charter

The United States could substantially benefit from adopting a principles-based approach like the United Kingdom, especially considering recent regulatory developments that address the concerns addressed by opponents of the federal FinTech charter. The Federal Financial Institutions Examination Council ("FFIEC") issued guidance regarding the risks and risk management practices that apply to the use of free and open source software ("FOSS").[231] The main risks that regulators identified include multiple risk management areas, including code customization, IT architecture, forking, systems integration and support, and legal risks.[232] On October 25, 2016, FinCen released an advisory to assist financial institutions in understanding their BSA obligations regarding cyber-events and cyber-enabled crime.[233] FinCen does not require financial institutions to report egregious, significant, or damaging cyber-events and cyber-enabled crime when such events and crime do not otherwise require the filing of a suspicious activity report (SAR).[234] The guidance encouraged reporting SARs, collaboration between BSA/AML compliance and cybersecurity risk units, and the sharing of information between financial institutions to combat money laundering, terrorist financing and cyber-enabled crime.[235]

Banks' information governance relates to data safeguards,[236] record-keeping

231 FED. FIN. INST. EXAMINATION COUNCIL, FIL-114-2004, Guidance on Risk Management of Free and Open Source Software (Oct. 21, 2004).

232 *Id.*

233 FINCEN, FIN-2016-A005, Advisory to Financial Institutions on Cyber-Events and Cyber0Enabled Crime (Oct. 25, 2016).

234 *Id.*

235 *Id* (identifying a "cyber-event" as [a]n attempt to compromise or gain unauthorized electronic access to electronic systems, services, resources, or information" and a "cyber-enabled crime" as "[i]llegal activities (e.g., fraud, money laundering, identity theft) carried out or facilitated by electronic systems and devices, such as networks and computers).

236 The Gramm-Leach-Bliley Act ("GLBA") applies to all financial institutions and governs the use, storage, and protection of personally identifiable information. Gramm-Leach-Bailey Act Pub. L. 106-102, 113 Stat. 1338, (codified in relevant part at 15 U.S.C. § § 6801-6809 and §§ 6821-6837). Personally identifiable information is defined as: Any information about an individual maintained by an agency, including (1) any information that can be used to distinguish or trace an individual's identity, such as name, social security number, date and place of birth, mother's maiden name, or biometric records; and (2) any other information that is linked or linkable to an individual, such as medical, educational, financial, and employment information; ERIKA MCCALLISTER ET AL., NIST GUIDE TO PROTECTING THE

requirements, and breaches of security information.[237] While a financial institution may outsource the function to a service provider, it is unable to outsource its responsibility for compliance.[238] The Board of Governors of the Federal Reserve System, the Office of the Comptroller of the Currency,[239] and the Federal Deposit Insurance Corporation, have harmonized the principles articulated in the aforementioned FFIEC and FinCen releases, and proposed joint standards for enhanced cyber risk management standards for large and interconnected entities under their supervision and those entities' service providers. [240] The enhanced cyber risk management standards described in the ANPR would apply on an enterprise-wide basis to banking organizations and financial institutions with US$50 billion or more in total consolidated assets.

As technology dependence in the financial sector continues to grow, so do opportunities for high-impact technology failures and cyber-attacks. Due to the interconnectedness of the U.S. financial system, a cyber incident or failure of one entity may result in systemic consequences involving related entities.[241] The agencies are considering implementing the enhanced standards in a tiered manner to imposing more stringent standards on the systems of those entities that are critical to the functioning of the financial sector. The proposed rule addresses five categories of cyber standards: cyber risk governance; cyber risk management; internal dependency management; external dependency management; and incident response, cyber resilience and situational awareness.[242]

CONCLUSION

Distributed ledger technology will have the most disruptive impact on the financial services industry since the invention of the Internet. Banking consor-

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CONFIDENTIALITY OF PERSONALLY IDENTIFIABLE INFORMATION (PII) B1, ES-1 (2010).

237 *See* FED. DEPOSIT CORP. INS., FIL-121-2004, GUIDANCE ON DEVELOPING AN EFFECTIVE COMPUTER SOFTWARE EVALUATION PROGRAM TO ENSURE QUALITY AND REGULATORY COMPLIANCE 2 (Nov. 16, 2004);
FED. FIN. INST. EXAMINATION COUNCIL, FIL-114-2004, GUIDANCE ON RISK MANAGEMENT OF FREE AND OPEN SOURCE SOFTWARE 1 (Oct. 21, 2004).

238 *See* KEVIN C. TAYLOR, FINTECH LAW: A GUIDE TO TECHNOLOGY LAW IN THE FINANCIAL SERVICES INDUSTRY 8-8, (2014).

239 The OCC is the primary regulator of banks chartered under the National Bank Act, 12 USC § 1 et seq. and federal savings associations chartered under the Home Owners Loan Act of 1933, 12 USC § 1461 et seq.

240 12 C.F.R. §30. The regulations governing banking operations enforced by the U.S. Office of the Comptroller of the Currency provide legal authorization for national banks to use electronic systems, including computer networks, to conduct their banking services.

241 12 C.F.R. §30. The regulations governing banking operations enforced by the U.S. Office of the Comptroller of the Currency provide legal authorization for national banks to use electronic systems, including computer networks, to conduct their banking services.

242 12 C.F.R. §30.

tiums' experimentation, development, and adoption of distributed ledger technology will substantially alter the intermediary roles of banks. Regulatory emphasis on the threat posed by virtual currencies, like bitcoin, has created an environment that is inhospitable to innovation. For the full potential of blockchain technology to become a reality, the OCC must create a limited national charter for FinTechs. Whether or not distributed ledger technology is endorsed within the next year or the next decade, the United States' participation in the global financial technology revolution warrants increased cybersecurity risk management standards.