

Chapter 13: Financial Technology and Hedge Funds

Wulf A. Kaal*

Abstract

Since their inception in the 1940s, hedge funds have been on the leading edge of technology in finance. Examples include big data, artificial intelligence, machine learning algorithms, and blockchain technology. This book chapter examines how and why private fund advisers utilize emerging technology. Some indicia suggest that emerging technology plays a primary role in front office and investment functions, in the securing of crypto assets, but also in private investment fund managers' attempts to satisfy the growth expectations of clients. The use of emerging technology in trade execution and other back-office functions goes hand-in-hand with an ever-increasing interest in the private investment fund industry in investing in digital assets.

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

JEL Categories: K20, K23, K32, L43, L5, O31, O32

* Professor, University of St. Thomas School of Law (Minneapolis). The author is grateful for outstanding support from Hayley Howe and Nicole Kinn.

Table of Contents

I.	INTRODUCTION	3
II.	FINANCIAL TECHNOLOGY AND HEDGE FUNDS	5
1.	<i>Semiconductors</i>	9
2.	<i>Artificial Intelligence and Big Data</i>	10
3.	<i>Blockchain Technology</i>	12
III.	IMPACT OF TECHNOLOGY ON THE HEDGE FUND INDUSTRY	21
1.	<i>Transaction Speed</i>	22
2.	<i>Performance</i>	23
3.	<i>Diversification</i>	26
4.	<i>Capitalizing on Disruption</i>	29
5.	<i>Administrative Process & Compliance</i>	30
6.	<i>Competitive Pressure</i>	32
IV.	CONCLUSION	33

I. Introduction

Hedge fund managers have historically pioneered the application and use of emerging technology in finance.¹ For instance, 56% of respondents to a BarclayHedge survey currently use artificial intelligence (AI) or machine learning (ML) to inform investment decisions and generate trading ideas.² However, just over a quarter of hedge funds use AI or ML for trade execution.³

Hedge fund managers have strong incentives to implement emerging technologies. Being able to use technology to optimize their performance makes them overall more competitive with other funds and with other financial institutions. Being more competitive through technology and creating higher returns for their clients, in turn, allows them to charge higher fees than traditional financial institutions. In recent years, it became increasingly more difficult to justify the 2 and 20 fee model.⁴ Embracing modern financial products allows them to produce returns that can still justify that fee model. Emerging technology also allows hedge fund managers to facilitate investment and process optimization.

¹ Steve Young, *Hedge Fund Technology: Operations and Industry Trends for 2019*, THE HEDGE FUND JOURNAL (2019), <https://thehedgefundjournal.com/hedge-fund-technology/>.

² Hayley McDowell, *More Than Half of Hedge Funds Now Using AI Technology*, THE TRADE (Jul. 19, 2018), <https://www.thetradenews.com/half-hedge-funds-now-using-ai-technology/>.

³ McDowell. *supra* note 2.

⁴ Wulf A. Kaal, *Blockchain Applications and Fee Structure Developments in Private Investment Funds* 5-6 (Apr. 27, 2017) (unpublished article) <https://ssrn.com/abstract=2959730>.

In a push to embrace an emerging foundational technology, 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 cryptocurrencies⁵ to avoid market fluctuations, others invest in and/or acquire companies that use blockchain technology to provide synergies to their other portfolio companies.⁶ Yet others go much further by fully automating a hedge fund secured by blockchain technology.⁷ Other fund managers combine data model optimization with the use of cryptocurrencies as a means of incentives for data scientists' competitive models that facilitate investment analysis efficiencies.⁸

This book chapters shows that the hedge fund advisers who use the technology in front office and investment functions, in the securing of crypto assets, but also with regards to the growth expectation of clients, can benefits. The article explores the reasons for the increasing

⁵ PANTERA CAPITAL, <https://www.panteracapital.com/> (last visited Jun. 8, 2019); POLYCHAIN CAPITAL, <https://polychain.capital/> (last visited Jun. 8, 2019).

⁶ See generally Tom Wilson, *Crypto Hedge Funds Grew Last Year Even as Bitcoin Slumped Report*, REUTERS (May 14, 2019), <https://www.reuters.com/article/crypto-currencies-int/crypto-hedge-funds-grew-last-year-even-as-bitcoin-slumped-report-idUSKCN1SJ1B4>; PRICEWATERHOUSECOOPER, 2019 CRYPTO HEDGE FUND REPORT (2019), <https://www.pwc.com/gx/en/financial-services/fintech/assets/pwc-elwood-2019-annual-crypto-hedge-fund-report.pdf>; Olivia Oran & Anna Irrera, *Goldman, JPMorgan to Invest in Blockchain Startup Axoni: sources*, REUTERS (Dec. 19, 2016), <https://www.reuters.com/article/us-axoni-blockchain-idUSKBN149073>; Amir Bozorgzadeh, *Impact Investing is Driving the Most Exciting Emerging Technologies*, VENTUREBEAT (Jan 30, 2019), <https://venturebeat.com/2019/01/30/impact-investing-is-driving-the-most-exciting-emerging-technologies/>.

⁷ MELONPORT, <https://melonport.com/> (last visited Jun. 8, 2019).

⁸ Richard Craib, Geoffrey Bradway, Xander Dunn with Joey Krug, *Numeraire: A Cryptographic Token for Coordinating Machine Intelligence and Preventing Overfitting*, Numer.ai (2017), <https://numer.ai/whitepaper.pdf>.

use of blockchain technology, among other technological trends in the industry. While the overall proportion of strategies of private investment funds that apply modern technologies, including blockchain technology, is still small, as the use of blockchain technology grows in the private investment fund industry, the innovation benefits for private investment funds and their clients promise to result in lasting change for the industry.

II. Financial Technology and Hedge Funds

The use of financial technology by hedge funds is diverse and constantly evolving. In the last decade and beyond, the core technologies pioneered by hedge funds included semiconductors to increase trade execution, artificial intelligence to optimize data models, big data applications to facilitate unprecedented trend analysis, as well as blockchain technology both on the investment side as well as a means of optimizing back office and compliance.

Emerging technologies play an important role in finance. In an effort to innovate, about 50% of financial services firms around the world plan to acquire FinTech start-ups in the next three to five years.⁹ Hedge fund managers see a need to partner with technologists such as portfolio or risk analytics providers, cybersecurity or EMS vendors.¹⁰

⁹ Nael Shabaz, *WealthTech-Business as Unusual*, in THE WEALTHTECH BOOK 19 (Susanne Chishti & Thomas Puschmann ed., 2018) (citing Edward Robinson, *Big Banks Poised to Scoop up Fintech Startups*, *Report Finds*, BLOOMBERG (Apr. 6 2017).

¹⁰ James Williams, *Technology Innovation Thriving but 'Software Intelligence' Necessary*, HEDGEWEEK: SPECIAL REPORT 3, 4 (Jun. 2018),

For example, Axioma Risk offers front-office and middle-office tools that are connected at the back-end.¹¹ Artificial intelligence (AI) and machine learning (ML) algorithms are trained by data in order to offer better user experience.¹² The current technology used in hedge fund trading is hard coded by a human. In contrast, a deep learning AI machine learning algorithm can be given a simple command and automatically find a result based on data.¹³ Cloud-based utilities can perform risk functions such as know-your-client (KYC), anti-money laundering (AML), and surveillance monitoring.¹⁴

The use of commercial hedge fund databases is proliferating in the hedge fund industry. The first electronic platform used to analyze hedge fund data was a MS-DOS program built through an affiliation between MAR and Burlington Hall Asset Management.¹⁵ The first directory of hedge fund information was published in 1990 and contained information on 70 offshore funds.¹⁶ In 1996, Strategic

https://www.hedgeweek.com/sites/default/files/Hedgeweek_Special_Report_Technology_Innovations_2018.pdf.

¹¹ *Id.*

¹² Dr. Yannis Kalfoglu, *Embracing Emerging Technology*, in THE WEALTHTECH BOOK 17 (Susanne Chishti & Thomas Puschmann ed., 2018).

¹³ Marshall Chang, AI Capital Management, TEDxBeaconStreetSalon Talks (Oct. 4, 2018).

¹⁴ Boudewijn Chalmers Hoyneck van Papendrecht, *FinTech Disruption Across the Wealth Management Value Chain – Will FinTech Dominate the Wealth Management Model of the Future or is there Still a Place for Traditional Wealth Managers?*, in THE WEALTHTECH BOOK 14 (Susanne Chishti & Thomas Puschmann ed., 2018).

¹⁵ Meredith Jones, *The Role of Technology in Hedge Fund Investing*, EUREKAHEDGE (Apr. 2004), http://www.eurekahedge.com/Research/News/1055/The_Role_of_Technology_in_Hedge_Fund_Investing.

¹⁶ *Id.*

Financial Solutions, LLC began offering multi-database analytic capabilities and continues to do so today through its flagship PerTrac 2000 desktop software platform.¹⁷ Since 1997, the electronic data market has grown exponentially.¹⁸ There are currently 12 major hedge fund databases available commercially.¹⁹

Easier access to trading data and information about the hedge fund industry has been a significant factor in the growth of hedge fund assets.²⁰ Information on other funds is easily manipulated and analyzed using analytic platforms and allows hedge funds to construct marketing materials with complex style and peer analysis.²¹ For example a fund of hedge funds database provides details about underlying constituent funds contained in the portfolio, allowing hedge fund managers to be able to better target marketing efforts.²² Roughly 9 percent of all hedge funds in 2016 made a majority of their trades with help from computer models, managing about \$197 billion.²³ However, according to research done by Prequin, the typical systematic fund doesn't always perform as well as funds operated by human managers.²⁴

¹⁷ *Id.*

¹⁸ *Id.*

¹⁹ *Id.*

²⁰ *Id.*

²¹ Jones, *supra* note 15.

²² *Id.*

²³ Cade Metz, *The Rise of the Artificially Intelligent Hedge Fund*, WIRED (Jan. 25, 2018), <https://www.wired.com/2016/01/the-rise-of-the-artificially-intelligent-hedge-fund/>.

²⁴ *Id.*

Advanced AI technology helps automate existing processes and realize new revenue streams and business models.²⁵ Bayesian networks use a handful of machines to predict market trends and pinpoint particular trades.²⁶ Hedge funds that base their strategies on AI have provided better results over the last five years than the average.²⁷ Algorithms for sentiment analysis and document classification are above 90% accuracy levels.²⁸ AI, natural language processing and neural networks in front-office solutions can be applied by hedge funds.²⁹ Robotic process automation for can be applied to simple processes or data handling and manipulation.³⁰

Machine learning can make predictions on real-time information, and analyze historical financial data to predict cash flow and important financial indicators based on past performance of similar companies.³¹ ML can help in accurate portfolio diversification by looking for uncorrelated instruments that match requirements of the risk profile.³² ML can also generate investment strategies parameterized by goals such as expected risk profiles, asset categories and tie span, resulting in sets of predictive models that may be applied in order to fulfill the

²⁵ Kalfoglu *supra* note 12, at 18.

²⁶ Metz, *supra* note 23.

²⁷ Michal Rozanski, *How AI Will Cause Robo-Advice to completely Outperform Human Advice*, in THE WEALTHTECH BOOK 275 (Susanne Chishti & Thomas Puschmann ed., 2018); EUREKAHEDGE, <http://eurekahedge.com/> (last visited Jun. 20, 2019).

²⁸ *Id.* at 276.

²⁹ Young, *supra* note 1.

³⁰ *Id.*

³¹ Rozanski, *supra* note 27, at 276.

³² *Id.*

assumptions.³³ Social media platforms impact those in the asset management industry.³⁴ ML can analyze management's public statements and activity on social networks in order to track the integrity of their past words, actions, and results.³⁵

Cloud adoption is also growing in the hedge fund industry.³⁶ Mobile offerings and delivery of trading and performance-related information to investors.³⁷ The fund industry is built on sharing information and making sure all of the data being examined is correct.³⁸ Trade confirmations and settlements could be offered through distributed ledger technology.³⁹ Distributed ledgers could also replace share registers for investor-level recordkeeping and servicing.⁴⁰

1. *Semiconductors*

Semiconductors amplify signals, switch, and convert energy.⁴¹ The number of transistors in a dense integrated circuit doubles approximately every two years – leading to fierce competition in the industry.⁴² Companies need to maintain large research and

³³ *Id.*

³⁴ Williams, *supra* note 10, at 3.

³⁵ Rozanski, *supra* note 27, at 276.

³⁶ Young, *supra* note 1.

³⁷ *Id.*

³⁸ *Id.*

³⁹ *Id.*

⁴⁰ *Id.*

⁴¹ James Chen, *SemiConductor*, INVESTOPEDIA (Feb. 26, 2018), <https://www.investopedia.com/terms/s/semiconductor.asp>.

⁴² *Id.*

development budgets to be able to compete in the semi-conductor business.⁴³ Hedge fund managers invest in semiconductors through the PHLX Semiconductor Index, and its derivative forms are traded in exchange-traded funds.⁴⁴ Semiconductor companies offer highly liquid securities that encourage risk-taking and varied profit strategies.⁴⁵ Hedge funds invest in Taiwan Semiconductor Manufacturing Company Limited (TSM).⁴⁶ In 2018, energy, semiconductors and healthcare led US sector hedge fund gains.⁴⁷

2. Artificial Intelligence and Big Data

Hedge fund managers have early embraced the use of artificial technology, machine learning, and big data.⁴⁸ The combination of big

⁴³ *Id.*

⁴⁴ *Id.*

⁴⁵ Alan Farley, *The Truth Behind Trading Semiconductor (Chip) Stocks (INTC, TXN)* INVESTOPEDIA (Oct. 25, 2018), <https://www.investopedia.com/articles/active-trading/031815/truth-behind-trading-semiconductor-chip-stocks.asp>.

⁴⁶ [Why You Should Care When Hedge Funds Invest in Taiwan Semiconductor Manufacturing Company Limited \(TSM\)](#), HedgeMaven (Nov. 27 2018).

⁴⁷ Komfie Manalo, *Global Hedge Funds Up 1.88% by mid-January*, OPALESCUE (Jan. 19, 2018), https://www.opalesque.com/667299/Global_hedge_funds_up_by729.html.

⁴⁸ See, e.g. Charles D'Haussey, *Welcoming an Artificial Intelligence Robot as a Colleague*, in THE WEALTHTECH BOOK 23 (Susanne Chishti & Thomas Puschmann ed., 2018); Katarina Prozorova, *How Emerging Technologies Will Change Emerging Markets- Welcome Robo-Advisor X.0!*, in THE WEALTHTECH BOOK 71 (Susanne Chishti & Thomas Puschmann ed., 2018); Richard Peers, *Digital Super Powers- The Role of Artificial Intelligence in Wealth Management*, in THE WEALTHTECH BOOK 77 (Susanne Chishti & Thomas Puschmann ed., 2018); Holger Boschke, *Using Artificial Intelligence in Wealth Management*, in THE WEALTHTECH BOOK 80 (Susanne Chishti & Thomas Puschmann ed., 2018); Catherine Flax, *Personal Financial Intelligence- AI and the Future of Money Management*, in THE WEALTHTECH BOOK 132 (Susanne Chishti & Thomas Puschmann ed., 2018); Jeremy Sosabowski, *Financial Forecasting and Portfolio Optimization in the 21st Century*, in THE WEALTHTECH BOOK 135 (Susanne Chishti & Thomas Puschmann ed., 2018); Yaron Golgher, Lipa Roitman, Dmitry Neginsky, *AI-Powered Wealth Management Products and Investment Vehicles*, in THE WEALTHTECH BOOK 138

data that is collected by using FinTech and LegalTech solutions and blockchain applications creates a surge of new and innovative platforms with disruptive effects for the financial industry. The combination of blockchain technology startups with platforms, artificial intelligence and machine learning offer opportunities for developing new technologies. Private investment funds often combine the benefits offered by emerging technology with other evolving technologies and cutting-edge applications to create synergies. By leveraging the big data that is collected by using FinTech and LegalTech solutions and blockchain applications in combination with machine learning, hedge fund managers are able to create more creative and faster tools for finance.⁴⁹

Perhaps the most prominent example of a private investment fund that very successfully incorporated the combination of technologies is Numerai. Numerai is a private investment fund with a global equity strategy. Numerai uses artificial intelligence to convert financial data into machine learning problems for data scientists.⁵⁰ Using data science for investment analysis creates efficiency through

(Susanne Chishti & Thomas Puschmann ed., 2018); Jerry Floros, *The Investment Managers of the Future are Going to be Millennials*, in THE WEALTHTECH BOOK 249 (Susanne Chishti & Thomas Puschmann ed., 2018); Alpesh Doshi, *An Industry Driven by Digital, Data and Artificial Intelligence*, in THE WEALTHTECH BOOK 254 (Susanne Chishti & Thomas Puschmann ed., 2018); Daniel Diemers, *Wealth-Tech-Taking Private Banking and Wealth Management Digital*, in THE WEALTHTECH BOOK 257 (Susanne Chishti & Thomas Puschmann ed., 2018).

⁴⁹ See, e.g. Richard Peers, *Digital Super Powers- The Role of Artificial Intelligence in Wealth Management*, in THE WEALTHTECH BOOK 77 (Susanne Chishti & Thomas Puschmann ed., 2018).

⁵⁰ 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.” Richard Craib, Geoffrey Bradway, Xander Dunn with Joey Krug, *supra* note 8.

a synthesis of data. Data scientists working in this model work to solve the same problems in their own unique ways with different strategies. Numerai synthesizes these models to create a meta-model out of all the predictions from the data scientists.⁵¹ In the Numerai model, the use of artificial intelligence increases efficiency and optimum capital allocation by reducing overhead costs.⁵²

Adaptive data analysis is one of the important problems that are being addressed in the Numerai model. When data scientists use the same data set repetitively a risk exists that the training model will overfit the test set of data, which can limit the performance of the applied model on a different dataset.⁵³ To overcome this problem, data scientists working for Numerai are tasked with staking Numeraire on their predictions which in effect represents data scientists' confidence in their model's live performance. The staking process, in turn, enables Numerai to choose the optimal model and in the process improve the performance of its hedge fund.⁵⁴

3. *Blockchain Technology*

Blockchain is a transformational technology that emerged in 2009 with the Bitcoin Protocol.⁵⁵ Between the years 2000 and 2012, despite

⁵¹ See Laura Shin, *This Is the World's First Cryptocurrency Issued by a Hedge Fund*, FORBES (Feb. 21, 2017),

<https://www.forbes.com/sites/laurashin/2017/02/21/this-is-the-worlds-first-cryptocurrency-issued-by-a-hedge-fund/#61dcf68560b6>.

⁵² See Daniel Fagglla, *Crowdsourcing a Machine Learning Hedge Fund*, TECHEMERGENCE (Nov. 10, 2016),

<https://www.techemergence.com/crowdsourcing-a-machine-learning-hedge-fund/> (providing excerpts from and the audio of an interview with Richard Craib, the founder of Numerai.).

⁵³ CRAIB, *supra* note 8.

⁵⁴ *Id.* at 2.

⁵⁵ See, e.g. Rainer Bohme, Nicolas Christin, Benjamin Edelman, and Tyler Moore, *Bitcoin: Economics, Technology, and Governance*, J. OF ECON. PERSP. 213(2015).

an initial pickup in 2005, the use of blockchain in private investment funds was minimal. In 2012, coinciding with the more public debate of blockchain based solutions, private investment fund managers started to get involved in the technology. They began to experiment with the technology by setting up separate and new fund entities that utilized the technology in various forms. In 2015, however, existing funds also started to create substructures that utilized blockchain technology.

The use of blockchain technology by hedge funds is strongly correlated with overall market developments of digital assets. Starting with the emergence of the Bitcoin protocol in 2009,⁵⁶ the digital asset market is a market for investment opportunities in digital assets. Such assets are instantiated through computer code and depend on so-called consensus computer algorithms to trigger and validate a transaction in a given digital asset. With the emergence of alt-coins in April 2011, e.g. coins that provide an alternative investment opportunity other than bitcoin,⁵⁷ public token sales a/k/a Initial Coin Offerings (ICOs) became possible. The first ICO was conducted by Mastercoin in July 2013.⁵⁸ Right from the start of the digital asset and altcoin market,

⁵⁶ Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN (May 24, 2009), <https://bitcoin.org/bitcoin.pdf>.

⁵⁷ See, e.g. Lawrence H. White, *The Market for Cryptocurrencies*, 35 CATO J. 383, 388 (2015); William J. Luther, *Bitcoin and the Future of Digital Payments*, 20 THE INDEPENDENT REVIEW 397, 399 (2016).

⁵⁸ INITIAL COIN OFFERING, https://en.wikipedia.org/wiki/Initial_coin_offering (June 12, 2019).

hedge fund managers saw a crucial technology-driven opportunity and invested.⁵⁹

Blockchain technology has vast disruptive innovative properties. For example, until recently, most commentators viewed Bitcoin as a hype, susceptible to fraud, price manipulation and corruption.⁶⁰ Yet, the pace of innovation in cryptocurrencies and their application in different industries and commercial settings is faster than ever.⁶¹ The high levels of investor activity in the blockchain area appears to provide a reliable indicator of the commercial maturity of blockchain technology.

Business, administrative, and legal processes that rely on legal intermediaries may become redundant because of advances in and acceptance and implementation of blockchain technology. Forms of keeping business and legal ledgers such as notary and registry services, legal motions practice in court, legal title companies, among several others, may be among the first services to disappear in the not too distant future. Similarly, corporate processes that have ledger functionality but rely on legal intermediaries could be streamlined very quickly by implementing blockchain technology. When blockchain technology becomes more widely accepted and applications are spreading into consumer territory, existing corporate

⁵⁹ PANTERA CAPITAL, <https://www.panteracapital.com/> (last visited Jun. 8, 2019); POLYCHAIN CAPITAL, <https://polychain.capital/> (last visited Jun. 8, 2019).

⁶⁰ Mark Fenwick, Wulf A. Kaal, and Erik P.M. Vermeulen, *The "Unmediated" and "Tech-driven" Corporate Governance of Today's Winning Companies* (TILEC Discussion Paper No. 2017-009, U of St. Thomas (Minn.) Legal Studies Research Paper No. 17-10, Lex Research Topics in Corporate Law & Economics Working Paper No. 2017-1), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2922176##.

⁶¹ *Id.*

processes and structures will likely be among the first processes to become redundant. Blockchain technology startups are already attempting to replace intermediaries in many types of transactions, including and most notably contract analyses, real estate, and intellectual property.⁶² Some commentators predict a future in which blockchain startups can remove lawyers altogether from commerce as smart contracts in the blockchain, such as the ones in the Ethereum platform,⁶³ regulate commerce entirely, enabled by the trust created between parties through immutable blockchain technology.⁶⁴

The limitations of blockchain technology became most apparent in the aftermath of the ICO boom of 2018. ICOs promised investors core decentralized infrastructure products that assumed a baseline infrastructure existed. This turned out to be false as Ethereum and other infrastructure products proved unable to deliver on the

⁶² See CLAUSE, <http://clause.io> (last visited June 30, 2017). Clause is a platform for self-managing legal contracts. The contract integrates “real-time data from the ‘internet of things’, web services, and business and accounting systems.” See also, BINDED, <https://binded.com> (last visited June 30, 2017) (uses blockchain to track and enforce copyright); ASCRIBE, <https://www.ascribe.io> (last visited June 30, 2017) (uses the bitcoin blockchain to establish digital ownership of art and other creative works); UBITQUITY, <https://www.ubitquity.io/web/index.html> (last visited June 30, 2017) (uses Software-as-a-Service (SaaS) blockchain platform to track property).

⁶³ ETHEREUM, <http://www.ethereum.org> (last visited June 30, 2017).

⁶⁴ See, e.g., Philipp Kristian, *How Do P2P Platforms Build Trust Between Strangers?*, E27 (Apr. 13, 2016), <https://e27.co/how-do-peer-to-peer-platforms-build-trust-between-strangers-20160413/>; Anand Iyer, *How Modern Marketplaces Like Uber and Airbnb Build Trust to Achieve Liquidity*, TC (Mar. 4, 2014), <https://techcrunch.com/2014/03/04/how-modern-marketplaces-like-uber-and-airbnb-build-trust-to-achieve-liquidity/>; Frederic Mazzella & Arun Sundararajan, *Entering the Trust Age*, BLABLACAR (2016), <https://blog.blablacar.com/trust/>; Eric Piscini et al., *Blockchain: Trust Economy*, DELOITTE U. PRESS_ (Feb. 7, 2017), <https://dupress.deloitte.com/dup-us-en/focus/tech-trends/2017/blockchain-trust-economy.html>.

expectations by the investing may reach full maturity by 2030. Legal limitations pertaining to smart contracts and blockchain technology originate mostly from concerns over the legal origin of smart contracting. While smart contracts may reflect the underlying contract between parties, lawyers may argue that “smart contracts” are void and unenforceable under the law.⁶⁵ Contractual legal rules regarding formation, interpretation, conditions and remedies require substantive adjustments for smart contracts in contract law.⁶⁶ Such limitations are slowly disappearing. For instance, Arizona passed a law in early 2017 that makes smart contracts fully enforceable under Arizona law.⁶⁷ Delaware is looking into similar rules proposed in the Blockchain Initiative.⁶⁸

The lack of regulatory recognition of Blockchain technology creates significant uncertainty for the blockchain community. While blockchain technology itself offers unprecedented genuine data and

⁶⁵Stuart D. Levi & Alex B. Lipton, *An Introduction to Smart Contracts and Their Potential And Inherent Limitations*, HARVARD LAW SCHOOL: FORUM ON CORPORATE GOVERNANCE AND FINANCIAL REGULATION (May 26, 2018) (citing Kevin Werbach & Nicolas Cornell, *Contracts Ex Machina*, 67 Duke L.J. 101 (2017), <https://poseidon01.ssrn.com/delivery.php?ID=304031003022084009011112068000099092100062053015068020110121122088005084072068115100121033016010020011028024107126071122116069117006094054007092020001081093065101066045024017083004093012108086074109120069019113086123099123093097103085123103118111088&EXT=pdf>); Mike Orcutt, *States That are Passing Laws to Govern "Smart Contracts" Have No Idea What They're Doing*, TECHNOLOGYREVIEW (Mar. 29, 2018), <https://www.technologyreview.com/s/610718/states-that-are-passing-laws-to-govern-smart-contracts-have-no-idea-what-theyre-doing/>.

⁶⁶ *Id.*

⁶⁷ H.R. 2417, 53rd Leg., Reg. Sess. (Ariz. 2017).

⁶⁸ Garrett Keirns, *Delaware is Drafting Law That Would Recognize Blockchain Records*, COINDESK (Mar. 15, 2017), <http://www.coindesk.com/delaware-drafting-law-recognize-blockchain-records/>.

privacy protection, the storage of blockchain data across a global network of nodes often will not comply with specific consumer protection rules, directives, and guidelines around the world.⁶⁹ The existing legal issues arising in the context of sharing platforms,⁷⁰ demonstrate that future blockchain-enabled sharing services may not be accepted quickly and without resistance on the part of incumbents challenged by new ways of delivering a service or product. 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.

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

⁶⁹ *Id.*

⁷⁰ Such as UBER (<https://www.uber.com/>) (transportation), LYFT (<https://www.lyft.com>) (transportation), SIDECAR (<https://www.side.cr/>) (transportation), RELAYRIDES (<https://Relayrides.Turo.com>) (transportation), SPINLISTER (<https://www.spinlister.com/>) (transportation) and JUSTPARK (<https://www.justpark.com/>) (transportation), AIRBNB (<https://www.airbnb.com>) (lodging) and DOGVACAY (<https://dogvacay.com/>) (lodging), POSTMATES (<https://postmates.com/>) (on-demand delivery services), PRIME NOW (<https://primenow.amazon.com>) (on-demand delivery services), and INSTACART (<https://www.instacart.com>) (on-demand delivery services), and RENT THE RUNWAY (<https://www.renttherunway.com>) (clothing).

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,⁷¹ the Northern Trust⁷² in cooperation with IBM, Numerai,⁷³ LendingRobot,⁷⁴ and Intellisys Capital LLC,⁷⁵ Melonport,⁷⁶ 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.⁷⁷ 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 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

⁷¹ POLYCHAIN CAPITAL, <https://angel.co/polychain-capital> (last visited Apr. 17, 2019).

⁷² NORTHERN TRUST, <https://www.northerntrust.com/> (last visited Apr. 17, 2019).

⁷³ NUMERAI, <https://numer.ai/> (last visited Apr. 17, 2019).

⁷⁴ LENDINGROBOT, <https://www.lendingrobot.com/#/> (last visited Apr. 17, 2019).

⁷⁵ INTELLISYS CAPITAL LLC, <http://www.intellisys.ai/> (last visited Apr. 17, 2019).

⁷⁶ MELONPORT, <https://melonport.com/>, (last visited Apr. 17, 2019).

⁷⁷ See Press Release, IBM, Northern Trust and IBM Pioneer Use of Blockchain Technology to Help Transform Private Equity Administration (Feb. 22, 2017), <http://www-03.ibm.com/press/us/en/pressrelease/51655.wss>.

lengthy, duplicative, and fragmented investment and administrative processes, the partnership's solution delivers an enhanced and efficient approach to private equity administration.⁷⁸ More specifically, unlike the current deal practice in private equity, which requires parties to reconcile multiple 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.⁷⁹

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.⁸⁰ Numerai operates on the Ethereum blockchain, utilizing a cryptocurrency called "Numeraire." 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."⁸¹

LendingRobot's LendingRobot Series is a fully automated hedge fund secured by blockchain technology.⁸² Unlike other blockchain-based hedge funds that invest specifically in

⁷⁸ See *id.*

⁷⁹ See *id.*

⁸⁰ Shin, *supra* note 51.

⁸¹ Richard Craib, Geoffrey Bradway, Xander Dunn with Joey Krug, *supra* note 8.

⁸² Press Release, deBanked, Introducing LendingRobot Series: One-Stop Investing in Alternative Lending (Jan. 26, 2017), <http://debanked.com/2017/01/introducing-lendingrobot-series-one-stop-investing-in-alternative-lending/>; Dan Cummings, *LendingRobot Introduces Robo-Fund LendingRobot Series*, ETHNEWS <https://www.ethnews.com/lendingrobot-introduces-robo-fund-lendingrobot-series>, (last visited Jun. 19, 2019).

cryptocurrency, such as Global Advisers and Polychain Capital, the LendingRobot Series invests in lending marketplaces— Lending Club, Prosper, Funding Circle, and Lending Home.⁸³ 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.⁸⁴

Jurisdiction over blockchain transactions presents a problem for those hedge funds that apply the technology. For private investment funds that use blockchain technology and are set up on the blockchain via the Ethereum network, the issues of domicile over their fund is particularly important. Some private investment funds may exist through the combination of smart contracts on the Ethereum blockchain.⁸⁵ Such funds may not have a domicile either foreign or domestic. If managers use digital currencies to invest in digital assets and are set up through Ethereum smart contracting via Melonport,⁸⁶ ostensibly the fund would exist entirely in cyberspace. However, managers cannot assume that they are judgment-proof. Instead, fund

⁸³ Press Release, deBanked, *supra* note 82; Cummings, *supra* note 82.

⁸⁴ Press Release, deBanked, *supra* note 145.

⁸⁵ See Reto Trinkler & Mona El Isa, *Melon Protocol: A Blockchain Protocol for Digital Asset Management*, (Jun. 28, 2000) (Draft), <https://github.com/melonproject/greenpaper/blob/master/melonprotocol.pdf> (“The Green Paper”) at 4.

⁸⁶ *Id.*

managers may be required to comply with more regulations not fewer.⁸⁷

III. Impact of Technology on the Hedge Fund Industry

The use of emerging technology has the potential to restructure large parts of the private investment fund and banking industry.⁸⁸ Most legacy systems at private investment funds and banks are much more expensive than emerging blockchain technologies, are subject to human error, and take much more time. Banks charged \$1.7 trillion in processing fees in 2014.⁸⁹

Blockchain technology is transparent, verifiable, self-authenticating, and self-enforcing, financial transactions can be executed instantaneously at near zero transaction costs, increasing the efficiency for business and individuals exponentially. These factors, in addition to blockchain technology's disintermediation through technology-driven democratized trust, precipitated the financial

⁸⁷ "[E]very transaction potentially comes under the legislative umbrella of wherever a node exists whether in respect of financial services or data protection." Gregory Brandman & Samuel Thampapillai, *Blockchain – Considering the Regulatory Horizon*, OXFORD BUS. L. BLOG (Jul. 7, 2016), <https://www.law.ox.ac.uk/business-law-blog/blog/2016/07/blockchain-%E2%80%93-considering-regulatory-horizon>.

⁸⁸ Lawrence J. Trautman, *Is Disruptive Blockchain Technology the Future of Financial Services?*, 69 CONSUMER FIN. L.Q. REP. 232 (2015).

⁸⁹ *Id.*

industry's substantial investments into blockchain technologies⁹⁰ in fear of becoming obsolete.⁹¹

1. *Transaction Speed*

Starting in 2005, transaction speed and execution capability became the new focus of hedge funds, placing cost control and efficiency higher in their priorities.⁹² Execution capability is aided by real-time data to enhance the investment decision-making process, direct market access, and algorithms.⁹³ Many robo-advisors are automating the processes of the execution of actual orders behind portfolio allocation and rebalancing strategies, passing generated orders to brokerage systems.⁹⁴ ML can be applied in execution algorithms that help execute large orders by dividing them into thousands of smaller transactions without influencing the market, while adjusting their aggressiveness to the market situation.⁹⁵ Complete and closed AI-based “analysis-to-decision-to-execution” system, with minimal to no input from the fund manager can also be implemented.⁹⁶ Opus uses “Smart Automation” to achieve highly

⁹⁰ Financial institutions are expected to spend over \$1 billion on blockchain projects in 2017. This is on top of the \$1.4 billion invested in the last three years. *Id.*

⁹¹ Reggie O'Shields, *Smart Contracts: Legal Agreements for the Blockchain*, 21 N.C. BANKING INST. 177 (2017).

⁹² Datamonitor, *Hedge Funds Turn to Technology* at 107-08 (2006).

⁹³ *Id.* at 108.

⁹⁴ Rozanski, *supra* note 27.

⁹⁵ *Id.* at 276.

⁹⁶ Yaron Golgher, Lipa Roitman, Dmitry Neginsky, *AI-Powered Wealth management products and investment vehicles*, in THE WEALTHTECH BOOK 140 (SUSANNE CHISHTI & THOMAS PUSCHMANN ED., 2018).

streamlined and efficient workflows.⁹⁷ In their banking team and distribution process, which processes thousands of distribution payments each month, Opus has been able to create “Smart Automation” to safely handle these high volumes. Finally, trade confirmations and settlements could be offered through distributed ledger technology.⁹⁸ Distributed ledgers could also replace share registers for investor-level recordkeeping and servicing.⁹⁹

2. *Performance*

Hedge funds are using technology to optimize their performance. In a 2018 survey conducted by BarclayHedge, more than half of respondents use AI/ML to inform investment decisions.¹⁰⁰ Two-thirds of respondents use AI/ML to generate trading ideas and optimize portfolios.¹⁰¹ Just over a quarter of respondents use automation to execute trades.¹⁰² Over half of the respondents have used AI for three or more years, and a third of respondents have used AI for five or more years.¹⁰³

Two-thirds of respondents used AI/ML to generate trading ideas to optimize portfolios.¹⁰⁴ Big data in combination with AI/ML allows traders and portfolio managers to scan immense data sets and

⁹⁷Mike Canini, *Smart Automation*, HEDGEWEEK 17 (Jun. 2018), https://www.hedgeweek.com/sites/default/files/Hedgeweek_Special_Report_Technology_Innovations_2018.pdf.

⁹⁸ Young, *supra* note 1.

⁹⁹ *Id.*

¹⁰⁰ BarclayHedge (2018).

¹⁰¹ *Id.*

¹⁰² *Id.*

¹⁰³ *Id.*

¹⁰⁴ *Id.*

act on data that informs a desired outcome because the algorithms optimize positive outcomes.¹⁰⁵ However, more than four out of ten of survey respondents still rely on conventional human thinking to guide their investment processes.¹⁰⁶ The technology is being used to formulate investment ideas and build portfolios informed by the complex data analysis AI allows.¹⁰⁷ More than one half of respondents said that AI/ML guides 20-60% of their decision-making process as a fund manager.¹⁰⁸ More than two-thirds of survey respondents use AI/ML on assets of less than \$50 million.¹⁰⁹

The hedge fund industry is using fully automated electronic trading systems. For example, Aidyia, based in Hong Kong, is uses a fully automated trading system to make all stock trades using AI.¹¹⁰ The Aidyia system identifies and executes trades entirely on its own.¹¹¹ The technology uses AI that includes techniques such as evolutionary computation and deep learning, as well as probabilistic logic, and runs across hundreds or thousands of machines.¹¹² The AI engines make market predictions each day and then “vote” on the best course of action.¹¹³ The goal of these systems is to be able to automatically recognize changes in the market and adapt in ways that

¹⁰⁵ *Id.*

¹⁰⁶ *Id.*

¹⁰⁷ *Id.*

¹⁰⁸ *Id.*

¹⁰⁹ *Id.*

¹¹⁰ Metz. *supra* note 23; *See also Hedge funds embrace machine learning – up to a point*, THE ECONOMIST (Dec. 9 2017), <https://www.economist.com/finance-and-economics/2017/12/09/hedge-funds-embrace-machine-learning-up-to-a-point>.

¹¹¹ Metz. *supra* note 23.

¹¹² *Id.*

¹¹³ *Id.*

traditional quant¹¹⁴ models cannot.¹¹⁵ Adidya trades in US equities and generated a 2 percent return on its first day.¹¹⁶ AI-driven fund management is looking for the best trades in the longer term by choosing strategy.¹¹⁷

Sentient Technologies of San Francisco has been trading with a similar system since 2015 backed by US\$143 million in funding.¹¹⁸ The company has not openly marketed its fund but has been making official trades since 2015 using money from private investors after a longer period of test trades.¹¹⁹ Sentient has worked with the hedge fund business inside JP Morgan Chase in developing trading technology.¹²⁰ The fund operates entirely through AI by automatically authoring a strategy then giving fund managers commands but allows the company to adjust risk settings.¹²¹ There is disagreement over whether deep learning may be able to identify particular features of a stock that could be profitable.¹²²

¹¹⁴ See Kevin McPartland, *Quantimental Investing: The New Way to Beat the Market*, FORBES, (Jul. 12, 2018), <https://www.forbes.com/sites/kevinmcpartland/2018/07/12/quantimental-investing-the-new-way-to-beat-the-market/#32437cab5f15>; Saijel Kishan & Vincent Bielski, *It's Been a Rough 2018 for Many Quant Hedge Funds*, BLOOMBERG (Jun. 26, 2018, 12:33PM CDT), <https://www.bloomberg.com/news/articles/2018-06-26/quants-beset-by-woes-as-jpmorgan-pulls-money-from-hedge-fund>.

¹¹⁵ Metz. *supra* note 23.

¹¹⁶ *Id.*

¹¹⁷ *Id.*

¹¹⁸ *Id.*

¹¹⁹ *Id.*

¹²⁰ Metz. *supra* note 23 (citing Kelly Bit, *The \$10 Hedge Fund Supercomputer That's Sweeping Wall Street*, BLOOMBERG (May 20, 2015), <https://www.bloomberg.com/news/articles/2015-05-20/the-10-hedge-fund-supercomputer-that-s-sweeping-wall-street>).

¹²¹ Metz. *supra* note 23.

¹²² *Id.*

As of 2016, Two Sigma and Renaissance Technologies were using AI and Bridgewater Associates and Point72 Asset Management were moving in the same direction.¹²³ Smart Automation is an important technology development that involves combining a deep understanding of workflows with robust granular data to allow highly efficient, accurate, and controlled decisions to be made.¹²⁴

FundNexus is a new technology that will offer a platform with uniform subscription documents and direct electronic delivery to and confirmation by administrators.¹²⁵ Custom platforms for data collection are also being built as well as a platform that will cross-check funds across databases to remove duplicate funds and offer data verification to the major databases.¹²⁶ A rating system is also being discussed.¹²⁷

3. *Diversification*

Diversification is a key element of emerging technology in the private investment fund industry. For example, a benefit of investing in digital currencies rather than traditional investments is that digital currencies can be immune to the vicissitudes of traditional stock investments and the equity markets. Although crypto investments can be just as and more volatile than traditional investments, digital currencies might be used to hedge against traditional investments.¹²⁸

¹²³ *Id.*

¹²⁴ Canni, *supra* note 97.

¹²⁵ Jones, *supra* note 15.

¹²⁶ *Id.*

¹²⁷ *Id.*

¹²⁸ In fact, bitcoin has been arguably more volatile. *See e.g.*, Neil Haran, *What's Keeping Cryptocurrencies From Mass Adoption?* TECHCRUNCH (Apr. 20, 2017),

Diversification derived from investments in digital assets is strongly related with the evolution of the Initial Coin Offering market. ICOs evolved rapidly and receded equally quickly. After Satoshi Nakamoto established the use case for blockchain technology for cryptocurrencies in 2008,¹²⁹ it took until 2012 for the first ICO to occur. However, the exponential growth of ICOs since 2015 culminated in ICO fundraising outperforming venture capital financing of crypto start-ups in the second quarter of 2017.¹³⁰ Following its rapid proliferation and market exuberance, ICOs receded equally quickly lockstep with the depreciation of bitcoin in early 2018.

Crypto hedge funds enable significant diversification for their clients. Examples include TheToken Fund,¹³¹ Polychain Capital,¹³² Pantera Capital,¹³³ and Logos Fund.¹³⁴ Such funds provide investors with exposure to a wide range of digital currencies without the risk of investing in either the underlying organization behind a protocol or the digital currency itself. Rather than make one large investment in one cryptocurrency, these funds employ an asymmetric investment strategy by making large-scale investments in numerous

<https://techcrunch.com/2017/04/20/whats-keeping-cryptocurrencies-from-mass-adoption>.

¹²⁹ Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN (May 24, 2009), <https://bitcoin.org/bitcoin.pdf>.

¹³⁰ Alex Sunnarborg, *ICO Investments Pass VC Funding In Blockchain Market First*, COINDESK (Jun. 9, 2017), <https://www.coindesk.com/ico-investments-pass-vc-funding-in-blockchain-market-first/>.

¹³¹ THE TOKEN, <https://thetoken.io/> (last visited June 30, 2019).

¹³² See Polychain Capital, *supra* note 5.

¹³³ PANTERA CAPITAL, <https://www.panteracapital.com/> (last visited Jun. 8, 2019).

¹³⁴ THE LOGOS FUND, <http://logos-fund.com> (last visited Apr. 24, 2019).

cryptocurrencies. The Logos Fund combines such crypto investment diversification with the mining of bitcoins to increase the value of the fund during downswings in the volatile cryptocurrency markets.

Since late 2017, the market for digital assets has moved back from the ICO model to the venture model, leading to less diversification. Historical examples show that nascent markets are subject to significant change.¹³⁵ The nascent market for digital assets' rapid proliferation in 2016-18 was followed by significant downward corrections, called the "crypto winter" in 2018-19.¹³⁶ Since its inception in 2009 until around January 2017, the digital asset market was dominated by one digital currency, namely Bitcoin. Until around April 15, 2011, the creation of the first known alt-coin (e.g. an alternative coin to Bitcoin), Bitcoin virtually dominated the market and was in fact the only digital asset.¹³⁷ Between 2017 and 2019, the alt-coin market proliferated significantly.¹³⁸ Correspondingly, from 2016 to 2017, Bitcoin's market share dropped dramatically.¹³⁹ At the end of 2014, with the instantiation of smart contracting in the Ethereum ecosystem and the ETH currency, the market for digital

¹³⁵ José Albuquerque de Sousa, Thorsten Beck, Peter A.G. van Bergeijk, and Mathijs A. van Dijk, *Nascent markets: Understanding the Success and Failure of New Stock Markets* (CEPR Discussion Paper No. DP11604, 2016), <http://www.lse.ac.uk/economics/Assets/Documents/finance-and-development-workshop/beck-nascent-markets.pdf>.

¹³⁶ Michael J Casey, *Crypto Winter is Here and We Only Have Ourselves to Blame*, COINDESK (Dec. 3, 2018), <https://www.coindesk.com/the-crypto-winter-is-here-and-we-only-have-ourselves-to-blame>.

¹³⁷ COINMARKETCAP, <https://coinmarketcap.com> (last visited Jun. 14, 2019). Note: 100% dominance assumed till April 15, 2011 (creation of first known altcoin). Linear interpolation from April 15, 2011 to April 28, 2013 (the date of coinmarketcap.com's first Bitcoin data point).

¹³⁸ *Id.*

¹³⁹ *Id.*

assets started to diversify and proliferate substantially. New alt-coins emerged almost weekly, leading to over 1600 cryptocurrencies in circulation in late 2018.¹⁴⁰ The percentage of ICOs in relation to total fundraising of blockchain startups dropped from 80% to around 35% in August 2018 and only marginally recovered between September 2018 and February 2019 at around 40% to 50% before dropping to 20% in March 2019.¹⁴¹ Other funding vehicles, such as venture fundraising, became more important for the blockchain industry in August 2018.

4. *Capitalizing on Disruption*

The disruption of legacy finance by ICOs has triggered attempts by private investment funds to capitalize on the source of disruption within the existing business model to benefit from its advantages.¹⁴² Funds can benefit from the early liquidity provided by cryptocurrencies in the lifecycle of a company. In the existing legacy business for private investment funds, the investment process is subject to long, complex, and time intensive processes leading up to a very late liquidity event in the form of an IPO or acquisition. By

¹⁴⁰ LIST OF CRYPTO CURRENCIES, https://en.wikipedia.org/wiki/List_of_Cryptocurrencies (last visited June 12, 2019).

¹⁴¹ ICOs % of Total Blockchain Funding, COINDESK, <https://www.coindesk.com/ico-tracker> (Jan 2016 – Dec 2016); ICORATING.COM, <https://icorating.com/statistics/market/> (Jan 2017 – Mar 2019).

¹⁴² Lionel Laurent, *Want to be a VC? Just Flip a Bitcoin*, BLOOMBERG (Apr. 18, 2017), <https://www.bloomberg.com/gadfly/articles/2017-04-18/beating-vc-funds-is-as-easy-as-flipping-a-bitcoin>.

contrast, ICOs provide liquidity to investors much faster.¹⁴³ Cryptocurrencies created by blockchain start-ups generate investment returns that cannot be matched by legacy investments.¹⁴⁴

5. *Administrative Process & Compliance*

A significant application of blockchain technology for private investment funds involves the improvement of administrative processes and compliance procedures. For instance, LendingRobot's LendingRobot Series is a fully automated hedge fund secured by blockchain technology.¹⁴⁵ Unlike other 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.¹⁴⁶ 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. This facilitates significant efficiencies and facilitates administrative and compliance optimization. Moreover, by recording all transactions in the public blockchain, LendingRobot is able to comply with its best execution

¹⁴³ Richard Kastelein, *What Initial Coin Offerings Are and Why VC Firms Care*, HARVARD BUSINESS REVIEW (Mar. 24, 2017), <https://hbr.org/2017/03/what-initial-coin-offerings-are-and-why-vc-firms-care>.

¹⁴⁴ For example, several cryptocurrencies such as Ether, Monero and NEM increased in value by 2,000% in 2017-18,¹⁴⁴ and Litecoin more than the 900% in 2017-18. See COINBASE, <https://www.coinbase.com/> (price at July 3, 2017).

¹⁴⁵ Press Release, deBanked, Introducing LendingRobot Series: One-Stop Investing in Alternative Lending (Jan. 26, 2017), <http://debanked.com/2017/01/introducing-lendingrobot-series-one-stop-investing-in-alternative-lending/>; Cummings, *supra* note 82.

¹⁴⁶ Press Release, deBanked, *supra* note 145; Cummings, *supra* note 82.

obligations as well as locate and audit past trades. The technology helps the firm conduct investigations, but it also facilitates reporting to the SEC.

Several key benefits are associated with the introduction of blockchain technology in private investment funds' back-office administrative processes and compliance. By automatically recording all transactions in a given private investment fund along with any documentation or information that is associated with a given transaction, blockchain technology reduces the otherwise significant costs associated with human oversight in recording, organizing, and maintaining investment fund data and records. Blockchain technology also creates a verified marketplace and provides market participants with reliable and fully transparent data on market transactions. The technology reduces the need for information exchange among parties because all transactions are fully recorded and transparent. Blockchain increases security because transactions are recorded in an immutable database that ensures the validity of data and removes expensive security procedures and labor-intensive data maintenance while reducing the need for a paper trail. Overall, the technology allows for a significant simplification of transactions and enormous increases in efficiency and speed of private investment fund transactions while providing significant security improvements.

Several concrete examples illustrate the cost savings and compliance opportunities of technology. Most prominently, 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.¹⁴⁷ 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 by simplifying the complex and labor-intensive transactions in the private equity market.¹⁴⁸ More specifically, unlike the current deal practice in private equity, which requires parties to reconcile multiple 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.¹⁴⁹

6. *Competitive Pressure*

The use of emerging technology increases the competitive pressure in the private investment fund industry. 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

¹⁴⁷ See Press Release, IBM, Northern Trust and IBM Pioneer Use of Blockchain Technology to Help Transform Private Equity Administration (Feb. 22, 2017), <http://www-03.ibm.com/press/us/en/pressrelease/51655.wss>.

¹⁴⁸ See *Id.*

¹⁴⁹ See *Id.*

finance directly contribute to that disintermediation and facilitate the accelerating evolution of the blockchain infrastructure in finance.

The competitive pressure in the private investment fund industry increases through operational and business efficiencies gained by those funds that implement the technology. 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.

IV. Conclusion

The proliferation of emerging technologies their prominent applications in the hedge fund industry illustrate the seismic technology-driven shift in the private investment fund industry. The book chapter has illustrated that the rise of blockchain applications in private investment funds already has an impact on the industry's front office and investment functions, in the securing of crypto assets, but

also in private investment fund managers' attempts to satisfy the growth expectation of clients. As the industry continues to evolve in the blockchain realm, more change is inevitable. Legacy infrastructure upgrades via blockchain technology may only be a first step towards crypto integration and evolution via the private investment fund industry. Regulatory guidance will be essential to ensuring the continuing evolution and blockchain integration for the private investment fund industry.