

**BLOCKCHAIN INNOVATION IN PRIVATE INVESTMENT
FUNDS**

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**A COMPARATIVE ANALYSIS OF THE UNITED STATES
AND EUROPE**

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Abstract

The use of blockchain technology in private investment funds is proliferating. Using a dataset of private investment fund advisers that utilize blockchain technology (N=120), we explore the core commonalities and differences in the use of blockchain technology between European and American fund advisers.

The data analysis in this article suggests that the market for private investment funds who invest in- and utilize blockchain technology appears to be near equally divided between the US and the EU, with Russia and China playing significant roles. We interpret parts of the data as suggesting that larger private investment fund advisers in Europe may be more willing to make the required investments into blockchain infrastructure whereas in the US the legacy systems utilized by larger private investment fund advisers create barriers to entry for larger advisers to invest in- and utilize blockchain technology. Larger European fund advisers use the technology predominantly to invest in- and secure crypto assets whereas American fund advisers appear to use the smart contracting features of the technology more frequently to build more advanced crypto businesses and business structures via blockchain technology.

While the overall proportion of strategies of private investment funds that utilize modern technologies, including blockchain technology, is still small, as the private investment fund industry’s use of blockchain technology grows and accelerates, the innovation benefits for private investment funds and their clients promise lasting change for the industry.

Key Words: Blockchain, Distributed Ledger Technology, Artificial Intelligence, Machine Learning, Data Science, Data Scientists, Meta Models, Innovation, Entrepreneur, Startup, Big Data, Private Investment Funds, Hedge Funds, Private Equity, Diversification, Compliance, Optimization, Efficiency

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I. Introduction

The disruptive properties of Blockchain technology have the potential to transform a significant part of the financial services sector. Blockchain is a distributed database¹ capable of holding a secure and immutable record of past transactions that is quickly adaptable to a broad range of activities and objectives.² The World Economic Forum (WEF) referred to Distributed Ledger Technology (DLT) as a technology “that will form the foundation of next generation financial services infrastructure.”³ Data on blockchain technology collected by the WEF between 2013-2016 suggests over \$1.4 billion venture capital investments in the industry; more than 2,500 DLT patent applications; more than 24 countries currently investing in DLT; more than 90 central banks engaged in DLT discussions worldwide; more than 90 corporations have joined DLT consortia; and 80% of banks are predicted to initiate a DLT project by 2017.⁴

Financial services’ infrastructure cost savings associated with blockchain technology are significant. Although the majority of blockchain applications has been developed in the context post-trading market operations,⁵ blockchain has the potential to replace a significant proportion of existing manual processes, where information needs to be

¹ See Satoshi Nakamoto, *Bitcoin: A peer-to-peer Electronic cash system* (November 2008), available at <https://bitcoin.org/bitcoin.pdf>

² Charles Brennan & William Lunn, *Blockchains, The Trust Disrupter*, 3 August 2016, available at <https://www.finextra.com/finextra-downloads/newsdocs/document-1063851711.pdf>. On the regulation of disruptive technology, see Mark Fenwick Wulf A. Kaal & Erik P.M. Vermeulen, *Regulation Tomorrow: What Happens When Technology is Faster than the Law?* (September 4, 2016), Lex Research Topics in Corporate Law & Economics Working Paper No. 2016-8; U of St. Thomas (Minnesota) Legal Studies Research Paper No. 16-23; TILEC Discussion Paper No. 2016-024; available at <https://ssrn.com/abstract=2834531> or <http://dx.doi.org/10.2139/ssrn.2834531>

³ World Economic Forum, *The future of financial infrastructure An ambitious look at how blockchain can reshape financial services* (2016), available at http://www3.weforum.org/docs/WEF_The_future_of_financial_infrastructure.pdf.

⁴ Id.

⁵ ECB, *Distributed Ledger Technology* (2016), available at https://www.ecb.europa.eu/paym/pdf/infocus/20160422_infocus_dlt.pdf: “keeping accounts at the top-tier level (depository/registrars service) and at lower level (custody service); checking the entitlement of an investor to the control of an asset (know-your-customer and antimoney-laundering obligations); transmitting and reconciling transfer orders prior to settlement (clearing function); facilitating settlement and hedging settlement risk until the transfer of funds and securities are final and enforceable (netting and risk management); discharging participants’ obligations through the transfer of funds and securities (settlement function); ensuring the integrity of an issuance and avoiding the unwarranted creation of securities (notary function); avoiding theft of private information, malicious updates and the denial of service (cybersecurity); and managing events initiated by an issuer of securities and their impact on end investors (asset servicing)”.

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communicated and stored but is prone to human error.⁶ Facilitated by its potential to eliminate market intermediaries⁷ and create new foundations for economic and social systems,⁸ blockchain technology is an important example of a disruptive technology that can create new market structures. By 2022 Santander estimates \$20 billion per year in savings for the US banking system will be attributable to blockchain technology because of the reduction of banks' infrastructure costs associated with cross-border payments, securities trading, and regulatory compliance.⁹

Private investment funds in Europe and the United States play a major role in the evolution of blockchain technology in the financial sector. Private investment funds have invested earlier in the blockchain sector than other financial players. Because of legacy systems in the private investment fund infrastructure, the proportion of private investment funds that invest in blockchain technology is still small as a proportion of all private investment fund investments in technology. However, a growing subgroup of private investment funds is embracing blockchain and smart contracts (as well as artificial intelligence (AI) and machine learning that are beyond the scope of this article).

Private investment funds benefit from blockchain in multiple and often parallel ways. While some funds use the technology for the purpose of investing in crypto-currencies or indirectly making profits investing in blockchain start-up companies, other private investment funds are investing in start-up companies with the purpose to internalize the new technological applications within their business model. By optimizing their internal processes via blockchain technology, smaller investment fund managers gain unprecedented opportunities to compete with more established fund managers in markets that were previously dominated by larger players. Moreover, consistently with the general trends of market fragmentation and disintermediation, smaller private investment fund managers started to erode the power of established market institutions such as banks and insurance companies.

This article evaluates the comparative differences between European and American private investment funds that invest in blockchain technology. To provide an overview of the findings, the

⁶ ASTRI, *Whitepaper On Distributed Ledger Technology* (November 2016), 71, available at [http://www.hkma.gov.hk/media/eng/doc/key-functions/financial-infrastructure/Whitepaper On Distributed Ledger Technology.pdf](http://www.hkma.gov.hk/media/eng/doc/key-functions/financial-infrastructure/Whitepaper%20On%20Distributed%20Ledger%20Technology.pdf).

⁷ Philipp Paech, *Securities, Intermediation and the Blockchain - An Inevitable Choice between Liquidity and Legal Certainty?* Uniform Law Review (2016) 21 (4), available at <https://ssrn.com/abstract=2697718> or <http://dx.doi.org/10.2139/ssrn.2697718>.

⁸ Marco Iansiti & Karim R. Lakhani, *The Truth About Blockchain*, Harv. Bus. Rev. (Jan.–Feb. 2017), available at <https://hbr.org/2017/01/the-truth-about-blockchain>.

⁹ Santander Innoventures & Oliver Wyman, *The Fintech 2.0 Paper: rebooting financial services* (2015), available at <http://santanderinnoventures.com/wp-content/uploads/2015/06/The-Fintech-2-0-Paper.pdf>.

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market for private investment funds investing in- and implementing blockchain technology appears to be near equally divided between Europe and US, with China and Russia emerging as significant players. An analysis of the data related to the two markets reveals specific traits and differences, both in terms of categories and dimensions of private funds investing in blockchain. While in the US the majority of private funds is homogenously distributed among the major asset classes (hedge funds, private equity funds, venture capitals), in Europe a clear predominance of venture capitals emerges. In addition, the size of private funds significantly diverges in the two geographic areas: the European market is characterized by more established and larger private funds, whereas the American market benefits from the presence of smaller and potentially more innovative funds. This could be affected by Europe larger private investment fund advisers' willingness to make the required investments into a blockchain infrastructure. Whereas in the US the legacy systems utilized by larger private investment fund advisers create barriers to entry for larger private investment fund advisers to invest in- and utilize blockchain technology. Nonetheless, the majority of the private fund advisers in both EU and US invest in blockchain technology to gain exposure to crypto assets, as a potential source of exponential returns.

II. Blockchain Technology

Blockchain is a specific type of DLT. While in a normal distributed ledger, records are stored in a continuous ledger,¹⁰ blockchain is structured as a series of blocks securely chained together,¹¹ where each block contains a collection of transactions. Starting from the first block in the ledger, the "Genesis block," each new block is appended and thereby forms a chain.¹² That blockchain represents the chronological order of the transactions¹³ via complex cryptography that secures the integrity of the data. The resulting chain forms a register of transactions as the official record¹⁴: all transactions

¹⁰ See UK Government Chief Scientific Adviser, *Distributed Ledger Technology: beyond block chain*(2016), 17, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf

¹¹ ASTRI, *supra* note 66, 5.

¹² *Id.*

¹³ ECB, *supra* note 5, 1.

¹⁴ *Id.* See also Andrea Pinna & Wiebe Ruttenberg, *Distributed ledger technologies in securities post-trading*, ECB Occasional papers n. 172/April 2016, 8, available at <https://www.ecb.europa.eu/pub/pdf/scpops/ecbop172.en.pdf>: "Some of the characteristic features of DLTs can be found in earlier database technologies that have been developed since the 1990s, e.g. in the field of master replication. These technologies allow a number of parties to update records in a common database, with conflicts being resolved by some form of consensus algorithm. It is possible that there will be a renewal of interest in technologies of this type, as a result of the current focus

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are immutably stored in that ledger, which is replicated among all validating nodes.¹⁵

Numerous definitions of DLTs have been elaborated in different contexts and there is no one common accepted legal definition.¹⁶ Among others, IOSCO defines DLT as “*a consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, and/or institutions. DLT are technologies used to implement distributed ledgers*”.¹⁷ Regardless of the legal definition, DLT is a combination of peer-to-peer networking, distributed data storage and cryptography.¹⁸

Blockchain has been defined by Vitalik Buterin, founder of Ethereum, as follows: “*Public blockchains: a public blockchain is a blockchain that anyone in the world can read, anyone in the world can send transactions to and expect to see them included if they are valid, and anyone in the world can participate in the consensus process—the process for determining what blocks get added to the chain and what the current state is. As a substitute for centralized or quasi-centralized trust, public blockchains are secured by crypto economics—the combination of economic incentives and cryptographic verification using mechanisms such as proof of work or proof of stake, following a general principle that the degree to which someone can have an influence in the consensus process is proportional to the quantity of economic resources that they can bring to bear. These blockchains are generally considered to be “fully decentralized”*.”¹⁹

on shared databases (and distributed ledgers), and that they will, as a result, be updated and come to represent a competing alternative to DLTs. They could allow otherwise traditional databases designed to be shared among financial institutions to be updated non-centrally”.

¹⁵ ASTRI, *supra* note 66, 19.

¹⁶ David Mills et al., *Distributed ledger technology in payments, clearing, and settlement* (2016), Finance and Economics Discussion Series 2016-095. Washington: Board of Governors of the Federal Reserve System, available at <https://doi.org/10.17016/FEDS.2016.095>.

¹⁷ IOSCO, *Research Report on Financial Technologies (Fintech)* (Feb. 2017), 51, available at <https://www.iosco.org/library/pubdocs/pdf/IOSCOPD554.pdf>.

¹⁸ David Mills et al., *supra* note 16..

¹⁹ Vitalik Buterin, *On Public and Private Blockchains*, ETHEREUM BLOG (Aug.7,2015), available at <https://blog.ethereum.org/2015/08/07/on-public-and-private-blockchains/>, contrasting public blockchains (the original idea) with consortium blockchains and fully private blockchains: “Consortium blockchains: a consortium blockchain is a blockchain where the consensus process is controlled by a pre-selected set of nodes; for example, one might imagine a consortium of 15 financial institutions, each of which operates a node and of which 10 must sign every block in order for the block to be valid. The right to read the blockchain may be public, or restricted to the participants, and there are also hybrid routes such as the root hashes of the blocks being public together with an API that allows members of the public to make a limited number of queries and get back cryptographic proofs of some parts of the blockchain state. These blockchains may be considered ‘partially decentralized.’” *Id.* “Fully private blockchains: a fully private blockchain is a blockchain where write

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The ledger aspect of blockchain technology is key. Similar to accounting ledgers, electronic ledgers are updated whenever a transaction takes place. However, while accounting ledgers are overwritten, in the context of DLT the nodes (the system participants) exchange the transaction information that is subsequently added as a new ledger entry.²⁰ In addition, different from accounting ledgers, electronic ledgers are “collectively maintained”²¹ by a shared or distributed network of participants.²² Typically, the distributed network is a “peer-to-peer” (P2P) network, where each connected computer is a “peer” node,²³ that joins “the network by connecting to one of the well-known peers, whose information has been made public. It then learns about other peers through the information received from this well-known node. At the same time, other nodes learn about this new node.”²⁴

Distributed networks disintermediate. The intermediation of a centralized validation entity (a central bank or a clearing-house) in charge of recording and validating the transactions is not necessary in a decentralized network.²⁵ Therefore, the framework implemented with DLTs is often referred as “*decentralized*.”²⁶ DLT users can “store and access information relating to a given set of assets and their holders in a shared database of either transactions or account balances.”²⁷ Information is distributed among users, who can implement a wide range of actions, without a trusted central counterparty acting as a validator.²⁸

1. *Distributed Consensus*

In the decentralized DLT model, “distributed consensus” replaces the trusted central validation system.²⁹ Consensus is a set of rules and procedures regulating the process by which the majority, or

permissions are kept centralized to one organization. Read permissions may be public or restricted to an arbitrary extent. Likely applications include database management, auditing, etc [sic] internal to a single company, and so public readability may not be necessary in many cases at all, though in other cases public auditability is desired.” On the definition of private and public blockchain see also, FINRA, *Distributed Ledger Technology: Implications of Blockchain for the Securities Industry* (Jan. 2017), available at https://www.finra.org/sites/default/files/FINRA_Blockchain_Report.pdf.

²⁰ ASTRI, *supra* note 6, 10.

²¹ *Id.*

²² ESMA, *The Distributed Ledger Technology Applied to Securities Markets* (Feb. 7, 2017), available at https://www.esma.europa.eu/sites/default/files/library/dlt_report_-_esma50-1121423017-285.pdf (last visited Jul. 11, 2017).

²³ ASTRI, *supra* note 6, 10.

²⁴ *Id.*

²⁵ ESMA, *supra* note 22.

²⁶ Vitalik Buterin, *supra* note 19.

²⁷ Pinna & Ruttenberg, *supra* note 6, 8.

²⁸ & *Id.*

²⁹ ASTRI, *supra* note 6, 10.

also the totality, of the networks validators reach an agreement on the state of a ledger, contributing to maintain “coherent set of facts between multiple participating nodes.”³⁰ The process of consensus can vary: in the context of Bitcoin, the “*longest chain*” – *the chain with the most proof-of-work* – is considered to be the valid ledger.”³¹ DLT users reach consensus on a particular version of the distributed ledger, namely on the sequential order of transactions, with the consequence that “there cannot be any doubt as to the users’ respective holdings,” replacing a central validation with “a set of cryptographic”³² solutions and economic incentives that combine to prevent illicit updates and reconcile discrepancies.”³³

In the process of “distributed consensus”, two phases can be distinguished: (i) validation of each transaction and (ii) the “broadcast” of the validated result to all nodes validates the other nodes of the distributed ledger.³⁴ In the first phase, the nodes establish whether or not new entries in a transaction block are valid. The nodes also validate that the transaction block can be admitted to the ledger. Validating every transaction in the block ensures that the contents are legitimate.³⁵ In the second phase of “broadcast & Consensus,” validating nodes agree on a consistent view of the new entry in the distributed ledger.³⁶ It begins when a validating node has validated one or more transactions and initiates the process of adding them to the ledger. The validating node first broadcasts information about the new block to the other validating nodes. The other validating nodes may also have validated the same set or different sets of transactions, but the consensus process allows them to communicate among themselves and agree on a common set of validated transactions to be added to the ledger.³⁷ The ledger can thus

³⁰ Tim Swanson, *Consensus-as-a-service: a brief report on the emergence of permissioned, distributed ledger systems*, (Apr. 6, 2015), available at <http://www.ofnumbers.com/wp-content/uploads/2015/04/Permissioned-distributed-ledgers.pdf> (last visited Jul. 11, 2017)

³¹ *Id.* “There are multiple alternative consensus mechanisms which have been developed over the past three decades. For instance, the Dijkstra Prize is an annual award for academic research on distributed computing. Some of the ideas and innovations from these proceedings have influenced both distributed databases which require fault tolerance (e.g., Paxos from Leslie Lamport) and distributed economic consensus methods. The primary distinction between the former and latter is that of maturity in formalization, analysis and implementation”

³² Cryptography encompasses “computer-based encryption techniques such as public/private keys and hash functions, to store assets and validate transactions”. See ESMA, see *supra* note 22.

³³ Andrea Pinna & Wiebe Ruttenberg, *supra* note 14, 9.

³⁴ ASTRI, *supra* note 6, 10.

³⁵ *Id.* Such validation may consist in verifying that “the sender of a transaction is the true owner of the asset being sold. For transactions containing a contract execution instruction, validating nodes will also execute the instruction that has been received and confirmed by the consensus process”.

³⁶ ASTRI, *supra* note 6, 10.

³⁷ *Id.*

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be considered authoritative, although its management is shared among users with conflicting incentives.³⁸

DLT uses digital signature technology. In order to verify the authenticity of transactions over the network and to further increase its security, DLT applies digital signature technology. The technology is a derivation of public-key-cryptography,³⁹ an asymmetric key cryptography, and serves to certify the authenticity of transactions.⁴⁰ The digital signature is based on three algorithms. First, via a key generation algorithm, a person concurrently generates a private signing key and public verification key, where a relationship exists between the two, and the private key may not be derived from the public key.⁴¹ Second, a signing algorithm hashes the message and binds the private key of the sending party to the message.⁴² Third, a signature verification algorithm uses the public key to ensure the corresponding private key was used to sign the digest,⁴³ with the consequence that anyone trying to sign the transaction using a different private key will be detected as bogus.⁴⁴

2. Smart Contracting

Through DLT platforms it is possible to implement “smart contracts.”⁴⁵ Smart contracts “*combine protocols with user interfaces to formalize and secure relationships over computer networks.*”⁴⁶ They

³⁸ Pinna & Ruttenberg, *supra* note 14, 8: “Sharing a database with no central validation system can create difficulties when different users have conflicting incentives. Due to the latency of communication via a network, a malicious user may lead a counterparty to believe that some cash/securities have been credited to its account, whilst other users believe these same assets to be recorded in another account – which might be that of the malicious user or of a third user.5 A similarly undesirable outcome might also arise when a dysfunction in the entry of information by a bona fide user in the network results in inconsistent information being recorded in the copies of the ledger held by the various users. Before all distributed copies of the ledger have been reconciled, the beneficiary of a transaction may perform what erroneously appears to be a delivery-versus-payment. There needs to be a way of avoiding or addressing such errors, and thus achieving consistency across different copies of the ledger”.

³⁹ Brennan & Lunn, *supra* note 2..

⁴⁰ ASTRI, *supra* note 6, 26.

⁴¹ Brennan & Lunn, *supra* note 2..

⁴² *Id.*

⁴³ *Id.*

⁴⁴ ASTRI, *supra* note 6, 26.

⁴⁵ The term “smart contract” was first introduced by Nick Szabo, a computer scientist and legal theorist, in 1994. See Nick Szabo, *Smart Contracts: The Blockchain Technology That Will Replace Lawyers* (1994), BLOCKGEEKS, <http://blockgeeks.com/guides/smart-contracts/> (last visited Jul. 11, 2017)

⁴⁶ Nick Szabo, *Formalizing and Securing Relationships on Public Networks*, First Monday, Volume 2, Number 9 - 1 September 1997, available at <http://ojs.berkeley.edu/index.php/fm/article/view/548/469>.

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are pre-written logic computer programs⁴⁷ that can be impartially executed by DLT itself⁴⁸ e.g. by DLT validating nodes.⁴⁹ The coded terms in smart contracts are a set of pre-defined terms and execution conditions that are agreed upon ex-ante by all relevant parties. One or a series of specific events trigger the transaction⁵⁰ without relying on a central authority.⁵¹ A smart contract is executed by transferring the value between the contract signing parties⁵² when the transaction is triggered, and its settlement – the settlement of both on-chain assets and off-chain assets.⁵³ In smart contracts, two further typical elements are multi-signature (or multi-sig) and oracles. The former guarantees the approval of transactions by two or more parties “before funds can be released or some other aspect of the contract can move forward.”⁵⁴ The latter serves to monitor and provide support regarding external input, including, inter alia, prices, performance, or some other aspect of the real world.⁵⁵

Smart contracts may have different degrees of complexity, from the simple purchase of music through Apple’s i Tunes platform⁵⁶ or a travel reservations⁵⁷, to derivative contracts.⁵⁸ Complex smart contracts involving several parties need to rely on a verifiable and unhackable system provided by blockchain technology. Through blockchain

⁴⁷ IOSCO, *supra* note 17, 51.

⁴⁸ ASTRI, *supra* note 6.

⁴⁹ *Id.*

⁵⁰ *Id.*

⁵¹ See CAPGEMINI, *Smart Contracts in Financial Services: Getting from Hype to Reality* (2017), available at <https://www.capgemini-consulting.com/resource-file-access/resource/pdf/smart-contracts.pdf>.

⁵² *Id.*: “Multisig allows two or more parties to the contract to approve the execution of a transaction independently – a key requirement for multi-party contracts”.

⁵³ ASTRI, *supra* note 6, 27.

⁵⁴ Houman Shadab, *What Are Smart Contracts, and What Can We do with them?* (15 December 2014), available at <https://coincenter.org/entry/what-are-smart-contracts-and-what-can-we-do-with-them> (last visited Jul. 11, 2017).

⁵⁵ See Houman Shadab, *supra* note 64, and CAPGEMINI, *supra* note 61.

⁵⁶ See Wulf A. Kaal, *Blockchain Applications and Fee Structure Developments in Private Investment Funds* (April 27, 2017), available at <https://ssrn.com/abstract=2959730> or <http://dx.doi.org/10.2139/ssrn.2959730>. See, e.g., Horsten Koepl & Jeremy Kronik, *BLOCKCHAIN TECHNOLOGY—WHAT’S IN STORE FOR CANADA’S ECONOMY AND FINANCIAL MARKETS?* 15 (2017), available at https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/Commentary_468_0.pdf; R. Douglas Vaugh & Anna Outzer, *Understanding How the Block Chain Could Impact the Legal Industry*, LAW 360 (Jan. 11, 2017), available at <https://www.law360.com/articles/879810/understanding-how-blockchain-couldimpact-legal-industry>.

⁵⁷ See Shadab, *supra* note 64.

⁵⁸ Houman B. Shadab, *Regulating Bitcoin and Block Chain Derivatives*, NYLS Legal Studies Research Paper (October 9, 2014), available at <http://dx.doi.org/10.2139/ssrn.2508707>.

technology, smart contracting often makes legal contracting unnecessary as smart contracts often emulate the logic of legal contract clauses. Ethereum, the leading platform for smart contracting, describes smart contracting in this context as follows:

Ethereum is a decentralized platform that runs smart contracts: applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third party interference. These apps run on a custom built blockchain, an enormously powerful shared global infrastructure that can move value around and represent the ownership of property. This enables developers to create markets, store registries of debts or promises, move funds in accordance with instructions given long in the past (like a will or a futures contract) and many other things that have not been invented yet, all without a middle man or counterparty risk.⁵⁹

III. Regulatory Recognition of Blockchain Technology

The lack of regulatory recognition of Blockchain technology creates significant uncertainty for the blockchain community and undermines the evolution of the crypto economy. The lacking recognition hinders the implementation of the technology across industries and undermines the infrastructure conversion via blockchain technology. The regulatory uncertainty derives from insufficient or non-existent regulatory guidance, lacking court decisions, and uncertainty over applicable jurisdiction.

American and European courts have not yet recognized blockchain technology or addressed its applications.. A review of published court opinions suggests that no court at the time of publication of this article had to review, assess, or scrutinize the uses and applications of blockchain technology.⁶⁰ It is unclear how courts may perceive and treat blockchain technology.⁶¹

⁵⁹ ETHEREUM, <https://www.ethereum.org/> (last visited Jul. 11, 2017)

⁶⁰ A search of “blockchain” or “block chain” in federal and state cases on Westlaw reveals that only two cases have mentioned blockchain technology. The courts in both cases refused to discuss blockchain in depth, and did not take a position on the legitimacy of the technology. See *In re Dole Food Co., Inc. Stockholder Litigation*, C.A. No. 8703–VCL, 2017 WL 624843 at n. 1 (Del. Ch. Feb. 15, 2017); *United States v. Petix*, 15-CR-227A, 2016 WL 7017919 (W.D. N.Y. Dec. 1, 2016). A search of “blockchain”, “block chain”, “dispositif d’enregistrement électronique partagé” on DeJure (Italy), Lexis Nexis and Legifrance (France), the portals Rechtspraak and Raadvanstate (Netherlands), Courts and Tribunals Judiciary (UK), Bundesministerium der Justiz und für Verbraucherschutz (Germany) and ECJ.eu (European Court of Justice) as well as the Network of the Presidents of the Supreme Judicial Courts of the European Union did not provide any significant result.

⁶¹ “While countless undisputed transactions utilizing smart contracts are likely to move forward on the basis of such automatic, electronic enforcement, there will likely always be the need for human intervention to settle legal disputes.” Reggie O’Shields,

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Traditional jurisdictional means have limited applicability in the context of Blockchain technology.⁶² The concept of location or presence in jurisdictional means does not apply to the blockchain. A location for the blockchain does not exist - not physically or even electronically. Nodes that contain the blockchain and all of its information are located all over the world. Transactions in the blockchain are fully networked and “present” only in cyberspace. The nodes hold imperfect partial copies of the blockchain; no particular node holds the entire blockchain. More specifically, jurisdiction over the public blockchain does not exist within the present doctrinal infrastructure for jurisdiction. In practice, the blockchain itself cannot be regulated or governed because it is decentralized and autonomous. No traditional jurisdictional principles can apply because the blockchain is a mere collection of agreed upon calculations by decentralized computer systems. The blockchain is merely an idea reached by the consensus of computation; it is pure information, contained only in the mathematical rules of its inception and the sum of the computation. The blockchain is entirely maintained and owned by a distributed group of anonymous users located throughout the planet who would not likely recognize or comply with any legal authority.

The unpredictability of the risks and the opportunities as well as the concrete outcomes of blockchain in reshaping financial markets are clear obstacles for regulators’ attempts at drafting new specific regulation. Although financial innovation and technological innovation have constantly developed, and their outcomes have always been uncertain, this transitional era, characterized by the spread of a new foundational technology, is particularly uncertain. This uncertainty frustrates blockchain innovation instead of providing a secured framework where revolutionary blockchain applications can flourish.

1. *European Union*

EU legislation in the context of DLT and blockchain technology is slowly evolving. Although the European Union launched the program “Digital Agenda for Europe” in 2010 and emphasized the relevance of investment in digital economy as a key issue for economic growth and prosperity,⁶³ the program did not mention either the blockchain or the DLT technology and did not refer to any concrete regulatory action to

Smart Contracts: Legal Agreements for the Blockchain, NORTH CAROLINA BANKING INSTITUTE (March 2017).

⁶² For a full analysis of jurisdictional shortcomings in the context of blockchain technology see Wulf A. Kaal & Craig Calcaterra, Open Source Blockchain Platform Ecosystem of Dispute Resolution for Crypto Transactions (on file with author).

⁶³ See European Commission, Press Release - Digital Agenda: investment in digital economy holds key to Europe's future prosperity, says Commission report (May 17, 2010), available at http://europa.eu/rapid/press-release_IP-10-571_en.htm?locale=en

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be considered in this regard.⁶⁴ Similarly, the European Commission in its communication to the European Parliament (“A Digital Single Market Strategy for Europe”) in 2015 did not provide any reference to blockchain.⁶⁵ Finally, in June 2016, the European Securities and Markets Authority (“ESMA”), Europe’s top financial watchdog,⁶⁶ launched a debate on the regulation of blockchain.⁶⁷ Because of the ongoing evolution of technological innovation and blockchain’s still rather limited practical applications, ESMA considered a regulatory response to the evolving technology premature.⁶⁸

No concrete outcomes exists in terms of regulatory initiatives, among the different Member States. In the last three years, the European Banking Authority (EBA) has issued two general informative reports, a first one in 2015⁶⁹ and a second one in 2016,⁷⁰ while constantly monitoring the development of blockchain within the markets,⁷¹ with an eye on banking issues, including payment services, currencies, asset registry, consistently with its institutional mission within the European Union. At the moment, only the French government has taken steps to implement blockchain to enhance efficiency in specific contexts,⁷²

⁶⁴ See European Commission, Digital Agenda for Europe (2015), available at

⁶⁵ See European Commission, A Digital Single Market Strategy for Europe (May 6, 2015), available at <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1447773803386&uri=CELEX%3A52015DC0192>.

⁶⁶ Yolanda Bobeldijk, *Esma: It's 'too early' to regulate blockchain*, Financial News London (Feb. 7, 2017, 12:48 PM), available at <https://www.fnondon.com/articles/european-watchdog-its-too-early-to-regulate-blockchain-20170207>.

⁶⁷ See ESMA, *supra* note 22.

⁶⁸ *Id.*

⁶⁹ EBA, Cryptotechnologies, a major IT innovation and catalyst for change: 4 categories, 4 applications and 4 scenarios An exploration for transaction banking and payments professionals (May 11, 2015), available at https://www.ab-e-ea.eu/downloads/knowledge-and-research/EBA_20150511_EBA_Cryptotechnologies_a_major_IT_innovation_v1_0.pdf

⁷⁰ EBA, Applying cryptotechnologies to Trade Finance (May 2016), available at https://www.ab-e-ea.eu/downloads/knowledge-and-research/EBA_May2016_eAPWG_Applying_cryptotechnologies_to_Trade_Finance.pdf.

⁷¹ See EBA, EBA Consumer Trend Report 2017 (Jun. 28, 2017), available at <http://www.eba.europa.eu/documents/10180/1720738/Consumer+Trends+Report+2017.pdf>: “One other trend identified is innovation in the payment infrastructure, primarily through the use of blockchain technology, which allows the settlement of payment transactions without the use of payment systems or correspondent banking [...] In this area, the EBA continues to monitor innovations such as blockchain technology and their impact on the products and services within the EBA’s scope of action, but it is currently prioritising the implementation of the six technical standards and five sets of guidelines that it has a mandate to develop under PSD2” (p. 26).

⁷² Passing the *Ordonnance n° 2016-520 du 28 avril 2016 relative aux bons de caisse*, amending the French Financial and Monetary Code, Article L. 223-12 «*Sans préjudice des dispositions de l'article L. 223-4, l'émission et la cession de minibons*

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applying the blockchain to “certificates of deposits,” and the Law “Sapin II,”⁷³ authorizing the government to amend the securities law in a view of applying the blockchain to specific categories of securities.⁷⁴

The immutability and eternal recording of blockchain technology may be the root of legal difficulties in European countries that recognize the “right to be forgotten” or certain other privacy rights. The right to be forgotten pertains to individuals’ rights to have certain data deleted to avoid third party tracing.⁷⁵ The European Union has considered widespread recognition of the right to be forgotten, and proposed revisions to the Data Protection Directive 95/46⁷⁶, that has represented, together with the Directive on Privacy and Electronic Communications 2002/58⁷⁷, the main instrument of data protection law in the European Union, to include such rights.⁷⁸ The approval of the

peuvent également être inscrites dans un dispositif d'enregistrement électronique partagé permettant l'authentification de ces opérations, dans des conditions, notamment de sécurité, définies par décret en Conseil d'Etat.»

⁷³ LOI n° 2016-1691 du 9 décembre 2016 relative à la transparence, à la lutte contre la corruption et à la modernisation de la vie économique, available at <https://www.legifrance.gouv.fr/eli/loi/2016/12/9/ECFM1605542L/jo#JORFARTI000033558708> (last visited Jul. 12, 2017).

⁷⁴ *Id.* Art. 120. “Dans les conditions prévues à l'article 38 de la Constitution, le Gouvernement est autorisé à prendre par voie d'ordonnance, dans un délai de douze mois à compter de la date de promulgation de la présente loi, les mesures relevant du domaine de la loi nécessaires pour : 1° Adapter le droit applicable aux titres financiers et aux valeurs mobilières afin de permettre la représentation et la transmission, au moyen d'un dispositif d'enregistrement électronique partagé, des titres financiers qui ne sont pas admis aux opérations d'un dépositaire central ni livrés dans un système de règlement et de livraison d'instruments financiers; 2° Aménager et modifier toutes dispositions de nature législative favorisant la mise en œuvre et tirant les conséquences des modifications apportées en application du 1°. Un projet de loi de ratification est déposé devant le Parlement dans un délai de six mois à compter de la publication de l'ordonnance”.

⁷⁵ Rolf H. Weber, *The Right to Be Forgotten: More Than a Pandora's Box?*, 2 JIPITEC 120, 121 (2011), available at <https://www.jipitec.eu/issues/jipitec-2-2-2011/3084/jipitec%202%20-%20a%20-%20weber.pdf>.

⁷⁶ Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data (Data Protection Directive), available at <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31995L0046>.

⁷⁷ Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications), available at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0058:en:HTML>.

⁷⁸ W. Scott Blackmer, *GDPR: Getting Ready for the New EU General Data Protection Regulation*, INFOLEGALGROUP (May 15, 2016), available at <http://www.infolegallgroup.com/2016/05/articles/gdpr/gdpr-getting-ready-for-the-new-eu-general-data-protection-regulation/>; Peter Hustinx, *EU Data Protection Law: The Review of Directive 95/46/EC and the Proposed General Data Protection Regulation*,

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Regulation 679/2016 (the General Data Protection Regulation)⁷⁹ has stressed the relevance of the “right to be forgotten”, providing that under specific circumstances “*The data subject shall have the right to obtain from the controller the erasure of personal data concerning him or her without undue delay and the controller shall have the obligation to erase personal data without undue delay*”.⁸⁰ While the proposal has yet to be adopted, other countries have followed the lead, specifically in Latin American and Asia.⁸¹ Currently, countries that recognize or are considering recognizing the right to be forgotten apply the concept almost exclusively in the context of internet search engines.⁸² However, the right to be forgotten is still in its infancy and its logic could apply to other technologies, such as blockchain.⁸³

2. United States

The Securities and Exchange Commission (SEC) has started to evaluate the application of blockchain technology in the financial services industry. In November of 2015, Commissioner Stein commented on blockchain’s potential for tracing securities lending, repo, and margin financing and monitoring systemic risk.⁸⁴ Commissioner Stein cautioned, however, that as blockchain becomes more fluent in the market “regulators need to be in a position to lead,

STATEWATCH (2014), available at <http://www.statewatch.org/news/2014/sep/eu-2014-09-edps-data-protection-article.pdf>.

⁷⁹ REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), available at http://ec.europa.eu/justice/data-protection/reform/files/regulation_oj_en.pdf.

⁸⁰ *Id.*, art. 17(1). Art. 17(2) further provides that: “*Where the controller has made the personal data public and is obliged pursuant to paragraph 1 to erase the personal data, the controller, taking account of available technology and the cost of implementation, shall take reasonable steps, including technical measures, to inform controllers which are processing the personal data that the data subject has requested the erasure by such controllers of any links to, or copy or replication of, those personal data*”.

⁸¹ Farhad Manjoo, ‘Right to Be Forgotten’ Online Could Spread, N.Y. TIMES (Aug. 5, 2015), https://www.nytimes.com/2015/08/06/technology/personaltech/right-to-be-forgotten-online-is-poised-to-spread.html?_r=0.

⁸² *Id.*

⁸³ “[S]ince the essence of blockchain technology is to allow for quicker, more efficient and more reliable data exchanges, the blockchain could revolutionize any industry that relies on data.” Stuart D. Levi, *Blockchains Offer Revolutionary Potential in Fintech and Beyond*, PRACTITIONER INSIGHTS COMMENTARIES (March 13, 2017).

⁸⁴ Financial Stability Oversight Council, *FSOC 2016 Annual Report*, (2016), 127, available at <https://www.treasury.gov/initiatives/fsoc/studies-reports/Documents/FSOC%202016%20Annual%20Report.pdf>.

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harnessing its benefits and responding quickly to potential weaknesses.”⁸⁵

Despite this early cautioning and call for action, the SEC has not yet addressed core issues pertaining to the recognition of blockchain technology applications in finance. Guidance is especially needed regarding the recognition and application of crypto-currencies, tokens as securities, and decentralized autonomous organizations (DAOs) as investment advisers, among many other issues pertaining to blockchain applications or derivatives that are applied in finance.

SEC recognition of the most basic crypto-currency features is uncertain. In early 2016, in a significant setback for crypto-currencies and the crypto-currency industry, the SEC rejected the Winklevoss twins’ application to establish an exchange traded fund (ETF) that was intended to invest in Bitcoin exclusively.⁸⁶ To allow individuals to invest in Bitcoin without creating a Bitcoin wallet, the proposed ETF had been intended to serve as a dollar-denominated proxy pegged to the price of Bitcoin.⁸⁷ In rejecting the application, the SEC reasoned that, because of the unregulated nature of Bitcoin, the proposed fund was susceptible to fraud.⁸⁸ The SEC’s decision regarding the Bitcoin ETF

⁸⁵ U.S. Securities and Exchanges Commission, Remarks of SEC Commissioner Kara Stein, *Surfing the Wave: Technology, Innovation, and Competition*, Harvard Law School’s Fidelity Guest Lecture Series (November 9, 2015), available at <https://www.sec.gov/news/speech/stein-2015-remarks-harvard-law-school.html>.

⁸⁶ Russell Brandom, *The SEC just handed Bitcoin a huge setback* THE VERGE (Mar. 10, 2017, 4:10 PM), available at <http://www.theverge.com/2017/3/10/14883350/sec-bitcoin-etf-order-winklevoss-denied>.

⁸⁷ *See id.*

⁸⁸ *Id.* The SEC disapproved the proposed rule change that would have allowed the listing of the shares of the Winklevoss Bitcoin Trust. See SEC, Release No. 34-80206 (March 10, 2017), available at <https://www.sec.gov/rules/sro/batsbzx/2017/34-80206.pdf>. Pursuant to Section 19(b)(2)(C) of the Exchange Act, the SEC must approve the proposed rule change of a self-regulatory organization (“SRO”) if the it finds that the proposed rule change is consistent with the requirements of the Exchange Act (p. 18). The SEC clarified that the Winklevoss proposal was similar to other past proposals “to list and trade shares of exchange-traded products (ETPs) holding precious metals assts that individuals could otherwise obtain directly (for example, in the form of bullion coins), but at the cost of having to secure those holdings” (p. 20). Therefore in reviewing the Winklevoss’ proposal the SEC used the standards applied to previous commodity-trust ETPs. To come to the decision to disapprove the proposed rule change, a topical issue is “the susceptibility of the shares or the underlying asset to manipulation”, emphasizing the relevance of Section 6(b)(5) of the Exchange Act. This rules requires “that the rules of a national securities exchange be designed to prevent fraudulent and manipulative acts and practices and to protect investors and the public interest” (p. 2). The Commission believes that, in order to meet this standard, an exchange that lists and trades shares of commodity-trust exchange-traded products (“ETPs”) must, in addition to other applicable requirements, satisfy two requirements that are dispositive in this matter. First, the exchange must have surveillance-sharing agreements with significant markets for trading the underlying commodity or derivatives on that commodity. And second, those markets

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reflects its distrust towards the crypto asset class as a whole, especially funds attempting to trade digital currencies.

The U.S. Commodity Futures and Trade Commission (CFTC), compared the blockchain technology to the internet revolution and supported a “do no harm” approach in regulating blockchain technology. The CFTC opined that this approach, promoted at the time of the internet transformation by the American administration, was successful and should be re-applied to blockchain.⁸⁹

The Coinflip case seems to suggest that the CFTC intends to regulate Bitcoin as a commodity.⁹⁰ In 2015, the CFTC brought an action against Coinflip, Inc. for operating a facility for trading commodities futures without being registered under the Commodities Exchange Act (CEA).⁹¹ In this case, Coinflip, Inc. operated a website that connected buyers and sellers of standardized Bitcoin options and futures contracts.⁹² The CFTC opined that “Bitcoin and other virtual currencies are encompassed in the definition and properly defined as commodities,”⁹³ and are thus subject to the CEA. The CEA defines the term “commodity” rather broadly to include “all services, rights, and interests in which contracts for future delivery are presently or in the future dealt in.”⁹⁴ Nevertheless, Coinflip agreed to settle the administrative action with the CFTC without admitting or denying this finding.

The IRS treats virtual currency, such as Bitcoin, as property. The IRS has opined generally that: “the sale or exchange of convertible virtual currency, or the use of convertible currency to pay for goods or services in a real-world economy transaction, has tax consequences that may result in a tax liability.”⁹⁵ In 2014, the IRS issued a notice in

must be regulated” (p. 2). The SEC also noted that “the significant markets for Bitcoins are unregulated. Therefore, as the Exchange has not entered into, and would currently be unable to enter into, the type of surveillance-sharing agreement that has been in place with respect to all previously approved commodity-trust ETPs—agreements that help address concerns about the potential for fraudulent or manipulative acts and practices in this market—the Commission does not find the proposed rule change to be consistent with the Exchange Act” (p. 2).

⁸⁹ See CFTC, *Special Address of CFTC Commissioner J. Christopher Giancarlo Before the Depository Trust & Clearing Corporation 2016 Blockchain Symposium* (March 29, 2016), available at <http://www.cftc.gov/PressRoom/SpeechesTestimony/opagiancarlo-13>.

⁹⁰ In the Matter of: Coinflip, Inc., d/b/a Derivabit, and Francisco Riordan, Respondents, 2015 WL 5535736, *2 (Sept. 17, 2015).

⁹¹ *Id.* at *1.

⁹² *Id.*

⁹³ *Id.* at *2.

⁹⁴ 7 U.S.C. § 1a(9) (2012).

⁹⁵ IRS Notice 2014-21: Virtual Currency Notice at 1 (March 25, 2014), available at <https://www.irs.gov/pub/irs-drop/n-14-21.pdf>.

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response to numerous questions on the tax status of digital currencies.⁹⁶ While the IRS acknowledged digital currencies have many of the characteristics of other currencies, the IRS stipulated that “it does not have legal tender status in any jurisdiction.”⁹⁷ Accordingly, the IRS declared that crypto currencies should be taxed as property for U.S. federal tax purposes, because “General tax principles applicable to property transactions apply to transactions using virtual currency.”⁹⁸ However, the IRS was very specific about limiting its current position to transactions involving “convertible virtual currency,” leaving the tax treatment of crypto-limited partnership interests unaddressed.

While the value of Bitcoin in 2013 under \$20 and its value appreciated to over \$1200 in 2017, in the past four years, the IRS has only received around 900 Form 8949 that would indicate some gain or loss from cryptocurrencies.⁹⁹ The IRS treats cryptocurrencies the same as any other security. However, the tech industry has not been claiming income from cryptocurrency in the same way other securities are being accounted for – requiring an 8949 to be filed when considering capital gains or losses.¹⁰⁰ As a result, the IRS has started investigating the under reporting of cryptocurrencies.

The States of Arizona, Nevada, Vermont and Delaware have launched their specific regulatory initiatives. The State of Arizona, passing the so-called “Blockchain Bill”¹⁰¹ into law, provided specific regulation for electronic signature, blockchain and smart contracts. The law now expressly defines blockchain¹⁰² and smart contracts.¹⁰³ It also recognizes “a signature ... secured through blockchain technology” as equivalent to an electronic signature in an electronic form and “a record or contract secured through blockchain” as equivalent to an electronic

⁹⁶ *IRS Virtual Currency Guidance: Virtual Currency Is Treated as Property for U.S. Federal Tax Purposes; General Rules for Property Transactions Apply*, INTERNAL REVENUE SERVICE (Mar. 25, 2014), <https://www.irs.gov/uac/newsroom/irs-virtual-currency-guidance> (page last reviewed or updated Sept. 14, 2016).

⁹⁷ *Id.*

⁹⁸ *Id.*

⁹⁹ *Id.*

¹⁰⁰ Ed Zwirn, No, you can’t avoid taxes by investing in Bitcoin, New York Post (Apr. 8, 2017), available at <http://nypost.com/2017/04/08/no-you-cant-avoid-taxes-by-investing-in-bitcoin/>.

¹⁰¹ “Signatures; electronic transactions; Blockchain technology”, Amending Section 44-7003, Arizona Revised Statutes; Amending Title 44, Chapter 26, Arizona Revised Statutes, By Adding Article 5; Relating To Electronic Transactions.

¹⁰² *Id.* “‘blockchain technology’ means distributed ledger technology that uses a distributed, decentralized, shared and replicated ledger, which may be public or private, permissioned or permissionless, or driven by tokenized crypto economics or tokenless. The data on the ledger is protected with cryptography, is immutable and auditable and provides an uncensored truth”.

¹⁰³ *Id.* “‘Smart Contract’ Means An Event-Driven Program, With State, That Runs On A Distributed, Decentralized, Shared And Replicated Ledger And That Can Take Custody Over And Instruct Transfer Of Assets On That Ledger”.

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record in an electronic form, as well as the existence of smart contracts.¹⁰⁴

Consistently with Arizona, the State of Nevada passed the Bill 398, providing a definition of blockchain¹⁰⁵ and included blockchain within the definition of electronic record for similar purposes.¹⁰⁶ Furthermore, the Bill prescribes that local governments shall not “(a) *Impose any tax or fee on the use of a blockchain by any person or entity;* (b) *Require any person or entity to obtain from the board of county commissioners any certificate, license or permit to use a blockchain; or* (c) *Impose any other requirement relating to the use of a blockchain by any person or entity.*”¹⁰⁷

The State of Vermont adopted a more prudent approach. The report “Blockchain Technology: Opportunities and Risk”¹⁰⁸ considered that “at present, the costs and challenges associated with the use of blockchain technology for Vermont’s public recordkeeping outweigh the identifiable benefits”.¹⁰⁹ The report also emphasized the relevance of recognizing blockchain technology, that would determine “a “first mover” advantage with the potential to bring economic activity surrounding the development of blockchain technology to Vermont”, remarking however the uncertainty around such potential, “difficult to quantify and challenging to capture due to the nature of the technology”.¹¹⁰ For the moment, Vermont has recognized the possibility to use blockchain in the context of a trial, under specific conditions.¹¹¹ Delaware launched the Delaware Blockchain Initiative in 2016, to maintain its leading role in the context of corporate governance.¹¹²

¹⁰⁴ Id. “a contract relating to a transaction may not be denied legal effect, validity or enforceability solely because that contract contains a smart contract term”

¹⁰⁵ See State of Nevada, Senate Bill 398 (Jun. 5, 2017), Section 1, available at <https://legiscan.com/NV/text/SB398/id/1626453>: ““Blockchain” means an electronic record of transactions or other data which is: 1. Uniformly ordered; 2. Redundantly maintained or processed by one or more computers or machines to guarantee the consistency or nonrepudiation of the recorded transactions or other data; and 3. Validated by the use of cryptography”.

¹⁰⁶ Id. Section 3: ““Electronic record” means a record created, generated, sent, communicated, received or stored by electronic means. The term includes, without limitation, a blockchain.”

¹⁰⁷ Id. Sections 4 and 6.

¹⁰⁸ State of Vermont, “Blockchain Technology: Opportunities and Risk”, 15 January 2016, available at <http://legislature.vermont.gov/assets/Legislative-Reports/blockchain-technology-report-final.pdf>.

¹⁰⁹ Id.

¹¹⁰ Id.

¹¹¹ See 12 V.S.A. § 1913. The Statute defines “blockchain technology” as “a mathematically secured, chronological, and decentralized consensus ledger or database, whether maintained via Internet interaction, peer-to-peer network, or otherwise”.

¹¹² See A. Tinianow, *Delaware Blockchain Initiative: Transforming the Foundational Infrastructure of Corporate Finance*, Harvard Law School Forum on Corporate Governance and Financial Regulation (March 16), 2017, available at

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The State of Illinois launched the Illinois Blockchain Initiative in November 2016, with the purpose “to determine if this groundbreaking technology can be leveraged to create more efficient, integrated and trusted state services, while providing a welcoming environment for the Blockchain community.”¹¹³ In addition, the State of Illinois has implemented a web-based eProcurement system (BidBuy) as part of the Illinois Blockchain Initiative: state agencies will use BidBuy for the advertisement of solicitation opportunities, evaluation of bids, and publication of contract awards, making it the State's primary solution for sourcing and placing orders from vendors for the Chief Procurement Office - General Services.¹¹⁴ Furthermore, the Illinois Department of Financial and Professional Regulation has been the first regulator in the world to join a blockchain consortium, the R3 consortium:¹¹⁵ led by the New York based start-up R3 CEV, the R3 consortium is supported by heterogeneous institutions, including banks, financial firms, professional associations, professional services firms as well as technology companies, for the purpose of developing a specific blockchain technology for financial services (Corda).¹¹⁶

Self-regulatory organizations have also opined on the regulatory environment for blockchain technology. The US Financial Industry Regulatory Authority (FINRA) has issued a report,¹¹⁷ establishing a common basis for a dialogue with market participants, raising a multitude of questions, without providing specific answers. Similarly, at the international level, IOSCO's initial study of blockchain culminated with the publication of the Research Report on Financial Technologies (Fintech)¹¹⁸ provided a preliminary assessment focusing on risks and benefits as well as opportunities. At this stage, an evaluation of the position of global institutions is premature.

<https://corp.gov.law.harvard.edu/2017/03/16/delaware-blockchain-initiative-transforming-the-foundational-infrastructure-of-corporate-finance/>.

¹¹³ See Illinois Department of Innovation, Blockchain in Illinois, available at <https://www2.illinois.gov/sites/doit/Pages/BlockChainInitiative.aspx>.

¹¹⁴ See Chief Procurement Office, The new State of Illinois eProcurement System - BidBuy Deployment, available at <http://www.purchase.state.il.us/ipb/IPBhomep.nsf?Open>.

¹¹⁵ R3, <https://www.r3.com/>. See also Business Insider, One US regulator has joined the R3 blockchain consortium (Mar. 20, 2017, 12:11 PM), available at <http://www.businessinsider.com/one-us-regulator-has-joined-the-r3-blockchain-consortium-2017-3?international=true&r=US&IR=T>. See also Anna Irrera, Illinois watchdog first U.S. regulator to join blockchain consortium R3, Reuters (Mar. 16, 2017), available at <http://www.reuters.com/article/us-blockchain-illinois-idUSKBN16N2FN>.

¹¹⁶ Id.

¹¹⁷ See FINRA, *supra* note 19..

¹¹⁸ IOSCO, *supra* note 17, 51.

IV. Private Investment Funds' Use of Blockchain Technology

Private investment funds have played a leading role in banking disintermediation in the past.¹¹⁹ Banking disintermediation emerged in the 70s¹²⁰ when corporations started obtaining funding from sources other than banks, including from non-bank lenders or by issuing bonds.¹²¹ Private investment funds' involvement in banking functions accelerated in the aftermath of the financial crisis of 2008. After the crisis, newly issued regulation restrained banks from lending, in particular to SMEs. This opened up a new market for private investment funds that stepped into the void left by the new regulatory regime.¹²²

Similar to the market structure changes triggered by private investment funds in the late 2000s, private investment funds implementing blockchain technology are facilitating and spearheading radical changes in financial markets. First and foremost, the structural characteristic of blockchain as a decentralized model for financial transactions disintermediates and disrupts the existing financial infrastructure. Private investment funds that are first movers in the implementation of the blockchain infrastructure systems in finance directly contribute to that disintermediation and facilitate the accelerating evolution of the blockchain infrastructure in finance.

This paper analyzes the different emphasis in blockchain applications employed by European and American private investment funds. While smaller private fund advisers currently appear to be the primary beneficiaries of blockchain technology in both Europe and the United States, larger private fund investors also have started consider blockchain optimization for their operations and investments. Because larger private fund advisers are restricted by legacy systems and infrastructure their involvement in blockchain technology is still limited. However, the involvement of larger private investment fund advisers with blockchain technology may change in the foreseeable future if and when larger managers realize that their smaller competitors

¹¹⁹ See Steven L. Schwarcz, *Framing Address: A framework for analyzing Financial Market Transformation*, 36 *Seattle U. L. Rev.* (2012-2013). See also Marcel Kahn & Edward Rock, *Hedge Fund Activism in the Enforcement of Bondholder Rights*, 103 *Nw. U. L. Rev.* (2009).

¹²⁰ See Charles K. Whitehead, *The Evolution of Debt Covenants, the Credit Market, and Corporate Governance*, J. Corp. L. 654 2008-2009.

¹²¹ See Marco Dell'Erba, *The introduction of credit funds through ELTIF The case of France and Italy*, *Rev. Trim. de Dr. Fin.*, n. 2-2016, 3.

¹²² See Steven L. Schwarcz, *Regulating Shadows: Financial Regulation and Responsibility Failure*, 70 *Wash. and Lee L. Rev.* (2013). 1781-1828; *Shadow Banking, Financial Markets, and the Real Estate Sector*, 32 *Rev. Banking & Fin. L.* (2012-2013); *Framing Address: A Framework for Analyzing Financial Market Transformation*, 36 *Seattle U. L. Rev.* (2012-2013); Iris H-Y Chiu, *Transcending Regulatory Fragmentation and the Construction of an Economy-Society Discourse: Implications for Regulatory Policy Derived from a Functional Approach to Understanding Shadow Banking*, 42 *J. Corp. L.* (2016-2017), 327-358.

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who utilize these technologies gain substantial operational efficiencies and cost savings and are able to substantially diversify their portfolio holdings via such technologies. The threshold for change for bigger managers may be dictated by the implementation cost of such new technologies. If and when the long-term benefits of using the technologies exceed the implementation cost, which are much larger for larger managers than for the smaller managers who are currently experimenting with such technologies, larger managers are incentivized to start the innovation process as well.

1. *United States*

Several private investment funds have spearheaded the implementation of blockchain technology and smart contracting in their business model. While some funds simply focus on trading bitcoin and other cryptocurrencies to avoid market fluctuations, others invest in and/or acquire companies that use blockchain technology to provide synergies to their other portfolio companies. Yet others go much further by fully automating a hedge fund secured by blockchain technology, using blockchain technology to improve administrative procedures of private equity deal making, or using cryptocurrencies as incentives for data scientists' competitive models that facilitate investment analysis efficiencies. Examples include private investment funds such as Polychain Capital,¹²³ the Northern Trust¹²⁴ in cooperation with IBM, Numerai,¹²⁵ LendingRobot,¹²⁶ and Intellisys Capital LLC,¹²⁷ Melonport,¹²⁸ among many others.

Several private investment funds have spearheaded and continue to expand the implementation of blockchain technology and smart contracting in their business models. In February 2017, Northern Trust and IBM entered into a partnership for the commercial use of blockchain in the private fund industry. The partnership provides an enhanced and efficient approach to private equity administration.¹²⁹ The implementation of the Northern Trust and IBM blockchain is intended to increase the efficiency, transparency, and speed of private equity transactions, improve security, and bring innovation to the private equity market by simplifying the complex and labor-intensive

¹²³ Polychain Capital, <https://angel.co/polychain-capital> (last visited Jul. 11, 2017).

¹²⁴ Northern Trust, <https://www.northerntrust.com/> (last visited Jul. 11, 2017).

¹²⁵ Numerai, <https://numer.ai/> (last visited Apr. 17, 2017).

¹²⁶ LendingRobot, <https://www.lendingrobot.com/#/> (last visited Jul. 11, 2017).

¹²⁷ Intellisys Capital LLC, <http://www.intellisys.ai/> (last visited Jul. 11, 2017).

¹²⁸ Melonport, <https://melonport.com/>, (last visited Jul. 11, 2017).

¹²⁹ See Northern Trust, Press Release- IBM, Northern Trust and IBM Pioneer Use of Blockchain Technology to Help Transform Private Equity Administration (Feb. 21, 2017), available at <https://www.northerntrust.com/about-us/news/press-release?c=70b5ba1adc9928f9977162844c34f57a>
<http://www-03.ibm.com/press/us/en/pressrelease/51655.wss>.

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transactions in the private equity market. While the current legal and administrative processes that support private equity are time consuming, expensive, lack transparency, and involve lengthy, duplicative, and fragmented investment and administrative processes, the partnership's solution delivers an enhanced and efficient approach to private equity administration.¹³⁰ More specifically, unlike the current deal practice in private equity, which requires parties to reconcile multiples copies of the documents that form the deals to understand the greater picture, the blockchain program announced by Northern Trust and IBM allows all involved parties in an equity deal to look at a single compiled version of the transaction and all other data relating to the deal.¹³¹

Another example of the use of blockchain technology for private investment funds is Numerai. Numerai is a private investment fund with a global equity strategy that will go live on the blockchain later this year.¹³² Numerai operates on the Ethereum blockchain, utilizing a cryptocurrency called "Numeraire." Numerai uses artificial intelligence to convert financial data into machine learning problems for data scientists. On February 21, 2017, Numerai, announced: "[Today] 12,000 data scientists were issued 1 million crypto-tokens to incentivize the construction of an artificial intelligence hedge fund."¹³³ Using data scientists for investment analysis creates efficiency through a synthesis of data. Data scientists working in this model work to solve the same problems in their own unique way with different strategies. Numerai synthesizes these models to create a meta-model out of all the predictions from the data scientists.¹³⁴ In the Numerai model, the use of artificial intelligence ultimately helps achieve the goal of efficiency and optimum capital allocation by reducing overhead costs because there is no cost of human capital.¹³⁵ In addition, Numerai eliminates barriers to entry because users do not need capital or any special finance or data knowledge.

LendingRobot's LendingRobot Series is a fully automated hedge fund secured by blockchain technology.¹³⁶ Unlike other

¹³⁰ See Id.

¹³¹ See Id.

¹³² See Laura Shin, *This Is the World's First Cryptocurrency Issued by a Hedge Fund*, FORBES (Feb. 21, 2017, 7:00 AM), available at <https://www.forbes.com/sites/laurashin/2017/02/21/this-is-the-worlds-firstcryptocurrency-issued-by-a-hedge-fund/#61dcf68560b6>.

¹³³ *A New Cryptocurrency for Coordinating Artificial Intelligence on Numerai*, MEDIUM (Feb. 21, 2017), available at <https://medium.com/numerai/a-new-cryptocurrency-forcoordinating-artificial-intelligence-on-numerai-9251a131419a>.

¹³⁴ See Shin, *supra* note 67.

¹³⁵ See Interview with Richard Craib, Founder, Numerai, Crowdsourcing a Machine Learning Hedge Fund, TECHEMERGENCE (Nov. 10, 2016), available at <https://www.techemergence.com/crowdsourcing-a-machine-learning-hedge-fund/>.

¹³⁶ Press Release, deBanked, Introducing LendingRobot Series: One-Stop Investing in Alternative Lending (Jan. 26, 2017), available at <http://debanked.com/2017/01/introducinglendingrobot-series-one-stop-investing-in->

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blockchain based hedge funds that invest specifically in cryptocurrency, such as Global Advisers and Polychain Capital, the LendingRobot Series invests in lending marketplaces— Lending Club, Prosper, Funding Circle, and Lending Home.¹³⁷ Its trading is determined by an algorithm based on the investor's risk preferences. Once the investor has created a trading profile, LendingRobot selects and executes trades that are recorded in the blockchain public ledger on a weekly basis. Unlike traditional hedge funds that are rather secretive, the LendingRobot ledger shows detailed holdings and provides a "hash code" signature as evidence that the data is tamper-proof in the blockchain.¹³⁸ Established private investment fund managers may consider implementing blockchain technologies in the foreseeable future. Most large fund advisers in the private equity and hedge fund industry have not yet considered implementing blockchain technology in combination with big data applications and artificial intelligence. This, however, may change in the foreseeable future if and when larger managers realize that their smaller competitors who utilize these technologies gain substantial operational efficiencies and cost savings and are able to substantially diversify their portfolio holdings via such technologies. The threshold for change for bigger managers may be dictated by the implementation cost of such new technologies. If and when the long-term benefits of using the technologies exceed the implementation cost, which are much larger for larger managers than for the smaller managers who are currently experimenting with such technologies, larger managers are incentivized to start the innovation process as well.

2. *Europe*

In Europe, venture capital funds are the most engaged asset class in blockchain technology. European venture capital funds are engaged in building new blockchain applications and platforms. A group of the UK's biggest asset management companies (Schroders Investment Management, Aberdeen Asset Management, Columbia Threadneedle Investments, Aviva Investors and Henderson Global Investors) partnered to invest in a secret project on blockchain, in particular to test if blockchain can be used to cut trading costs, by removing intermediaries and reducing manual processing of trades, and

alternative-lending/; Dan Cummings, *LendingRobot Introduces Robo-Fund LendingRobot Series*, ETHNEWS (Jan. 30, 2017), available at <https://www.ethnews.com/lendingrobot-introduces-robo-fund-lendingrobot-series>.

¹³⁷ Press Release, deBanked, *supra* note 61; Cummings, *supra* note 61.

¹³⁸ Press Release, deBanked, *supra* note 61; Cummings, *supra* note 61.

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intervening in the direct trading of illiquid securities.¹³⁹ Moreover, Neufund¹⁴⁰ (participated by the Atlantic Fund), is building a blockchain-based and investor-directed platform, whose main purpose is to bridge the world of blockchain and venture by enabling the creation of a new kind of VC fund. The fund attempts to unlock the resources of cryptocurrency and blockchain to fund startups and any form of technological innovation and disruption.¹⁴¹

Similarly, Bigchain DB,¹⁴² financed by Anthemis¹⁴³ (London) and Early Bird¹⁴⁴ (Berlin), attempts to support developers and enterprises to deploy blockchain proof-of-concepts, platforms, and applications with a scalable blockchain database.¹⁴⁵ Bitbond¹⁴⁶ (financed by Point Nine)¹⁴⁷ is a global marketplace lending platform for small business loans who attempts to make investing and financing globally accessible.¹⁴⁸ Point Nine has also invested in Chainalysis,¹⁴⁹ to manage the security of digital assets. Coinsilium,¹⁵⁰ venture capitalist based London, invests in the development of blockchain companies through a consortium of investors. Among others, Coinsilium has invested in SatoshiPay,¹⁵¹ a company that “is developing a two-way payment platform, which enables online content providers to monetise their digital content through the acceptance of nanopayments.”¹⁵²

¹³⁹ <https://www.ft.com/content/3be95e82-cc19-11e5-a8ef-ea66e967dd44>. See also Daniel Palmer, Five UK Mutual Funds Partner on Blockchain Trading Project, 8 (Feb. 8, 2016, 2:40 AM), available at <http://www.coindesk.com/five-uk-mutual-funds-partner-blockchain/>

¹⁴⁰ Neufund, <https://neufund.org/> (last visited Jul. 11, 2017).

¹⁴¹ See Id.

¹⁴² Bigchain DB, <https://www.bigchaindb.com/> (last visited Jul. 11, 2017)

¹⁴³ Anthemis, <http://www.anthemis.com/> (last visited Jul. 11, 2017).

¹⁴⁴ Early Bird, <https://www.earlybird.com/> (last visited Jul. 11, 2017).

¹⁴⁵ Crunchbase, profile of Bigchain DB, available at <https://www.crunchbase.com/organization/bigchaindb#/entity> (last visited Jul. 11, 2017); “BigchainDB supports a wide range of industries and use cases from identity and intellectual property to supply chains, energy, IoT and financial ecosystems without sacrificing scale, security or performance. With high throughput, sub-second latency and powerful crypto-condition escrow functionality to automate release-of-assets, BigchainDB looks, acts and feels like a database but has the core blockchain characteristics that enterprises want”

¹⁴⁶ Bitbond, <https://www.bitbond.com/> (last visited Jul. 11, 2017)

¹⁴⁷ <http://www.pointninecap.com/> (last visited Jul. 11, 2017)

¹⁴⁸ <https://www.crunchbase.com/organization/bitbond#/entity> (last visited Jul. 11, 2017)

¹⁴⁹ Chainalysis, <https://www.chainalysis.com/> (last visited Jul. 11, 2017).

¹⁵⁰ Coinsilium, <https://www.coinsilium.com/> (last visited Jul. 11, 2017). See also Peter Campbell, Coinsilium becomes first blockchain company to float, Financial Times (Dec. 14, 2015), available at <https://www.ft.com/content/c76f781e-a27b-11e5-8d70-42b68cfae6e4>.

¹⁵¹ SatoshiPay, <https://satoshipay.io/> (last visited Jul. 11, 2017).

¹⁵² Coinsilium, Investee Company Update, 17 May 2017, available at <https://www.coinsilium.com/regulatory-announcements/investee-company-update-3/>.

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The venture capital firm Blockchain Capital¹⁵³ is raising capital through an Initial Coin Offering (ICO), a new form of crowdfunding based on cryptocurrency tokens,¹⁵⁴ selling its own Ethereum-based smart contract digital token for its venture fund,¹⁵⁵ where they represent an indirect fractional non-voting economic interest in Blockchain Capital III, Digital Liquid Venture Fund, LP.¹⁵⁶ Started as a phenomenon that is revolutionizing the way start-up companies investing in blockchain raise capital (in the last 12 months ICOs have raised \$331 million, overtaking venture capitalists' investments),¹⁵⁷ it may become an alternative method for many traditional companies.¹⁵⁸

The implementation of blockchain technology often goes hand in hand with the use of big data applications and artificial intelligence, also by established larger managers. The abovementioned examples refer all to the implementation of blockchain and smart contracts. A similar trend is the one of investment fund managers implementing AI and machine learning technologies. This is the case, among others, of Aidyia,¹⁵⁹ a Hong-Kong based hedge fund, trading in US equities,¹⁶⁰ or

¹⁵³ Blockchain Capital, <http://blockchain.capital/> (last visited Jul. 11, 2017).

¹⁵⁴ Ben Dickson, Can you trust crypto-token crowdfunding?, (Feb. 12, 2017), available at <https://techcrunch.com/2017/02/12/can-you-trust-crypto-token-crowdfunding/>. On the different types of digital tokens, see Mona El Isa, *The Difference Between Protocol Tokens and Traditional Asset Tokens* (May 16, 2017), available at https://www.linkedin.com/pulse/difference-between-protocol-tokens-traditional-asset-mona-el-isa?trk=v-feed&lipi=urn%3Ali%3Apage%3Ad_flagship3_feed%3BCaaKpuzaDcB010Q%2B4fWtJw%3D%3D.

¹⁵⁵ Cade Metz, The Initial Coin Offering, the Bitcoin-y Stock That's Not Stock—But Definitely a Big Deal, *Wired* (March 16, 2017, 7:00 AM), available at <https://www.wired.com/2017/03/initial-coin-offering-stock-thats-not-stock/>.

¹⁵⁶ See Richard Kastelein, *Blockchain Capital Closes ICO – \$10 Million in Six Hours Raised in Record Time*, *Blockchain News*, (Apr. 11, 2017), available at <http://www.the-blockchain.com/2017/04/11/blockchain-capital-closes-ico-10-million-in-six-hours-raised-in-record-time/>.

¹⁵⁷ See Nick Tomaino, Tokens, Tokens and More Tokens, 1 May 2017, available at <https://thecontrol.co/tokens-tokens-and-more-tokens-d4b177fbb443>. See also Richard Kastelein, ICO Token Raises Blow Past VC for Blockchain Investment in last 12 Months, 6 May 2017, available at <http://www.the-blockchain.com/2017/05/06/ico-token-raises-blow-past-vc-blockchain-investment-last-12-months/>.

¹⁵⁸ See Alex Tapscott & Don Tapscott, *How blockchain is Changing Finance*, *Harv. Bus. Rev.* (Mar. 1, 2017), available at <https://hbr.org/2017/03/how-blockchain-is-changing-finance>.

¹⁵⁹ Aidyia, <http://aidyia.com/> (last visited Jul. 11, 2017).

¹⁶⁰ Cade Metz, *The Rise of the Artificially Intelligent Hedge Fund*, *Wired* (Jan. 25, 2016, 7:00 AM), available at <https://www.wired.com/2016/01/the-rise-of-the-artificially-intelligent-hedge-fund/>.

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Bridgewater,¹⁶¹ building an algorithmic model to automate the firm's management.¹⁶²

V. Data

The dataset for this article comprises a sample of private investment funds implementing blockchain technology in either their strategy or operation (N=120). The authors hand-coded individual use of blockchain technology for each fund in the dataset. We contacted the private investment fund advisers in our sample via e-mail, phone-calls, interviews, and their websites (see Figure 1). The 120 fund advisers in our sample did not answer all questions and often we were unable to obtain available information on all questions.

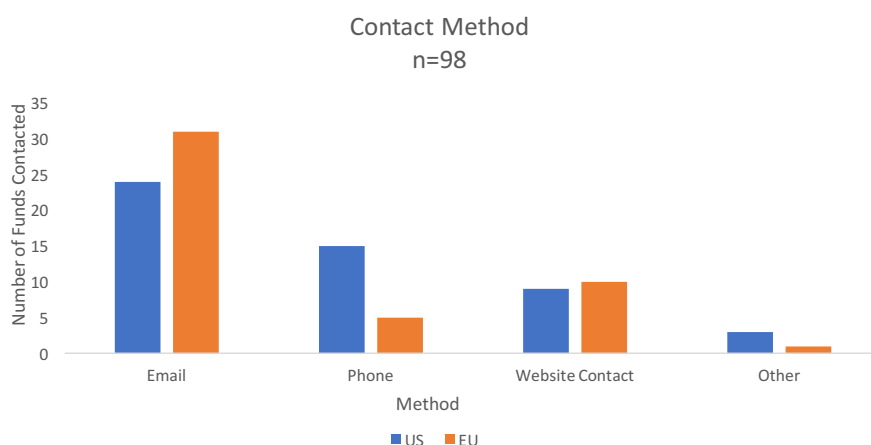


Figure 1: Contact method US vs. EU.

Figure 1 shows the contact method for the two datasets. Given that email success rates were lower in the US, the phone contact follow up is higher for US fund advisers who utilize blockchain technology.

¹⁶¹ Bridgewater Associates LLP, <https://www.bridgewater.com/> (last visited Jul. 11, 2017)

¹⁶² Rob Copeland & Bradley Hope, The World's Largest Hedge Fund Is Building an Algorithmic Model From its Employees' Brains, Wall Street Journal (Dec. 22, 2016, 1:14 PM), available at <https://www.wsj.com/articles/the-worlds-largest-hedge-fund-is-building-an-algorithmic-model-of-its-founders-brain-1482423694>.

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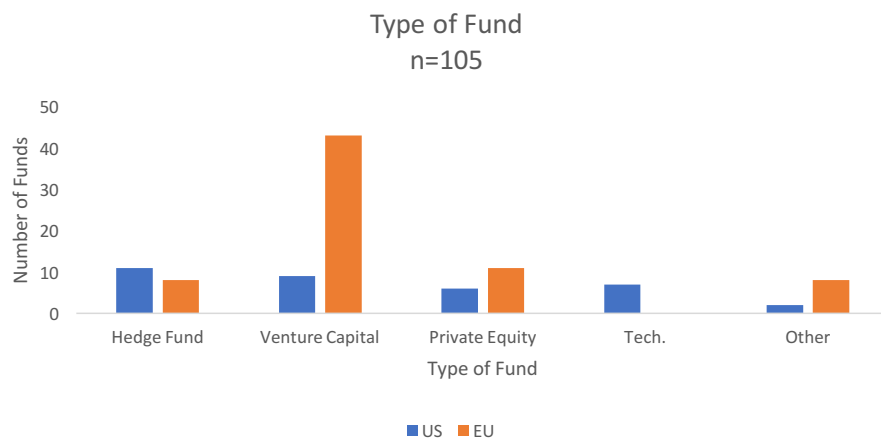


Figure 2: Types of Funds in US vs. EU.

Figure 2 illustrates the different categories of private investment funds that use blockchain technology in Europe and the US. In the US, the majority of private funds are hedge funds (10), tech funds (7), private equity (5), venture capitals (4) and others (2). In Europe, the distribution among the types of investors is different: the majority of the private funds identified are venture capitals (22), followed by hedge funds (5) and private equity funds (3). Moreover, the vast majority of European private funds invest in “Seed” and “Early stage Ventures,” focusing on European companies.

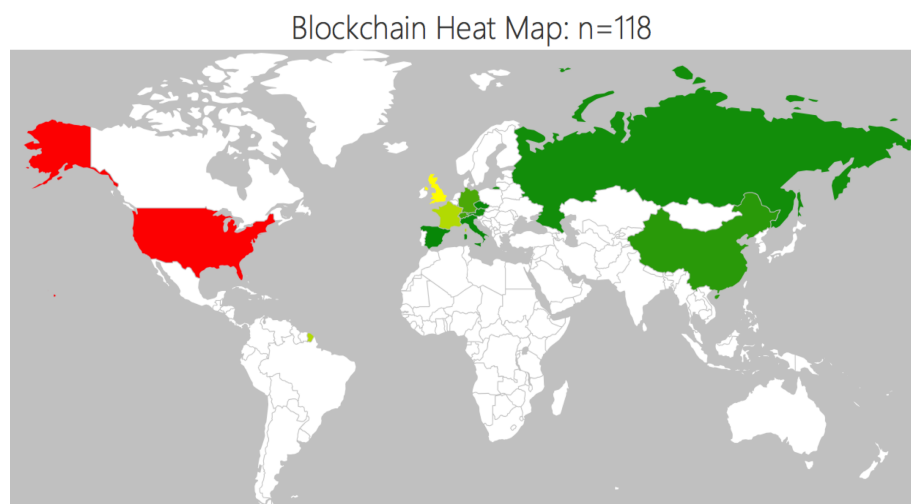


Figure 3: Blockchain Engagement by Private Investment Funds by Region compiling all 28(27) EU countries as a single representative not as an EU block.

Figure 3 shows that United States is the only country in red, suggesting the highest proportion of blockchain-based private investment funds. Other countries, such as the United Kingdom are visible in yellow and the rest of the countries in different shades of

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green. This would seem to indicate that the private investment funds in the United States are investing more than private investment funds in other countries in blockchain technology. However, when standardizing the comparison units, in the entire United States, there are 43 private investment funds that are utilizing blockchain in some capacity. This outnumbers any individual country in Europe by almost double. If we consider Europe as a whole, instead of each individual country, Europe has a total of 70 funds utilizing blockchain technology (excluding Russia which has 2). Although the United States as a country seems to be investing in blockchain heavily, Europe and their financial institutions are pursuing FinTech at the same or greater rate when compared to the United States. The United States has a population of roughly 321 million people and 43 funds. This averages about 7.5 million people per fund utilizing blockchain. By comparison, the UK has 65 million people with 23 funds utilizing blockchain technology. This averages roughly 2.8 million people per fund. Although the map suggests that the United States is heavily invested in blockchain, in comparison with other countries we see a more even distribution between countries than the map would suggest.

The geographic distribution emerging from the data highlights that three main European poles emerge: London, Paris¹⁶³ and Berlin. Regarding Luxembourg, traditionally a leading hub for private funds, it has not been possible to identify any private fund investing in blockchain. This is likely due to the unavailability of public information connected to Luxembourgian funds investing in blockchain rather than to a lack of Luxembourgian funds, in principle to be excluded. However, Luxembourg, together with Switzerland, has been active in establishing specific initiatives with the purpose of attracting new market players and start-up investing in blockchain: in Luxembourg Schorechain,¹⁶⁴ Fundchain,¹⁶⁵ as well as Fundsquare¹⁶⁶ of the Group Luxembourg Stock Exchange together, and in Swiss CryptoValley Association.¹⁶⁷

¹⁶³ John Dizard, Paris turns to English law to lure City business, Financial Times (May 19, 2016), available at <https://www.ft.com/content/113f6c78-3bdd-11e7-821a-6027b8a20f23>.

¹⁶⁴ Scorechain, <https://www.scorechain.com/> (last visited Jul. 11, 2017).

¹⁶⁵ Fundchain, <http://fundchain.lu/> (last visited Jul. 11, 2017).

¹⁶⁶ Fundsquare, <https://www.fundsquare.net/homepage> (last visited Jul. 11, 2017).

¹⁶⁷ CryptoValley Association, <https://cryptovalley.swiss/> (last visited Jul. 11, 2017).

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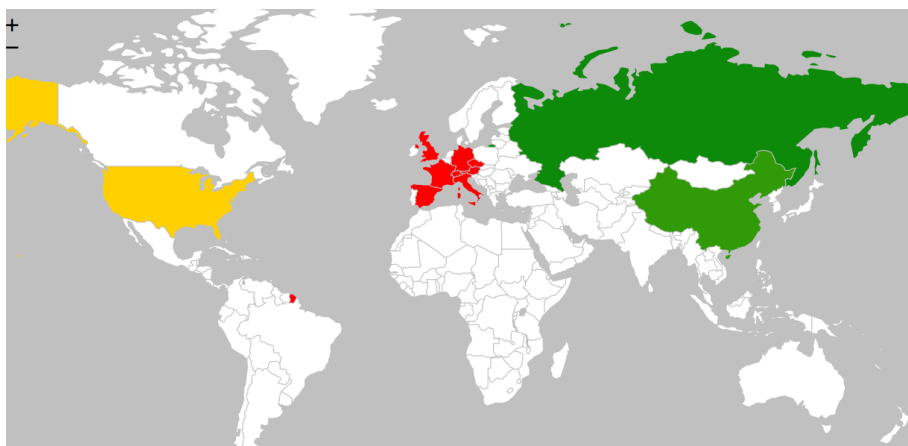


Figure 4: Private Investment Funds with Blockchain Applications – US vs. EU compiling all 28(27) EU countries in the dataset as an EU block

Figure 4 shows the US vs. EU fund managers who utilize blockchain technology by showing all 28(27) EU countries in the dataset as an EU block. Naturally, showing all funds in European countries as one country changes the proportions and the United States does no longer look as strongly represented (in yellow). The biggest takeaway, however, from comparing Figure 3 with Figure 4 is that Russia, including Baltic states¹⁶⁸ and former Russian countries, and China retain their role (in green) consistently. In summary, the market for private investment funds who invest in- and utilize blockchain technology appears to be near equally divided between the US and the EU with Russia and China playing a significant yet not as strong role.

¹⁶⁸ Among Baltic states, Estonia is implementing radical transformations adopting the blockchain technology not only for commercial activities (the project E-residency allows foreign citizens to establish a business with Estonian jurisdiction)) but also to enhance the development of to the so-called “Govtech”, transferring to the blockchain a broad range of activities connected to public services. These activities include medical records, governmental records, notary services (the “Public notary” project grants remote access to notary services), banking infrastructure (implemented by LHV Pank), and e-voting systems (led by the Estonian division of Nasdaq). See Guest Author, *How Estonia Brought Blockchain Closer to Citizens: GovTech Case Studies*, The Cointelegraph (Mar. 7, 2017), available at <https://cointelegraph.com/news/how-estonia-brought-blockchain-closer-to-citizens-govtech-case-studies>.

See Alicia Naumoff, *Power to the People: Blockchain Replaces Government in Europe*, The Cointelegraph (Jan. 27, 2017), available at <https://cointelegraph.com/news/power-to-the-people-blockchain-replaces-government-in-europe>.

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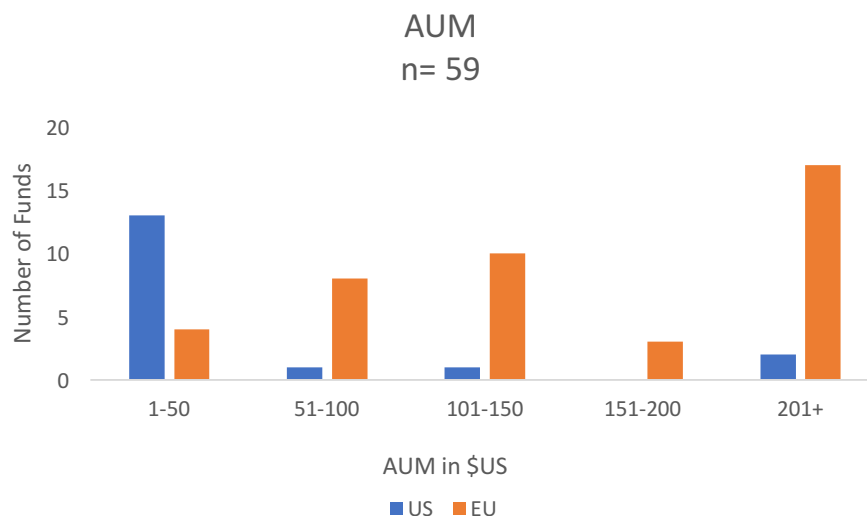


Figure 5: Assets Under Management US vs EU.

Figure 5 shows the size of private investment funds (data available for 59 funds) in the US vs. the EU. While in the US, the majority of the private funds have AUM varying in a range comprised between \$1 to #50 million AUM with only 2 funds whose AUM are between \$101-150 AUM and above to \$ 200 million AUM, in Europe the situation is rather different: private funds with an AUM higher than \$200 million are the majority and smaller funds are distributed in the different clusters.

This could suggest that in Europe larger private investment fund advisers are more willing to make the required investments into a blockchain infrastructure whereas in the US the legacy systems utilized by larger private investment fund advisers creates a barrier to entry for larger private investment fund advisers to invest in and utilize blockchain technology. Theoretically, however, legacy systems in the EU should create the same barriers for larger private investment fund advisers. There is no reason to believe that legacy systems in the United States would constitute more of an obstacle than legacy systems in the EU.

The differences in size between the American the European market can partially be explained by the age, characteristics, and investment purpose of American and European private investment fund blockchain initiatives. American private investment funds investing in blockchain are mostly newly and ad hoc created investment vehicles, focused exclusively on blockchain. Whereas the vast majority of European private funds are more established and older financial institutions, that simply diversify their investments with investments in blockchain and cryptocurrencies.

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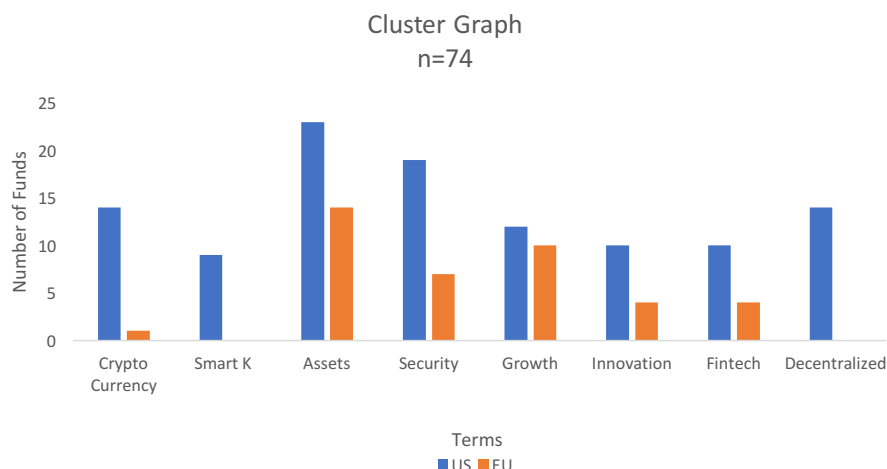


Figure 6: Cluster Categories of Blockchain Use in Private Investment Funds US vs. EU.

Private investment funds describe their funds' use of blockchain technology with several key words in their marketing materials. Clustering these words allowed the authors to identify the funds' strategy and approach in their use of blockchain technology. The authors identified nine key terms to see how these companies are discussing their services. The purpose of the word cluster graph is to show how often these United States and European funds are using certain words on their websites when discussing the approach and strategy of their respective fund. The categories in Figure 4 are the popular terms used by private investment fund advisers that are consistently associated with the Blockchain platform.

The terms therein are defined as follows: (1.) Crypto Currency: Digital currency in which encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds, operating independently of a central bank;¹⁶⁹ (2.) Smart Contracts: Smart contracts are computer protocols that facilitate, verify, or enforce the negotiation or performance of a contract, or that make a contractual clause unnecessary;¹⁷⁰ (3.) Digital Assets: A financial instrument – such

¹⁶⁹ Ex. "DC converts cash deposits into DC Assets, a form of digital currency that is secured by the Ethereum network and collateralized by these customer deposits." How Does Decentralized Capital Work?, Decentralized Capital - Government Currencies on the Ethereum Blockchain, available at <https://www.decentralizedcapital.com/#!/faq> (last visited Jul. 11, 2017). Ex. "Our unique model enables us to deploy our resources to build the crypto currencies and blockchain ecosystem over the long term." The nexus of blockchain technology and finance., Digital Currency Group, <http://dgc.co/> (last visited May 28, 2017).

¹⁷⁰ Ex. "Workflow Automation; Smart contracts ensure all relevant parties remain synchronized, even on the most complex financial instruments" Workflow Automation, Axoni, <https://axoni.com/home> (last visited Jul. 11, 2017). Ex. "Smart contracts represent a next step in the progression of blockchains from a financial

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as a dollar, bond, or derivative that is cryptographically issued, held, and transferred on a blockchain. This novel medium for assets, which is similar to bearer instruments like cash, but digital, is better suited to the security and innovation requirements of modern financial applications than centralized ledgers that immobilize assets and depend on messaging and reconciliation;¹⁷¹ (4.) Security: Process to create rules and to take actions such as implementing systems and measures to protect a fund and their clients against attacks over the Internet;¹⁷² (5.) Growth: Attainable growth;¹⁷³ (6.) Innovation: A new method, idea, or product that a fund is using in the financial industry;¹⁷⁴ (7.) FinTech:

transaction protocol to an all-purpose utility. They are pieces of software, not contracts in the legal sense, that extend blockchains' utility from simply keeping a record of financial transaction entries to automatically implementing terms of multiparty agreements." Blockchain- the benefits of smart contracts, Deloitte United States, available at <https://www2.deloitte.com/us/en.html> (last visited Jul. 11, 2017).

¹⁷¹ Ex. "The value of DC Assets is directly tied to that of the government currency backing it, e.g. 1 DUSD = 1 USD. As the value of the government currency fluctuates against other assets, so will the value of the DC Asset representing said currency." Decentralized Capital - Government Currencies on the Ethereum Blockchain, available at <https://www.decentralizedcapital.com/#/faq> (last visited Jul. 11, 2017). Ex. "Chain Core is enterprise software that enables institutions to issue and transfer financial assets on permissioned blockchain networks. The assets on Chain blockchain networks are not new cryptocurrencies but are rather issued assets like currencies, securities, derivatives, gift cards, and loyalty points. " What is Chain Core?, Chain, <https://chain.com/faq/> (last visited Jul. 11, 2017). Ex. "the assets on a blockchain are controlled directly by the owners of those assets through the use of secure, cryptographic keys." Explore the Blockchain Potential, Blockchain Solutions, <http://www.blockchain-solutions.com/> (last visited Jul. 11, 2017).

¹⁷² Ex. "This is an added security feature available to members who have Static IPs if they choose to use it. Members who's IPs regularly change, that will be most of the world, should not use this function as it will lock you out of your account once your IP changes." WE ARE COMMITTED TO YOUR SUCCESS, cryptofund, <https://www.cryptofund.org/> (last visited Jul. 11, 2017). Ex. "Chain's technology is specifically designed for moving financial assets in permissioned, high-scale environments that require enterprise-grade security and privacy" What is a blockchain?, Chain, <https://chain.com/faq/> (last visited Jul. 11, 2017).

¹⁷³ Ex. " Focus is on driving innovation in fintech and blockchain technologies, enabling businesses to take advantage of growth opportunities." City AM featuring NEX Exchange, We are Coinsilium, <https://www.coinsilium.com/> (Jul. 11, 2017). Ex. " We build applications on top of the Factom™ network that can be used as a public utility. These applications leverage the immutability of the blockchain and the growth of the network." FAQ, Factom, <https://www.factom.com/about/faqs> (last visited Jul. 11, 2017)

¹⁷⁴ Ex. "we continually strive to innovate, to make banking easier, more practical and better adapted to the needs of all our customers." Our Response to a Changing World, Bank BNP Paribas | The bank for a changing world, <https://group.bnpparibas/en/> (last visited Jul. 11, 2017); Ex. "invests in the best entrepreneurs who are fostering innovation in the Blockchain economy." Homepage, Blockchain Capital, <http://blockchain.capital/> (last visited Jul. 11, 2017); Ex. " Our mission is to act as the catalyst for widespread blockchain adoption and innovation." About | Pantera Capital - Blockchain Investment Firm, Pantera Capital, <https://panteracapital.com/about/> (last visited Jul. 11, 2017).

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Algorithmic solutions and other technology used to support or enable banking and financial services;¹⁷⁵ (8.) Decentralized: A market structure that consists of a network of various technical devices that enable investors to create a marketplace without a centralized location.¹⁷⁶

Once the authors defined the cluster category terms in the previous paragraph, the authors and a team of researcher assistants examined the funds in the sample for services, goals, strategies, policies and other accessible information to find the nine key cluster category terms. If a fund mentioned one of these words the authors would code it as “yes=1”, if they did not then it would be recorded as “no=0”. With a completed list of all funds, the author combined all 1’s within the data sheet and entered them into a bar graph to show how many funds were using these nine terms. The bar graph in Figure 4 is a representation of these funds as a whole to demonstrate how these funds are describing their services.

Figure 6 shows the investment strategies implemented by private funds.¹⁷⁷ In the context of the purpose of the use of blockchain technology, the data from Europe and US are overall more homogenous: funds use of blockchain technology to gain exposure to crypto assets are the majority in both Europe and US. Other uses of the blockchain technology by funds in Europe and the US include securing assets and attaining growth objectives for clients. A significant difference highlighted by Figure 6 is the lack of consideration of smart contracting applications in European funds. This is consistent, however, with the size differences between European and American private investment

¹⁷⁵ Ex. “Financial Technology has evolved to the stage where it could help overhaul and reshape traditional industry structures and operating models.” Blockchain: What you need to know, Northern Trust | Wealth Management, Asset Management & Asset Servicing, <https://www.northerntrust.com/> (last visited Jul. 11, 2017); Ex. “Financial Technology start-up companies continue to alter the industry norm.” The blockchain revolution in trade finance, Barclays, available at <https://www.barclayscorporate.com/insight-and-research/trading-and-exporting/blockchain-revolution-in-trade-finance.html> (last visited Jul. 11, 2017).

¹⁷⁶ Ex. “connects all members of the supply chain to a decentralized network and allows them a direct exchange of documents.” Blockchain for the people, Waves Platform | Blockchain for the people, <https://wavesplatform.com/> (last visited Jul. 11, 2017); Ex. “By having decentralized storage and execution one can mitigate some of today’s real world inefficiencies such as custody, counter-party and settlement. Melon creates a true alternative to traditional asset management.” About Melonport, Melonport, <https://melonport.com/> (last visited Jul. 11, 2017); Ex. “Blockchains are clunky databases, so why would you want to use one? Traditional systems have inherent flaws that make them easy targets for corruption of data. A Factom™ system gives a single version of the truth through a Decentralized Network of Authority. Once everyone can agree on a single version of the truth, then the truly game-changing applications can be built.” - Why Decentralized?, Factom, <https://www.factom.com/about> (last visited Jul. 11, 2017).

¹⁷⁷ A minority of funds implements more than one investment strategy. This explains why the dataset for this graph is equal to 74.

funds that use blockchain technology. The data seems to suggest that the larger European private fund advisers implement more conservative investment strategies and use the technology predominantly to invest in- and secure crypto assets. Whereas American fund advisers appear to more frequently use the smart contracting features of the technology to build more advanced and innovative crypto businesses and business structures via blockchain technology. This may imply that American private investment funds will have a better opportunity to launch future disruptive implementations of blockchain technology, while at the same time they may experience a higher rate of failure, due to a greater exposure to technological risks.

VI. Discussion

The data analysis in this article suggests that the market for private investment funds who invest in- and utilize blockchain technology appears to be near equally divided between the US and the EU with Russia and China playing a significant role. We interpret parts of the data as suggesting that larger private investment fund advisers in Europe may be more willing to make the required investments into blockchain infrastructure whereas in the US the legacy systems utilized by larger private investment fund advisers create barriers to entry for larger private investment fund advisers to invest in and utilize blockchain technology. On the other hand, the data also seems to suggest that the larger European fund advisers use the technology predominantly to invest in- and secure crypto assets whereas American fund advisers appear to use the smart contracting features of the technology more frequently to build more advanced crypto businesses and business structures via blockchain technology. While the overall proportion of strategies of private investment funds that utilize modern technologies, including blockchain technology, is still small, as the private investment fund industry's use of blockchain technology grows and accelerates, the innovation benefits for private investment funds and their clients promise lasting change for the industry.

Private investment funds' bank disintermediation through the implementation of blockchain technology will depend on their ability to find scale opportunities. Future bank disintermediation via private investment funds also depends on the funds' ability to participate in the technological integration of blockchain systems with other technologies such as artificial intelligence, machine learning, and big data.