Cryptocurrency – An Institutional Investor Perspective

Date and Time: Friday, November 16, 2018, 2:00 - 3:00 PM EST
Presented by: Institutional Investors Committee
Co-sponsors: Commercial Finance Committee
Federal Regulation of Securities Committee

Program Co-Chairs: Jody Shaw, Deputy Counsel, Office of the Attorney General, Maryland State Retirement and Pension System
Jonathan Cardenas, Associate, Crowell & Moring LLP and Fellow, Stanford-Vienna Transatlantic Technology Law Forum

Panelists: Jim Liew, Assistant Professor of Finance, Johns Hopkins Carey Business School
Jenny E. Cieplak, Counsel, Crowell & Moring LLP
Marlon Q. Paz, Seward & Kissel LLP
Mary C. (Molly) Moynihan, Partner, Perkins Coie LLP
Andrew J. (Buddy) Donohue, Of Counsel, Shearman & Sterling LLP

Moderator: Jonathan Cardenas, Associate, Crowell & Moring LLP and Fellow, Stanford-Vienna Transatlantic Technology Law Forum

Program Description: Panelists will provide an overview of cryptocurrency investments, fund management, and regulation, focusing on the perspective of institutional investors considering investments in crypto assets or related investment vehicles. Topics will also include idiosyncratic opportunities and risks associated with investments in crypto assets.
Cryptocurrency – An Institutional Investor Perspective

Program Materials

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Primary Materials

2) Jonathan Cardenas, “Crypto Asset Investment Funds: An Overview of the Ecosystem”

3) Jim Kyung-Soo Liew, “The Case for Bitcoin for Institutional Investors: Bubble Investing or Fundamentally Sound?”

4) Jenny E. Cieplak, “Cryptocurrency Investments for Institutional Investors: Commodities and AML Regulation”

5) Marlon Q. Paz, “Cryptocurrency - An Institutional Investor Perspective”

Secondary Materials

6) Jose Arrieta and Jim Kyung-Soo Liew, Swensen, Pelé, and the Blockchain, Special Edition of Journal of Alternative Investments on ICOs (October 7th, 2018)


9) Jim Kyung-Soo Liew, Richard Ziyuan Li and Tamas Budavari, Crypto-Currency Investing Examined, April 2018


11) Crypto Fund Research, Cryptocurrency Investment Fund Industry Overview, July 2018

12) Molly Moynihan and Dana Syracuse, Blockchain, Tokens, and Mutual Funds — We’re Not There Yet, The Investment Lawyer, Vol. 25, No. 7, July 2018

Cryptocurrency – An Institutional Investor Perspective

Panelist Biographies

Jim Kyung-Soo Liew, PhD
Assistant Professor
Johns Hopkins Carey Business School
Baltimore, Maryland

Dr. Jim Kyung-Soo Liew is an Assistant Professor of Finance at Johns Hopkins Carey Business School and revels in pushing the boundaries of financial knowledge and product development both as an academic and FinTech Data Scientist. He has published pioneering research in the intersection of social media big data and financial markets.

He currently teaches "Big Data Machine Learning," "Advanced Hedge Fund Strategies," and "Leading Entrepreneurship and Innovation" at the Johns Hopkins Carey Business School. Additionally, he serves as the Chairman of the Johns Hopkins Innovation Factory and has received the Dean’s Award for Faculty Excellence 2015-2017. He also serves on the Editorial Board of Journal of Portfolio Management and co-authored the most read Invited Editorial "iGDP?".

He owns and operates SoKat Consulting, LLC (www.SoKat.co). SoKat creates world-class Machine Learning / AI products and services primarily servicing large hedge funds, government agencies, academic institutions and select-startups. SoKat unlocks the hidden value of data through thoughtful and creative solutions, comprising of actionable business intelligence, transparent data analytics, and bold predictive modeling.

Previously, Jim has been with the Carlyle Asset Management Group, Campbell and Company, and Morgan Stanley. He holds a BA in Mathematics from the University of Chicago and a Ph.D. in Finance from Columbia University.

He currently lives just outside of Baltimore with his wife and two daughters, who he plans to raise as the next generation disruptors.

Honors & Distinctions

- Editorial Advisory Board Journal of Portfolio Management
- Chairman of NYU Stern Hedge Fund Association
- Outstanding Teaching Assistant Award, Columbia Business School, 1996

Selected Publications

• “Is It Possible to OD on Alpha?,” Kakushadze, Z., and Liew, J., Journal of Alternative Investing, Fall 2015.
Jenny E. Cieplak
Counsel
Crowell & Moring LLP
Washington, D.C.

Jenny E. Cieplak focuses her practice on technology transactions, in particular FinTech and the financial services industry. Her experience includes work on the creation, governance, and sale of electronic trading platforms, exchanges, swap execution facilities, clearinghouses, and data repositories. She provides her clients with a unique combination of skills based on her knowledge of technology and her experience with collaborative arrangements between IP creators and users, especially in the financial industry.

Technology Transactions and Counseling

Ms. Cieplak provides counsel to clients on technology transactions and IP portfolio management, advising on all aspects of IP creation, protection, licensing, and sales. Ms. Cieplak structures and drafts IP agreements that are key to a company’s lifecycle, from procurement, development, licensing, and hosting agreements to and M&A and similar exit transactions. She advises clients on collaborative development arrangements, including joint development agreements, use of open source technologies, and joint ventures. Her practice also includes management of the IP and technology aspects of mergers and acquisitions, financings, capital markets, and other corporate transactions. Ms. Cieplak also counsels clients on the implementation of new technologies such as blockchain and distributed ledgers, and the development of innovative products such as virtual currencies and blockchain-based assets.

Joint Ventures, M&A, and Strategic Investments

Much of Ms. Cieplak’s practice focuses on arrangements between commercial users of technology, such as large financial institutions, and providers of technology – not only in licensing and services arrangements but also in developing collaborative relationships between technology users and technology providers, including investment and governance arrangements. Ms. Cieplak is experienced in the creation and governance of complex joint ventures, advising on matters such as entity formation, ownership structure, corporate governance, intellectual property ownership and use, staffing approaches, and exit strategies. She also represents clients in connection with mergers and acquisitions and strategic investments, managing the diligence process, structuring transactions, and drafting and negotiating documents ranging from early-stage investments in startup companies to public company acquisitions.

Derivatives Regulation

Ms. Cieplak provides regulatory advice to clients in the financial services industry, particularly in relation to regulation of the OTC derivatives markets. Ms. Cieplak has advised trading platforms, swap dealers, major swap participants, and end users regarding the CFTC’s regulatory regime, including with respect to registration issues, reporting, documentation, and internal and external business conduct requirements.
Representative matters that Ms. Cieplak has handled include:

- Represented R3 in connection with creating its enterprise licensing structure and creating a framework for the operation of business networks using its blockchain-inspired technology.
- Represented R3 and a consortium of global financial institutions in their initial collaborative exploration of distributed ledger and blockchain technology, followed by representation of R3 in the largest ever investment in distributed ledger technology from 44 global institutions, including SBI Group, Bank of America Merrill Lynch, HSBC, Intel, Temasek, ING, Banco Bradesco, Itaú Unibanco, Natixis, Barclays, UBS, and Wells Fargo.
- Outside corporate counsel to FXSpotStream LLC, a multibank FX price aggregation service in which Bank of America Merrill Lynch, BNP Paribas, Citi, Commerzbank, Credit Suisse, Goldman Sachs, HSBC, J.P. Morgan, Morgan Stanley, and UBS act as liquidity providers.
- Represented Signature Group Holdings, Inc. in connection with a $110 million senior secured asset-based revolving credit facility and a €50 million receivables factoring facility, used to finance Signature’s acquisition of the world's largest independent aluminum recycler.
- Represented borrowers and lenders in various financing transactions associated with Alaska's oil and gas production tax credits.
- Represented thirteen leading investment banks in a prepaid fee arrangement with a third party to fund the build-out of a swap data repository, a new service mandated by Dodd-Frank.
- Represented eight leading commercial and investment banks in their investment in a data exchange, and accompanying restructuring regarding privacy and third party technology service provider arrangements.
- Represented ICAP and its wholly-owned subsidiary Traiana in the sale of an equity stake in Traiana to Bank of America Merrill Lynch, Barclays, Citi, Deutsche Bank, J.P. Morgan, Nomura, and Royal Bank of Scotland.
- Outside corporate counsel to The Green Exchange, a designated contract market that was a consortium among the Chicago Mercantile Exchange, Morgan Stanley, Goldman Sachs, J.P. Morgan, and other major market participants, including in connection with the sale of The Green Exchange to the Chicago Mercantile Exchange.
- Represented Goldman Sachs in its joining ELX Futures, L.P., a new fully electronic futures exchange, as a founding partner.
- Represented ICAP in its investment in and eventual acquisition of Enso Financial Management LLP, a provider of innovative portfolio reporting and data analytics services for hedge funds and asset managers.

Ms. Cieplak received a Bachelor's of Music, with high honors, in violin performance from The Catholic University of America and a J.D., with honors, from the Georgetown University Law Center. During law school, she served as a member of the Georgetown Journal of Legal Ethics.
Marlon Q. Paz
Partner
Seward & Kissel LLP
Washington, D.C.

Marlon Paz, a partner at Seward & Kissel LLP, regularly advises broker-dealers and other financial services firms in matters related to securities regulation, SEC and FINRA enforcement, internal investigations and examinations, compliance, and white collar crime.

Marlon has substantive expertise with federal securities laws, with particular expertise with issues related to the business of broker-dealers. Marlon served in senior positions during his six-year tenure at the Securities and Exchange Commission, where he played a key role in developing the SEC’s positions on many important regulatory and enforcement matters. Marlon was part of the team dealing with the financial crisis and has worked on a number of regulatory measures, including fraud, anti-manipulation, credit ratings agency reform, the respective fiduciary duties of broker-dealers and investment advisers, hedge funds, and enhancements to capital and financial controls over broker-dealers. He handled a number of regulatory actions involving foreign financial institutions. During his tenure at the SEC, Marlon worked on more than 100 enforcement matters involving complex securities issues. He worked closely with senior members of the SEC on issues related to the oversight of the securities markets, broker-dealers, clearance and settlement, transfer agents, and credit ratings agencies.

Marlon has spent several years in private practice, focusing on complex securities litigation, corporate and fiduciary litigation, and corporate finance matters. In addition, Marlon served as the Principal Integrity Officer of the Inter-American Development Bank, where he led a team of lawyers and investigators in the development, investigation and prosecution of fraud and corruption cases, and had oversight over compliance procedures relating to issues such as integrity due diligence, anti-money laundering, offshore financial centers, and the Office of Foreign Assets Control Specially Designated Nationals List.

Marlon currently serves as the General Counsel to the D.C. Bar and as the Chair of the Trading and Markets subcommittee of the Business Law Section of the American Bar Association. He has been recognized as one of the “100 Most Influential U.S. Hispanics” by Hispanic Business Magazine. He is a Past President of the Hispanic Bar Association of D.C. and a former National Vice-President of the Hispanic National Bar Association. He has been honored with the Leadership Award from the Hispanic National Bar Foundation and appointed an Ambassador by the American Bar Association Business Law Section.

Marlon is a member of the adjunct faculty of Georgetown University Law Center, where he teaches a course on the U.S. regulation of financial institutions and the securities markets and a course on international business litigation and federal practice. In addition, Marlon has been a frequent speaker on the federal securities laws, white collar criminal defense, and internal investigations.
Select Experience with SEC Releases and Commission Initiatives

- Status as broker-dealer and registration requirements, particularly **Rule 15a-6, Exemption of Certain Foreign Brokers or Dealers**, 73 FR 39182 (Jul. 8, 2008); Application of the Investment Advisers Act of 1940 to broker-dealers.
- Interpretive/no action request under Regulation ATS.
- Short sale regulation and disclosure of short selling activity by money managers, such as Regulation SHO; **Rule 10a-3T and Form SH**, 73 FR 61678 (Oct. 17, 2008); short sale price tests. Regulation M – Anti-manipulation Rules Concerning Securities Offerings, **Rule 105 – Short Selling In Connection With A Public Offering**, 71 FR 75002 (Dec. 13, 2006).
- Clearance and settlement – **The Roundtable on Proxy Voting Mechanics**.
- Broker-dealer financial responsibility issues – Rule 15c3-1 (net capital) and Rule 15c3-3 (customer protection); Rules 17h-1T and 17h-2T (risk assessment); prime brokerage; PCAOB registration of broker-dealer auditors.

Select Representative Litigation Matters

- SEC enforcement action against certain registered broker-dealers and their executives charging fraud for failure to provide best execution.
- SEC enforcement action against large fund manager and its senior executives for improperly accepting travel, entertainment, and other gifts paid for by outside broker-dealers courting trading business generated by the money manager on behalf of mutual funds.
- SEC enforcement action against British trader charged with insider trading in United States using derivatives. SEC enforcement action involving backdating of stock option grants. SEC enforcement action against a hedge fund for market manipulation.
- SEC enforcement actions against a life insurance company and its senior vice president for their roles in a late trading and market timing scheme.
- SEC enforcement action against certain financial professionals engaged in a Ponzi scheme. SEC enforcement action against publicly traded Mexican media company and its senior executive involving fraud, books and record violations and internal control deficiencies.
• SEC enforcement action against trader for fraudulent trading scheme involving inverse floating rate collateralized mortgage obligations.
• SEC enforcement action against broker-dealer for its involvement in fraud and unregistered offering of securities.
• Represented public pension fund in class action litigation alleging fraud by large publicly traded telecommunications company.
• Represented hedge fund in class action securities litigation alleging fraud by a large Italian dairy company.

Professional Affiliations

• American Bar Association, Business Law Section, Federal Securities Regulation Committee, (Chair, Trading and Markets Subcommittee); International Business Law Committee (Chair, International Banking and Finance Subcommittee).
• American Bar Foundation (Fellow)
• Hispanic National Bar Foundation (former Director)
• Hispanic Bar Association of the District of Columbia (Past President)
• Delaware Bar Foundation (Former Director)
• Multicultural Judges and Lawyers, Delaware Bar Association (Former Vice-Chair)
• Hispanic National Bar Association (Former National Vice-President)

Honors and Awards

• Recognized as one of the Top 20 Latino Leaders Under 40, Latino Leaders Magazine (2010)
• Named one of the 100 Most Influential U.S. Hispanics, Hispanic Business Magazine (2008)
• Rising Legal Star, Hispanic Bar Association of the District of Columbia (2006)
• Ambassador, American Bar Association, Section of Business Law (2006)
• Regional President of the Year Award, Hispanic National Bar Association (2006)
Mary C. (Molly) Moynihan
Partner
Perkins Coie LLP
Washington, D.C.

Mary C. (Molly) Moynihan focuses her practice on investment management clients including: registered open-end investment companies, registered investment advisers, independent directors of fund complexes and private funds.

Molly serves as fund counsel to a major fund complex, in which capacity she regularly counsels on fund formation, regulatory requirements, and compliance. She has in-depth experience with risk management issues associated with portfolio management and valuation and has developed and provided counsel on adviser and fund compliance and risk management programs. She has also provided counsel in connection with mergers and acquisitions of affiliated and unaffiliated investment companies and investment advisers, affiliated transactions and distribution issues. Her representation includes funds serving as underlying investment vehicles for variable insurance products.

Molly also represents the independent directors of several mutual fund complexes. She regularly counsels registered investment advisers to private funds, including hedge funds and private equity funds. She has served as counsel to a series of investment vehicles for highly compensated employees and partners of a major international investment bank. She has worked on the formation of private funds and has extensive experience in the development of off-shore investment vehicles.

Molly served for six years as general counsel to a multi-billion-dollar registered investment company, whose primary investors were large public and ERISA-regulated pension plans where she handled the company's regulatory filings and compliance and acted as liaison to the board of trustees. In addition, she was responsible for structuring issues related to mortgage-backed securities and real estate transactions and advice relating to the funds pension plan investors.

Molly is also experienced in the emerging area of blockchain and fintech as related to the investment management area. Molly regularly lectures on the role of independent directors, risk management and current regulatory issues faced by the industry.

Professional Leadership

- Foundation of the National Archives, Board of Directors, Member
- American Bar Association, Business Law Section, Sub-Committee on Investment Companies and Investment Advisers

Bar and Court Admissions

- District of Columbia
- New York
Andrew J. (Buddy) Donohue  
Of Counsel  
Shearman & Sterling LLP  
New York, NY

Andrew J. Donohue, widely known as Buddy Donohue, is Of Counsel in the Investment Funds practice.

Buddy has over 40 years of experience in both senior government and private sector roles, having most recently served as SEC Chief of Staff to Chair Mary Jo White (2015-2017). He is best known for his service as Director of the SEC’s Division of Investment Management (2006-2010) (where he was effectively the most senior regulator for the U.S. funds industry), Global General Counsel at Merrill Lynch Investment Managers (2003-2006), Executive Vice President and General Counsel at OppenheimerFunds Inc. (1991 – 2001) and Investment Company General Counsel at Goldman Sachs (2012-2015).

Buddy has been an officer, director and counsel for numerous investment advisers, broker-dealers, commodity trading advisers, transfer agents and insurance companies, and has served on the boards of business development companies, registered open-end funds, closed-end funds, exchange traded funds, Cayman funds and Dublin- and Luxembourg-based UCITS. He has also served as Chairman of the ABA Investment Companies and Investment Advisers Subcommittee, and as an Editor of the ABA Guide for Fund Directors.

Buddy is an acknowledged and highly respected thought leader within the industry, having published, lectured and delivered talks on a variety of investment fund topics. He currently is also an Adjunct Professor teaching investment management law at Brooklyn Law School.

**Professional Activities**

- Adjunct Professor, Brooklyn Law School
- Independent Director, Oppenheimer Funds (Denver Board)
- Member, American Bar Association, Investment Companies and Investment Advisers Subcommittee
- Member, American Bar Association, Hedge Fund Subcommittee
- Member, Federal Bar Association, Executive Council
- Member, New York State Bar Association, New Jersey State Bar Association, New York County Lawyers Association and Association of the Bar of the City of New York
- Member, Association of Securities & Exchange Commission Alumni (ASECA)
- Member, Board of the Mutual Fund Directors Forum

**Awards & Accolades**

- Recipient of *Fund Directions* “2011 Lifetime Achievement Award”
- Recipient of *Strategic Insight’s* “Visionary of the Modern Mutual Fund - 2011 Award”
- Prominent industry thought-leader, having participated as a speaker or panelist at numerous industry conferences, including those sponsored by American Bar Association, Investment Company Institute, Independent Directors Council, Mutual Fund Directors Forum & Practicing Law Institute
Jonathan Cardenas is a corporate associate in Crowell & Moring’s Washington, D.C. office.

Prior to joining Crowell & Moring, Jonathan served as a post-doctoral research fellow with the Information Society Project at Yale Law School. Jonathan received a J.D. from New York University School of Law, where he was a Jacobson Leadership Program in Law & Business Scholar, and where he served as managing editor of the NYU Journal of Law & Business. He received an M.Phil. in international relations from the University of Cambridge and a B.A. in political science, summa cum laude, from the University of Pennsylvania.

**Affiliations**

Admitted to practice: District of Columbia, Florida, New York

**Professional Activities and Memberships**

- Chair, Financial Services Technology Subcommittee, ABA Business Law Section Commercial Finance Committee
- Fellow, Stanford-Vienna Transatlantic Technology Law Forum

**Speeches & Presentations**


**Publications**

Cryptocurrency –
An Institutional Investor Perspective

ABA Business Law Section Fall Meeting
November 15, 2018
Washington, D.C.

Presented by: Institutional Investors Committee
Co-sponsors: Commercial Finance Committee
Federal Regulation of Securities Committee

Panelists:
Jim Liew
Assistant Professor of Finance, Johns Hopkins Carey Business School
Jenny E. Cieplak
Counsel, Crowell & Moring LLP
Marlon Q. Paz
Partner, Seward & Kissel LLP
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Of Counsel, Shearman & Sterling LLP

Moderator: Jonathan Cardenas
Associate, Crowell & Moring LLP

Program Co-Chair: Jody Shaw
Deputy Counsel, Maryland State Retirement and Pension System
Crypto Asset Investment Funds: An Overview of the Ecosystem

Cryptocurrency – An Institutional Investor Perspective
ABA Business Law Section Fall Meeting
November 15, 2018
Washington, D.C.

Jonathan Cardenas
Associate, Crowell & Moring LLP
The International Comparative Legal Guide to Fintech 2018

The 2018 Guide is accessible for free at iclg.com without any sign-up or registration restriction. The book is also available to order in hard copy via the website.

https://iclg.com/practice-areas/fintech
Global Legal Insights:
Blockchain & Cryptocurrency Regulation 2019

The 2019 Edition is accessible for free at iclg.com without any sign-up or registration restriction. The book is also available to order in hard copy via the website.

Crypto Asset Fund Market Overview: Market Size

Growth of Crypto Assets Under Management
Millions (USD)

Source: Crypto Fund Research
Crypto Asset Fund Market Overview: Fund Investment Strategies & Estimated AUM

Source: Autonomous NEXT
Crypto Hedge Funds and Venture Capital Funds

Source: Crypto Fund Research
Crypto as Institutional Asset Class?

Update: Bitcoin, Cryptocurrencies and Blockchain

James Faucette, Betsy Graseck, Sheena Shah
October 31, 2018

Morgan Stanley does and seeks to do business with companies covered in Morgan Stanley Research. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of Morgan Stanley Research. Investors should consider Morgan Stanley Research as only a single factor in making their investment decision. For analyst certification and other important disclosures, refer to the Disclosure Section, located at the end of this report.

Available at: https://www.slideshare.net/loukerner2/morgan-stanley-update-bitcoin-cryptocurrencies-and-blockchain
Crypto as Institutional Asset Class?

- **Morgan Stanley Report: “Update: Bitcoin, Cryptocurrencies and Blockchain” (October 31, 2018)**

  - **Current Thesis:** “Bitcoin & Cryptos as new institutional investment class (2017-Present)”

  - But reporting that **three major obstacles** are preventing large scale institutional investment in crypto space:
    - 1) Underdeveloped regulation, creating reputational risk for asset managers
    - 2) Lack of custodial solutions to hold cryptocurrencies and private keys
    - 3) Lack of large financial institutions and asset managers currently invested
Crypto as Institutional Asset Class?

- **Recent Developments**
  - 1) Regulation is in the works
    - Switzerland, European Union, Japan, Singapore, U.S., UK and more
  - 2) Custodial solutions are being developed
    - Citibank Digital Asset Receipt
    - Fidelity Digital Asset Services
    - Coinbase Custody Trust Company LLC
  - 3) Major players are currently invested
    - Goldman Sachs – $58.5 M Series B financing round of BitGo (October 2018) *(Source: Coin Telegraph)*
    - HSBC – $36 M Series B financing round of Axoni (November 2018) *(Source: PR Newswire)*
    - Yale University – Reportedly invested in a16z and Paradigm crypto fund *(Sources: CNBC, CoinDesk)*
Questions?

Jonathan Cardenas

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Washington, DC 20004-2595
jcardenas@crowell.com
+1 202.624.2647
The Case for Bitcoin for Institutional Investors: Bubble Investing or Fundamentally Sound?

UPDATED

By Jim Kyung-Soo Liew, Ph.D.

November 16th, 2018

Contents

• Motivation
• Results
• Updated Results
• Conclusions
Motivation
Motivation

Levar Hewlett, MSF Maryland State Retirement and Pension System

Should Pension Funds Invest in Bitcoin?

Researchers from a consulting firm and a pension fund make the case for institutional investments in cryptocurrencies.

January 02, 2018

A traditional portfolio of stocks and bonds versus a portfolio with a 2 percent allocation to Bitcoin. (Source: Jim Liew & Levar Hewlett)
Results
Results

• Empirical analysis of Bitcoin (BTC) from the vantage of an Institutional Investor
• Data from August 2010 to October 2017 (87 obs.)
• Findings:
  • BTC provides unique diversification benefits
  • BTC is very volatile, but the Sharpe Ratio of 1.176 attractive
  • Optimal allocation to BTC => 1.3%

➢ Controversial -- Empirical evidence suggests that Institutional Investors are under allocated to BTC
Updated Results
Exhibit 1: Historical Price of Bitcoins
Exhibit 1: Historical Price of Bitcoins

Aug-2010 to Oct-2017 (87 Monthly Observations)

<table>
<thead>
<tr>
<th>Candidates</th>
<th>Ann.Ret</th>
<th>Ann.Std</th>
<th>Sharpe (Rf=1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTC</td>
<td>298%</td>
<td>253%</td>
<td>1.176</td>
</tr>
<tr>
<td>US Large Stock</td>
<td>14.5%</td>
<td>11.3%</td>
<td>1.197</td>
</tr>
<tr>
<td>US Small Stock</td>
<td>15.4%</td>
<td>16.4%</td>
<td>0.873</td>
</tr>
<tr>
<td>US 30 Day TBill</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.749</td>
</tr>
<tr>
<td>US LT Corp</td>
<td>7.2%</td>
<td>8.3%</td>
<td>0.466</td>
</tr>
<tr>
<td>US LT Govt</td>
<td>5.8%</td>
<td>10.3%</td>
<td>0.361</td>
</tr>
<tr>
<td>US IT Govt</td>
<td>2.1%</td>
<td>3.0%</td>
<td>0.784</td>
</tr>
<tr>
<td>FTSE NAREIT</td>
<td>12.2%</td>
<td>14.3%</td>
<td>0.924</td>
</tr>
<tr>
<td>CS Hedge Fund</td>
<td>4.6%</td>
<td>3.9%</td>
<td></td>
</tr>
</tbody>
</table>

May-2013 to Oct-2018 (66 Monthly Observations)

<table>
<thead>
<tr>
<th>Candidates</th>
<th>Ann.Ret</th>
<th>Ann.Std</th>
<th>Sharpe (Rf=1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTC</td>
<td>151.3%</td>
<td>207.7%</td>
<td>0.724</td>
</tr>
<tr>
<td>US Large Stock</td>
<td>12.2%</td>
<td>10.1%</td>
<td>1.111</td>
</tr>
<tr>
<td>US 30 Day Tbill</td>
<td>0.4%</td>
<td>0.2%</td>
<td>-0.084</td>
</tr>
<tr>
<td>US IT Govt</td>
<td>0.8%</td>
<td>2.9%</td>
<td></td>
</tr>
</tbody>
</table>
Mean-Variance Optimization

\[
\text{Max } 
\gamma_p = \frac{R_p - R_f}{\sigma_p}
\]

Subject to

\[
R_p = \sum_{i=1}^{N} \omega_i R_i, \quad \sum_{i=1}^{N} \omega_i = 1, \omega_i \geq 0 \forall i
\]

With the following:

\(\gamma_p\) = the Sharpe Ratio of portfolio \(p\);
\(R_p\) = the expected rate of return on portfolio \(p\);
\(R_f\) = the risk-free rate of return;
\(\sigma_p\) = the standard deviation of monthly rates of return on portfolio \(p\);
\(\omega_p\) = the weight on investment \(i\) in portfolio \(p\); and
\(R_i\) = the expected rate of return on asset \(i\).
<table>
<thead>
<tr>
<th>Investments</th>
<th>Exclude BTC</th>
<th>Include BTC</th>
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<tbody>
<tr>
<td>BTC</td>
<td>44.29%</td>
<td>45.30%</td>
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<tr>
<td>US Large Stock</td>
<td>8.51%</td>
<td>9.61%</td>
</tr>
<tr>
<td>US Small Stock</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>US LT Corp</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>US LT Govt</td>
<td>47.19%</td>
<td>49.88%</td>
</tr>
<tr>
<td>US IT Govt</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>FTSE NAREIT</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>CS Hedge Fund</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>CS Managed Futures</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>US TIPS</td>
<td>0.00%</td>
<td>0.00%</td>
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<tr>
<td>MSCI EAFE</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>S&amp;P GSCI</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Gold</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
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<table>
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<tr>
<th>Sum</th>
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</thead>
<tbody>
<tr>
<td>Ann.Ret</td>
<td>10.5%</td>
<td>13.9%</td>
</tr>
<tr>
<td>Ann.Std</td>
<td>5.4%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Sharpe Ratio (Rf=1%)</td>
<td>1.76</td>
<td>2.03</td>
</tr>
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### Optimal Allocations

<table>
<thead>
<tr>
<th>Investments</th>
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<th>(2) Include BTC</th>
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<tr>
<td>BTC</td>
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<td>1.30%</td>
</tr>
<tr>
<td>US Large Stock</td>
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<tr>
<td>FTSE NAREIT</td>
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</tr>
<tr>
<td>CS Hedge Fund</td>
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<tr>
<td>CS Managed Futures</td>
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<td>US TIPS</td>
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<tr>
<td>MSCI EAFE</td>
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<tr>
<td>S&amp;P GSCI</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Gold</td>
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<td>0.00%</td>
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</table>

| Sum                | 1.0             | 1.0             |

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<tr>
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</thead>
<tbody>
<tr>
<td>Ann.Ret</td>
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<td>13.9%</td>
</tr>
<tr>
<td>Ann.Std</td>
<td>5.4%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Sharpe Ratio (Rf=1%)</td>
<td>1.76</td>
<td>2.03</td>
</tr>
<tr>
<td>Sum</td>
<td>1.0</td>
<td>1.0</td>
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Include BTC

<table>
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<td>BTC</td>
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<td>US Large Stock</td>
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<td>US IT Govt</td>
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| Sum                | 1.0          |

<table>
<thead>
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<th></th>
<th>Include BTC</th>
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<tr>
<td>Ann.Ret</td>
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</tr>
<tr>
<td>Ann.Std</td>
<td>8.4%</td>
</tr>
<tr>
<td>Sharpe Ratio (Rf=1%)</td>
<td>1.25</td>
</tr>
</tbody>
</table>
Conclusions

• Results robust to the most current period from May-2013 to Oct-2018 (66 obs.)
• Optimal allocation in the 1-2% range, even with BTC’s pull-back in Q1 of 2018
• Observation that Institutional Investors are under-allocated remains intact
• Implications => certain cryptos and tokenized assets investment will be important for Institutional Investors
Questions?

Thanks again and please stay in touch!

@ProJimLiew
Email: kliew1@jhu.edu

https://www.EJEN.net/
Cryptocurrency Investments for Institutional Investors

Commodities and AML Regulation

Jenny Cieplak, Crowell & Moring LLP
The U.S. Regulatory Landscape

- If a cryptocurrency isn’t a security, it falls into the broad category of “commodities” which are regulated by the CFTC (with some important limitations).
  - A “commodity” is basically everything that isn’t a security (except onions...)
  - Includes things like interest rates, FX, even the weather...
  - *CFTC v. My Big Coin Pay* – court specifically found that cryptocurrencies are commodities even if a particular cryptocurrency doesn’t have its own futures contract
- However, this doesn’t mean that the CFTC is the only regulator with authority.
- FinCEN, the Department of Justice, and state regulators have all expressed concern regarding the cryptocurrency markets and have taken regulatory steps. These regulators have authority over cryptocurrencies that are securities and that are commodities.
CFTC Jurisdiction

• Most of the CFTC’s regulatory authority relates to options, derivatives and futures – contracts in commodities that have a future delivery component. These contracts can be simple (an agreement by X to purchase 10 BTC from Y in one month’s time at a set price) or extremely complex.

• Standardized contracts are traded on futures exchanges or swap execution facilities, but derivatives can also be traded over-the-counter.

• Derivatives contracts where one party is not an “eligible contract participant” must be traded on a futures exchange. Non-eligible contract participants cannot participate in swap transactions.

The CFTC’s authority is mostly over futures and swaps. Futures are standardized contracts traded on designated contract markets. Swaps can be more bespoke and may be traded on swap execution facilities or OTC.
Who is subject to CFTC supervision?

- Exchanges where commodity futures, options or derivatives are traded must register with the CFTC as designated contract markets or swap execution facilities.
- Dealers in commodity contracts with non-eligible contract participants must register as futures commission merchants.
- Dealers in commodity contracts with only eligible contract participants, as well as other highly significant market participants, must register as swap dealers or major swap participants.
- Operators of funds formed for the purpose of investing in commodity contracts must register as commodity pool operators, and the pools themselves must be registered.
- Persons providing tailored investment advice related to commodity contracts must register as commodity trading advisers (note that providing general advice not tailored to specific investors does not require registration).
- All of the foregoing must meet capital, risk and compliance requirements.
CFTC Jurisdiction Over Non-Derivatives

• Where there is not a “future delivery” component to a commodity transaction (commonly known as a “spot” contract), the CFTC’s jurisdiction is much more limited.
  • No authority to require spot contracts to be traded on exchanges subject to CFTC supervision
  • No authority to require specific disclosure
  • No authority to limit who can invest
• So, what exactly is a “spot” transaction?
  • Generally – a transaction that results in “actual delivery” within 28 days (or 2 days for FX – which does not include cryptocurrency)
  • The definition of “actual delivery” is open to interpretation – the CFTC issued proposed guidance that caused an uproar in the cryptocurrency community, as it excluded methods of delivery such as commingled wallets held by an exchange
  • This guidance was issued in the context of what constitutes a “leveraged” transaction, but has broader implications
CFTC Jurisdiction Over Non-Derivatives

• The CFTC has asserted, and the cryptocurrency commodity has mostly accepted, that the CFTC has the authority to prevent fraud or manipulation with respect to spot contracts. This was confirmed by the Eastern District of New York and the District Court of Massachusetts.

• However, based on a very detailed reading of the Commodity Exchange Act, at least one judge has agreed that the CFTC only has authority to prevent activity that constitutes both fraud AND manipulation...
  • *CFTC v. Monex* (Central District of California) – judge did a detailed legislative history reading and concluded that with respect to spot markets, the CFTC must prove both fraud and manipulation
  • The CFTC has appealed
  • Both the EDNY and D. Mass courts rejected this analysis
FinCEN Jurisdiction

- FinCEN’s role differs from the CFTC – its role is prevention and tracking of criminal activity, while the CFTC’s role is geared more toward investor protection.
- FinCEN issued guidance in 2013 stating that “administrators” or “exchangers” of “convertible virtual currency” must register as money transmitters.
- “Convertible virtual currency” is cryptocurrency that has an equivalent value in real currency or can act as a substitute for real currency – almost any cryptocurrency could fall into this category.

FinCEN guidance promulgated broad authority to regulate crypto issuers and service providers. This authority does not appear to have been challenged in court, perhaps because it has been only sporadically exercised.
Administrators and Exchangers

• Administrator: a person engaged as a business in issuing (putting into circulation) a virtual currency, and who has the authority to redeem (to withdraw from circulation) such virtual currency. An administrator is an MSB if it (1) accepts and transmits a convertible virtual currency or (2) buys or sells convertible virtual currency in exchange for currency of legal tender or another convertible virtual currency for any reason.

• Exchanger: a person engaged as a business in the exchange of virtual currency for real currency, funds or other virtual currency. An exchanger must register with FinCEN if it (1) accepts and transmits a convertible virtual currency or (2) buys or sells convertible virtual currency in exchange for currency of legal tender or another convertible virtual currency for any reason.

• So how does this impact:
  • Cryptocurrency funds?
  • Lenders?
Implications of FinCEN registration

- Registrants must have a written AML program and have transaction monitoring systems in place.

- Must file suspicious activity reports when a transaction:
  - Involves funds derived from illegal activity or is intended or conducted in order to hide or disguise funds or assets derived from illegal activity,
  - Designed to evade the requirements of the Bank Secrecy Act, whether through structuring or other means, or
  - Serves no business or apparent lawful purpose, and the reporting business knows of no reasonable explanation for the transaction after examining all available facts.

- Must have customer due diligence program.

- BUT – even non-registrants should have some form of customer/third party diligence...

Sanctions rules apply to everyone.
State Jurisdiction

- NY Virtual Currency Regulation (“BitLicense”)
  - Similar to a banking charter for virtual currency businesses that are located in NY or interact with NY residents
  - Includes capital requirements, disclosure requirements, transaction monitoring...
  - Same standards are applicable to a broad spectrum of businesses that include – but are not limited to – exchanges, transmitters, issuers, and custodians
  - Entities chartered under the NY banking law are exempt – but not other banks
- Regulation of Virtual Currency Businesses Act (Uniform Law Commission)
  - Similar in scope to BitLicense, but a few additional exceptions

Many states are passing or considering virtual currency laws or regulations. Enforcement has been sporadic and regulators have exercised some discretion in enforcement.
Creating a National Regulatory Framework

- Registration and regulatory requirements remain a patchwork with duplicative coverage, potential gaps and potential overreach
  - State regulations are not preempted by federal law in many cases
- Proposals to bridge these gaps:
  - State MSB agreement – agreement to recognize each others’ money services business registrants (Georgia, Illinois, Kansas, Massachusetts, Tennessee, Texas and Washington so far)
  - OCC proposal for FinTech charters – would provide preemption over state registration requirements
TOPICS

• Opportunities to redefine clearance, settlement and custody of securities
• Securities Regulatory Oversight
• Issues for Investment Advisers
• Recent Enforcement Actions
• Questions
OPPORTUNITIES TO REDEFINE CLEARANCE, SETTLEMENT AND CUSTODY OF SECURITIES

BLOCKCHAIN
How Blockchain Works

1. A wants to send money to B
2. The transaction is represented online as a 'block'
3. The block is broadcast to every party in the network
4. Those in the network approve the transaction is valid
5. The money moves from A to B

Source: GAO, GAO-17-361
REGULATORY OVERSIGHT
SECURITIES LAW
“Yes, it would be wonderful if the regulators, you know, got into the 20th century, much less the 21st and we would be able to avoid some issues. I have to deal with the cards that have been dealt me and with that I’ll thank you for your time..”

Judge Raymond Dearie
Initial Coin Offerings (ICOs) have been used by startups and other parties to issue cryptographic tokens on a blockchain network to raise capital.

In September 2017, the U.S. Securities and Exchange Commission (SEC) made two key announcements in September of 2017.

- Cyber unit to target violations involving distributed ledger technology and ICOs as part of a new effort to fight cybercrime.
- Retail strategy task force that will develop proactive, targeted initiatives to identify misconduct impacting retail investors, including to pursue “misconduct perpetrated using the dark web,” where bitcoin and other cryptocurrencies are used to pay for illicit goods.
“I have yet to see an ICO that doesn’t have a sufficient number of hallmarks of a security . . . there is also a distinct lack of information about many online platforms that list and trade virtual coins or tokens offered and sold in ICOs.”

SEC Chairman Clayton | November 9, 2017
FIRST SEC CYBER UNIT CASE

- Dec. 2017 - SEC filed charges against a recidivist Quebec securities law violator, Dominic Lacroix, and his company, PlexCorps.
- Lacroix and PlexCorps marketed and sold securities called PlexCoin on the internet to investors in the U.S. and elsewhere, claiming that investments in PlexCoin would yield a 1,354 percent profit in less than 29 days.
- “The ICO for the PlexCoin Tokens was an illegal offering of securities because there was no registration statement filed or in effect during its offer and sale, and no applicable exemption from registration.”
Munchee Tokens

- Munched, Inc. halted its ICO after being contacted by the SEC, and agreed to an order in which the SEC found that its conduct constituted unregistered securities offers and sales.

- Munchee was seeking $15 million in capital to improve an existing iPhone app centered on restaurant meal reviews and create an “ecosystem” in which Munchee and others would buy and sell goods and services using the tokens. The company communicated through its website, a white paper, and other means that it would use the proceeds to create the ecosystem, including eventually paying users in tokens for writing food reviews and selling both advertising to restaurants and “in-app” purchases to app users in exchange for tokens.
ARE ICOs SECURITIES?

- To determine how traditional securities regulation applies to ICOs, the SEC will undoubtedly apply the four-pronged Howey Test, derived from the 1946 Supreme Court decision in SEC vs. W.J. Howey Co., which states that a security is an investment contract in which a person:
  - 1) invests their money;
  - 2) in a common enterprise;
  - 3) with an expectation of profits;
  - 4) based on the efforts of the promoter or a third party.

In order to be considered a security, an offering must meet all four prongs.
On July 25, 2017, the SEC provided guidance on its views of whether ICOs are securities when it released a Section 21(a) Report of Investigation on its findings regarding the token sale by The DAO.

In applying the *Howey* test, the SEC focused on whether the efforts of others were “the undeniably significant ones ... that affect the failure or success of the enterprise.”
ICO Being Marketed by Unregistered Broker-Dealers?

- If tokens are deemed securities, intermediaries such as token exchanges and promoters would likely need to comply with broker-dealer registration requirements.
- Section 15(a)(1) of the Exchange Act makes it unlawful for a person to “effect a transaction in securities” or “attempt to induce the purchase or sale of, any security” unless they are registered as a broker or dealer.
ICO OPERATING AS AN UNREGISTERED INVESTMENT ADVISER?

- Consider that a sponsor of a token offering may be deemed an investment adviser under the Investment Advisers Act of 1940 and subject to registration with the SEC or with one or more states as such.
- Section 203A of the Investment Advisors Act generally makes it unlawful for any “investment advisor, unless registered, to use any means of interstate commerce in its advisory business.”
  - Section 202(a)(11) defines “investment advisers” as persons who receive compensation for providing advice about securities as part of a regular business.
- Investment advice regarding certain ICOs.
RECOIN GROUP FOUNDATION, LLC


- Zaslavskiy, et al, were charged by the United States Department of Justice (DOJ) and by the United States Securities and Exchange Commission (SEC) with securities fraud in connection with several ICOs.
ISSUES FOR INVESTMENT ADVISERS
SEC’S STAFF LETTER ON CERTAIN ISSUES RELATED TO CRYPTOCURRENCY

On January 18, 2018, the staff of the Investment Management Division sent a letter to the Investment Company Institute (“ICI”) and the Securities Industry and Financial Markets Association (“SIFMA”) highlighting a number of investor protection issues regarding cryptocurrencies.

- Valuation
- Liquidity
- Custody
- Potential Manipulation and Other Risks
VALUATION AND LIQUIDITY

- Do advisers have the information necessary to adequately value cryptocurrencies or cryptocurrency-related products? How would advisers develop and implement policies and procedures to value, and in many cases “fair value,” cryptocurrency-related products?
- How would advisers’ accounting and valuation policies address the information related to “significant events” relevant to cryptocurrencies? What policies would an adviser implement to identify, and determine eligibility and acceptability for, newly created cryptocurrencies offered by promoters?
- How would differences among various types of cryptocurrencies impact advisers’ valuation and accounting policies? How would advisers consider the impact of market information and any potential manipulation in the underlying cryptocurrency markets on the determination of the settlement price of cryptocurrency futures?
- For advisers to funds, how would a fund classify the liquidity of cryptocurrencies and cryptocurrency-related products?
**Framing the Concerns**

<table>
<thead>
<tr>
<th>Exchange</th>
<th>Price at a given date</th>
<th>Location</th>
<th>Volume (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OKEx</td>
<td>$10,443.80</td>
<td>China</td>
<td>7.58%</td>
</tr>
<tr>
<td>Bitfinex</td>
<td>$10,424.00</td>
<td>Hong Kong SAR</td>
<td>6.66%</td>
</tr>
<tr>
<td>Binance</td>
<td>$10,949.10</td>
<td>Hong Kong SAR</td>
<td>4.87%</td>
</tr>
<tr>
<td>Upfit</td>
<td>$10,454.30</td>
<td>South Korea</td>
<td>3.41%</td>
</tr>
<tr>
<td>bitFlyer</td>
<td>$10,454.60</td>
<td>Japan</td>
<td>3.04%</td>
</tr>
</tbody>
</table>

- The table above sets forth (1) the top five cryptocurrency exchanges where Bitcoin trades, (2) the current price of Bitcoin on those exchanges (as of a specific date), (3) the location of the exchange, (4) approximate trading volume as a percentage of total trading.

- Key takeaways from the information above are:
  - There is a difference of 5.0% from the highest and lowest prices on these exchanges.
  - None of these exchanges are located in the U.S.
  - Most of the trading volume of Bitcoin is not in U.S. dollars.
  - The aggregate trading volume of the top five bitcoin exchanges is only 25.56% of the total volume globally.
ISSUES AND APPROACHES TO VALUATION AND LIQUIDITY

- Fragmentation: Cryptocurrencies trade on multiple venues, trade at different prices.
- Volatility: Cryptocurrencies are extremely volatile. According to Bloomberg, Bitcoin, which may be the least volatile cryptocurrency, is approximately 10 times more volatile than the S&P 500 and almost 35 times more volatile than U.S. treasuries.
- 24-hour Global Markets: Cryptocurrencies are traded 24 hours a day and a large portion of the trading is outside of the U.S. and therefore not in U.S. dollars.
- “Virtual Currency Events” have Real World Implications: Forks and air drops functionally are similar to corporate events that affect equity securities. A “fork” in its simplest terms is a split in a blockchain, which is similar to a corporate spin out, and an “air drop” is similar to a special dividend.
- The foregoing concerns are even more pronounced for specific tokens or coins.
PRACTICAL CONSIDERATIONS OF VALUATION AND LIQUIDITY POLICIES

- Which market price to use? Currently, for certain cryptoassets there is no market where it is “primarily” traded
- Timing of valuations (when and where)
- Flexibility to handle periods of extreme volatility
- FX considerations
- How to address “Virtual Currency Events”
- Potential Responses: Cryptoassets are no different than any other asset?
CUSTODY

- Under the Custody Rule (Section 206(4)-2 of the Advisers Act), “it is a fraudulent, deceptive or manipulative act, practice or course of business” for an investment adviser who is registered with the SEC to “have custody of client funds or securities” unless:
  - A qualified custodian maintains those funds or securities
  - Currently, there are very few qualified custodians in the United States authorized to hold cryptocurrencies (and none are broker-dealers)
  - Concerns raised by the SEC:
    - Validation of exclusive ownership and software functionality of private cryptocurrency keys and other ownership records
    - Cybersecurity threats, such as the potential for hacks on digital wallets
    - Ability to receive and custody underlying cryptocurrency in physical settlement of cryptocurrency-related derivatives
A “qualified custodian” is:
- A bank, a trust company or a savings association with deposits insured by FDIC;
- A broker-dealer;
- A futures contract merchant; and
- A foreign financial institution that customarily holds financial assets for its customers, provided that the foreign financial institution keeps the advisory clients' assets in customer accounts segregated from its proprietary assets.

Independent Verification: Client funds and securities for which the adviser has custody must be verified by actual examination at least once during each calendar year.
PRACTICAL CUSTODY ISSUES

- In order for custodian to have “control” of a cryptoasset, it likely needs to be transferred to the custodian
- Titling in name of custodian “for benefit of customers”?  
- Hot Storage versus Cold Storage
  - Risk allocation between security and ease of access for transactions
  - Immutable nature of transactions of blockchain makes reversal of transaction in case of error impossible
  - Audit/Examination of ownership by independent accountant
SEC’s First Enforcement Actions Against Cryptocurrency Firms Failing to Register as a Broker-Dealer, Investment Company, or Exchange
Sept. 11, 2018, the SEC filed its first enforcement action alleging that an online platform that bought and sold digital assets was operating as an unregistered broker-dealer.

From July 2017 through late February 2018, a self-styled “ICO superstore,” **TokenLot** was alleged to operate an online platform where 5,800 retail investors purchased digital tokens during and after an ICO.

TokenLot marketed the digital tokens; accepted investors’ orders and funds for payment; worked with issuers to transfer purchased digital tokens to investors; and disbursed the proceeds of the sales to the issuer.

The company also operated as a broker by listing for sale and participating in secondary sales of digital tokens issued by 145 different issuers.

Further, TokenLot operated as a dealer by purchasing digital tokens at a discount during the ICOs and then selling them to retail investors for a profit.

TokenLot operated as a broker by facilitating sales of digital tokens offered by nine issuers in ICOs.
The SEC brought an action against Crypto Asset Management, failed to register CAF as an investment company, it also misrepresented that CAF had filed a registration statement with the SEC and that it was the “first regulated crypto asset fund in the United States,” according to the SEC’s findings.

CAM managed Crypto Asset Fund, or CAF, a pooled investment vehicle formed for the purpose of investing in digital assets.

From August 1, 2017, through December 1, 2017, CAM raised over $3.6 million from 44 investors, most of whom were individuals. There was no pre-existing relationship between CAM and these investors; rather, CAM engaged in a general solicitation of investors through the company’s website, social media accounts and traditional media outlet interviews.

The SEC charged CAM and its owner with several violations of the securities laws, including:

- Offering or selling unregistered securities;
- Failing to register CAF as an investment company;
- Making material misrepresentations or omissions in connection with the offer or sale of securities; and
- Making material misrepresentations or omissions to prospective investors in a pooled investment.
On Nov. 8, 2018, the SEC announced settled charges against Zachary Coburn, the founder of EtherDelta, a digital "token" trading platform. This is the SEC's first enforcement action based on findings that such a platform operated as an unregistered national securities exchange.

According to the SEC's order, EtherDelta is an online platform for secondary market trading of ERC20 tokens, a type of blockchain-based token commonly issued in Initial Coin Offerings (ICOs).

The order found that Coburn caused EtherDelta to operate as an unregistered national securities exchange.

EtherDelta's smart contract was coded to validate the order messages, confirm the terms and conditions of orders, execute paired orders, and direct the distributed ledger to be updated to reflect a trade.

EtherDelta provided a marketplace for bringing together buyers and sellers for digital asset securities through the combined use of an order book, a website that displayed orders, and a “smart contract” run on the Ethereum blockchain.

Over an 18-month period, EtherDelta's users executed more than 3.6 million orders for ERC20 tokens, including tokens that are securities under the federal securities laws.

Almost all of the orders placed through EtherDelta's platform were traded after the SEC issued its 2017 DAO Report, which concluded that certain digital assets, such as DÃO tokens, were securities and that platforms that offered trading of these digital asset securities would be subject to the SEC's requirement that exchanges register or operate pursuant to an exemption.

EtherDelta offered trading of various digital asset securities and failed to register as an exchange or operate pursuant to an exemption.
QUESTIONS
ABOUT ME...

Marlon Paz, a partner at Seward & Kissel LLP, regularly advises broker-dealers and other financial services firms in matters relating to securities regulation, SEC and FINRA enforcement, internal investigations and examinations, compliance and white collar crime. Marlon also serves on the faculty of Georgetown University Law Center and UC Berkeley School of Law.

Mr. Paz served in senior positions during his six-year tenure at the SEC, where he played a key role in developing the SEC’s positions on many important regulatory and enforcement matters. He also has extensive experience with global anti-corruption issues, including the Foreign Corrupt Practices Act, anti-money laundering matters, and U.S. economic sanctions laws.
Swensen, Pelé, and the Blockchain

By Jose Arrieta\(^1\) and Jim Kyung-Soo Liew\(^2\)

October 7th, 2018
Submitted to the Special Edition of
Journal of Alternative Investments on ICOs

Introduction

Swensen’s in!\(^3\) 2018 was a critical year for cryptocurrencies as Yale’s endowment made their first allocation to funds dedicated to cryptocurrencies. As the first credible institutional investor and thought-leader to do so, this move provided a tremendous and much-needed vote of confidence for the cryptocurrency industry and blockchain technology. Other institutional investors now feel safer in advocating for investing in cryptocurrency and blockchain opportunities when presenting to their investment committees.

2017 is memorialized in the history books as the “Bitcoin Hype” year. With the hype over cryptocurrencies having mostly receded and the real advantages they serve as an investment instrument gaining more validity, the debate is no longer whether to allocate to this market, but, rather, how much to allocate. Institutional investors find themselves, therefore, considering the following questions when deliberating the size of an allocation:

- Should investors enter through purchases in equity or ICOs?
- What about gaining passive exposure to the BTC index or an index of cryptocurrencies?
- Should institutional investors even consider investments into ICOs?
- Should investors want exposure to blockchain technology and why?

Those institutional investors who are still skeptical about adding cryptocurrencies to their investment portfolio are hesitating, perhaps, because their memory of how much

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\(^1\) Jose Arrieta is an Adjunct Professor at Johns Hopkins Carey Business School teaching Blockchain.
\(^2\) Jim Kyung-Soo Liew is an Assistant Professor at Johns Hopkins Carey Business School teaching Blockchain, Big Data Machine Learning/Al, and Entrepreneurial Finance and the co-Founder of SoKat.co.
BTC has lost since its peak in December is fresh in their minds. Many participants who bought BTC back in December are sitting on substantial losses now, and those who bought into ICOs during that same time are also nursing serious wounds. Consequently, these investors are not convinced that cryptocurrencies are a market that institutional investors should be examining; it may just be unnecessary career-risk. And in the case of an institutional investor who has moved beyond skepticism to more active interest, how would the investor be able to better understand the difference between cryptocurrency investments and blockchain technology so that they can identify these opportunities in the marketplace? Our goal in this is to be able to provide some guardrails to help calibrate investment decisions going forward.

In this work, we will provide a non-technical discussion about the cryptocurrency market, ICOs, the fundamental impact blockchain technology may have on a range of market segments and the structural mechanisms with which companies create value and facilitate value exchange with their consumers. Furthermore, we will highlight how the combination of blockchain technology, low cost cloud computing offerings, machine learning, artificial intelligence (AI), etc., are changing the way market participants create, distribute, and exchange value. The combination of the technologies listed above are and will continue to be the fundamentals driving the transformation of commerce globally.

**Background on ICOs**

An ICO is a mechanism by which a startup, typically blockchain-based or emerging technology-based, raises funds to build their business. Typically, all that is needed is a credible team, a website landing page, and an idea captured in a white paper. All these materials are, generally, publicly available and signing-up for updates about the developments require nothing more than an email address and password. Additionally, many ICOs have Telegraph and Slack channels to keep fans abreast of all exciting developments within the organization.

In the similar vein, as a traditional IPO, the startup issues tokens in exchange for US dollars, BTC, or ETH. Tokens appreciate in value if the startup is successful in building its business and accomplishing stated milestones. Pricing of these tokens are generally done on the crypto-exchanges but holders are typically free to exchange at any rate and even give their tokens away. Note that there are many levers that the entrepreneur could move with the issuance of the token so as to incentivize investors. Examples are: providing a deep discount for early purchasers, varying the total number of tokens issued (bounded or unbounded quantities), rewarding those that write favorable articles and/or speak at conferences, providing bounties and rewards for behavior that helps
build the startup eco-system, which includes catching bugs in the software programs, etc. Understanding the business model of the issuer is important in addition to the timing of the launch; 2017 was a great year to launch ICOs and many did with great success.

Since ICO launches were very loosely regulated in the early years, many unsavory participants took liberties with their business models and the promise of returns. Some of these launches were fraudulent from the outset, while many others were sincere from day one and continue in their dedication to building their technologies, perhaps in hopes of disrupting current incumbent leaders such as Bitcoin, Ethereum, and Ripple, etc.\(^4\)

An ICO’s tokens are purchased in the gamble that the startup will succeed in fulfilling their mission as provided in their white paper or pivot into the right opportunity over time. Betting on the founders is critical; similar to traditional venture investing, a prior track-record of success by the founder increase the chances to raise capital and have a successful ICO.

A common reasons for issuing tokens are to raise capital to hire programmers and staff to build the software technologies needed for the business idea. These ideas are bold and transformative, but also very risky. The moonshot ideas could catapult the startup to the coveted unicorn status but the reality is that a majority of them will fail to manifest their grandiose ideas.

For example, some make the claim that they plan to create a platform to process millions of transactions each second, when compared to the current existing technology for processing credit cards which yields around 5,000-10,000 transactions per second. This claim is an astounding improvement of over 200x!\(^5\) Impressible, but is it really technologically feasible? Is the ability to process a million transactions more important than the ability to understand the behavior of a consumer base? What is more valuable from and investment perspective? It is a question we will continually return to in this article as we explore the transformative nature of blockchain technology on value exchange. The answer to this question (which we will not provide) will be the determining factor in how to invest to capture the returns that will be created by this transformative disruption to global markets.

The Morphing Instrument from Investment Contract to Commodity

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\(^4\) Coinmarket cap (https://coinmarketcap.com/) provides an easy view into the cryptocurrency world. It is similar to the “WEI Index <Go>” for those Bloomberg lovers.

In 2017, many startups tried desperately to argue that their token was an utility-token so as to avoid the regulation of the SEC, as provided for under the Security Act of 1933. The SEC regulates any security or investment contract as defined by The Howey Test. The Howey Test determines if an instrument qualifies as a security or investment contract by looking for the presence of the following four traits:

1. There exists an investment of money
2. in a common enterprise
3. with the expectation of profits
4. based solely on the efforts of others

As of now, it appears that tokens may in fact actually change in characteristics over time. A token can initially be issued as an investment contract in a common enterprise with the anticipation of increasing value based on the effort of others. Then, once the platform has been created successfully, the instrument morphs into a commodity that can be used within the ecosystem that has been created from initial efforts. Arguably ETH, and to some extent BTC, has followed this metamorphosis. Currently the SEC does not regard BTC and ETH as securities.

Clearly, the blockchain industry will require an update in financial textbooks to include a chapter in "Morphing Instruments." The point here is that this emerging technology has forced academics, regulators, and entrepreneurs to re-think prior fundamental assumptions about securities and regulations. The tokens based on the distributed ledger technologies have shown that they do not fit so easily into existing compartments that have historically govern financial instruments.

**Who Can Invest in ICOs?**

In the US, only accredited investors can participate in ICOs. Outside of the US, except for China, anyone with a computer can buy a startup’s token. It should be noted that 90% of all startup businesses fail and this number would probably be slightly higher given the startup nature of many ICOs. Also, do not invest an amount that you can’t afford to lose because the odds are against you.

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Liew and Hewlett (2017) suggest that an 1.6% allocation makes sense from a purely empirical vantage to a traditional institutional portfolio in regards to cryptocurrency exposure. Unsurprisingly, BTC has low correlation to traditional assets and positive drift, so net strong diversification benefits accrue from this appreciating investment. Interest in BTC has fueled this early frenzy. In the Fall of 2017, there were over 11.7 million users accounts at Coinbase, more users than the Charles Schwab brokerage service.

The process in investing in ICOs generally starts with converting US dollars into BTC or ETH. These well-established cryptocurrencies are then exchanged into that which is issued by the startup in the ICO. Additionally, if the token has success, listing it on an exchange becomes imperative. Exchanges currently provide liquidity for these tokens since they can be freely exchanged with other more liquid tokens, such as BTC and ETH. Once exchanged into the liquid token, they can be easily converted into the US dollar through Coinbase or other services. Note that the more legitimate the exchange, the higher the fees are associated with this conversion.

With many ICOs raising in upwards of over $20 million, can we truly consider successful ICOs startup-class funding? In business school, we teach that startups can be founded with less than $100,000. All you need is a unique name, EIN number, bank account, and you’re ready to go. So why do these startups raising with ICOs need so much more? One reason is that ICOs are built on emerging technologies and ideas. The technological programming expertise is valuable, scarce, and therefore commands a premium. Programming the blockchain components of the startup is a high demand skill as of this article’s publishing. Over five years have passed since the Ethereum foundation’s ICO in 2013. Looking back, it is surprising that the labor market has adjusted at a glacial rate to accommodate the growing demand for blockchain coders. Those premium wages commanded over the past four or five years have not subsided; a typical blockchain coder may charge around $200 per hour or more. The open question is do you really need a blockchain coder? This is another item that will need to be revisited over time to truly understands the evolution of the marketplace.

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For those who want to start learning about blockchain and ICOs, the Satoshi (2009)\textsuperscript{10} white paper is a popular source. When reading the Satoshi white paper one must remember that Satoshi is describing an application built on top of blockchain technology versus the capability or goal of blockchain itself. Additional sources of knowledge are online courses or in traditional classroom environments. Foundational knowledge combined with knowledge of the current blockchain environment leads many to believe that blockchain has yet to reach its disruption potential. One possible area of additional disruption potential, due to the distributed nature of the original BTC blockchain, is the decentralization of authority while solving the double-spend problem. Overall, it is important to note that the value of blockchain extends far beyond surveillance and automated auditing. Truthfully, doing business in a decentralized manner off of a data set that is an accurate reflection of what has occurred up to that point in time in an organization or an ecosystem creates an environment that rewards creativity for the investor. For the business Executive, buyout firm, entrepreneur this technology creates a legitimate opportunity to recreate marketplaces in an applied manner by acquiring data sets and experimenting with how value exchange between the customer and the business can be redefined to integrate horizontal disparate markets. The ability to send digital value over the internet provides an amazing opportunity for those gritty enough to pursue startup ventures or established companies that are willing to potentially cannibalize current cash flow for the opportunity to define the fundamentals of an emerging product or service market and increase cash flow, margins, market share, and efficiency.

**Examples of ICOs on the Horizon**

Blockchain voting startups, such as Voatz (https://voatz.com/), hold the promise of eliminating voter fraud and strengthening democracies worldwide. However, many in the tech industry have questioned whether Voatz, a mobile voting platform, has the bulletproof cryptography and security infrastructure to combat independent or state-sponsored hackers.\textsuperscript{11} Not only that, but voter coercion may become a greater problem when voting becomes a press of your smartphone button.

Additionally, in the real estate space, EJEN (https://www.ejen.net/) is an exciting startup that will attempt to tokenize real estate assets for institutional investors. Their goal is to offer a best-of-breed, institutional-quality transparency and trustworthy token backed by


cash flows generated from real estate assets. Given the sheer size of the global real estate market of $8.5 trillion, there appears lots of opportunities in their endeavor.\textsuperscript{12}

Another startup BlockMedx (https://blockmedx.com/en/) heroically aims to save lives. Motivated to address the opioid crisis in the US, they are currently building a healthcare infrastructure focused on prescription drug fraud, abuse, and non-adherence. They intend to be the world’s first completely secure, HIPAA-compliant, end-to-end solution from physicians to pharmacies using the blockchain technology to address the opioid epidemic. BlockMedx launches it’s ICO on Monday October 7, 2018.

Finally, we all know that Amazon is the dominate e-commerce platform in the global economy. Could a company really challenge Amazon? There are a few entrepreneurs that believe challenging Amazon is legitimate, possible, and a natural evolution of the e-commerce marketplace. For example, Argentina Moise, the founder of a startup called Bleexy (https://www.bleexy.com/) from Northern Virginia believes this is not only possible but this is a natural evolution of the e-commerce marketplace. She founded Bleexy as an e-commerce platform that will allow brands to control the data that they have created while establishing and growing their brand. This includes direct control over; consumer data, distribution information, and marketing insights. As an example private label brands that build marketplaces on Bleexy will control the data related to their customer base and distribution network and Bleexy will not have visibility into that data unless the private label brand decides to share it with Bleexy. They will be given the authority to share this data with any other actor in the marketplace as they see fit. This authority protects the intellectual property associated with establishing a brand and building a marketplace. Furthermore, this protects their initial investment in creating a market and allows them to create a strategic well thought out partnership strategy for growth. Bleexy may be far from dethroning Amazon has the global e commerce platform of choice but it is clearly a compelling example of the power of Blockchain technology. It also shows us that no market leader is truly safe unless it is embracing emerging technology.

ICOs span many diverse industries from voting, real estate, social-entrepreneurship, and e-commerce to name a few. But there are clearly many more, these were just a few examples to help illustrate how the technology underlying ICOs can be applied in a tremendously number of diverse industries. Clearly, the future implications is that blockchain will have an immeasurable impact on tomorrow’s business and society.

\textsuperscript{12} Teuben, Bert, and Bothra, Hanskumar, “REAL ESTATE MARKET SIZE 2017”, Annual Update on the Size of the Professionally Managed Global Real Estate Investment Market, MSCI, June 2018.
Many of the examples listed above are all focused on leveraging the surveillance capability of blockchain to improve trust in an existing system. Our focus in this article has been to extend your thinking beyond that and peer into the next market of use cases and the possibilities associated with redefining how markets function and exchange value leveraging blockchain as a catalyst in the new reality of how firms deliver value.

Blockchain and Uncle Sam

It is no secret that bureaucratic institutions are sluggish when it comes to adopting new technologies. However, the potential of blockchain technology has caught the eye of the United States government, thanks in part to executives at the Department of Health and Human Services (HHS). The HHS is a data rich, decentralized agency, that’s primary mission of protecting the human condition makes it a very unique institution that is unrivaled globally. For example (a couple of many), as the agency designed to protect humanity from infectious disease while eliminating cancer and funding research that will help individuals recover from traumatic brain injury the business of HHS and the data it’s collected is “siloeed;“ that is, stored in separate places on separate systems.13 This means that the HHS business process is swamped with manual tasks and an inability to analyze all relevant data on an issue in real time.

Technological modernization used to mean replacing all of a business’ current systems with a newer version or maintaining legacy systems and building tools on top of legacy systems to improve functionality, efficiency, and effectiveness. However, the flaw in both of these approaches is related to complexity. Replacing the legacy payments platform at JP Morgan Chase that processes trillions of dollars in transactions a day would be very difficult. Integrating additional capabilities in a legacy Information Technology platform of that size is extremely complex and the operations and maintenance costs associated with changing the legacy IT system and the 60 applications it interacts with as an example, is extremely expensive.

Historically, companies and agencies’ approach to modernization are centered on standardizing business processes to lower costs, thereby increasing underlying revenue. This approach has forced executives within private companies and federal agencies alike to choose vanilla information technology services to achieve consensus

and provide value to the entire organization. Unfortunately, this approach limits a firm or agency’s ability to maximize value to the end consumer, as well as eliminating flexibility.

One of the interesting lessons of the way Jamie Dimon manages JP Morgan Chase is that each individual business unit is fully responsible for their P&L and all of the capabilities and risk that help deliver that P&L. Therefore, there isn’t a third party internal IT provider or shared service focused on providing centralized support for revenue generating business functions. This creates accountability at the business unit level and creates a direct measurement for performance. While this approach has many benefits, it is also an operating model that can create the appearance of redundancy and overlapping sets of capabilities.

In the private sector, the largest firm in a market vertical may purchase the fourth or fifth largest firm in a market vertical, eliminating redundant administrative functions and standardizing processes to lower costs and hopefully offer cross pollination of business offerings, all in an effort to increase profits (lower cost, increase sales) and the overall value of the firm. However, blockchain technology has created an ability for a new equation to be employed to create value: One centralized tenet includes standardized data sets with decentralized, distributed ability to execute in a disparate manner using the most up to date data available to the entire organization without additional reconciliation costs.

HHS has proven that executives in the private or public sector now have a unique opportunity to actually layer existing systems with blockchain technology. This creates a staging zone of standard data indexed within a blockchain operating system, while allowing existing operating environments to deliver services in the manner in which they operated historically. This blockchain power data layer can then be used to rapidly rebuild business processes and give a company or agency the ability to redefine value to the end user or customer. This approach minimizes risk and creates flexibility at the point of profit generation or the ability and agility to shift the focus of the capabilities to meet the agencies objectives and mission.

The main driver leveraging this approach is centered on using a standard blockchain based data layer that is regularly updated from existing operating systems in a company or agency. HHS is using machine learning and AI algorithms to cleanse and structure the data before it is tagged on the distributed blockchain based data layer and stored in a distributed database. Moreover, HHS has been able to create the blockchain operating system (hyperledger fabric) in a cloud environment and build machine learning and AI based microservices off the data layer to streamline and automate business processes.
This approach has allowed HHS to analyze approximately $24.2B in annual spend and 100,000 contracts in a matter of seconds and more importantly, perform that analysis in a real time, independent manner for thousands of users of the system at the same time. Historically, analyzing the contracts and spend highlighted above across siloed data sets would have proved very difficult.

In the current approach, leveraging automation, HHS can identify opportunities and risks for the customer base and create value and visibility in an efficient manner. Again, this approach is not just to empower the leadership (Chief Executive Officer, Secretary, and Board) of the organization. This approach empowers the intern in the organization with the data he or she needs to make a business decision and the ecosystem gives the leadership of the organization the ability to govern and manage performance at the intern level. Clear visibility into the execution function of the business and the ability to align performance objectives, in real time, with an individual operation in the ecosystem, in real time. This approach also creates agility in delivering innovative solutions quickly for customers and to solve internal challenges.

Lastly, and most importantly, the capability set described above is a standardized distributed ecosystem where microservices can be shared amongst internal and external participants. The ecosystem creates an ability to record and understand behavior associated with the workforce and the industry base that interact with and within the ecosystem. This creates an ability to learn behavior and empower individual actors within the ecosystem with the benefit of information, data, and outcomes that occurred on the basis of previous engagements. However, this operational model allows HHS to distribute value by sharing microservices and allowing microservices to be defined by any individual operating within the existing ecosystem without changing or altering the existing data set. The organization can now inexpensively adjust microservices in a node specific manner to meet the need of one actor in the ecosystem at minimal costs. Overall, this approach could modernize and fundamentally create synergies in historically separate market verticals where investors, executives, political leaders, private equity leaders, etc., could not have imagined that synergies existed before.

A simple example of an opportunity that probably has not been foreseen or considered before is combining the data sets associated with the sales of a large regional beer distributor and the cosmetics sales data from the supermarket established in the infield at Phoenix Raceway (ISM Raceway) during a NASCAR race week. Cosmetics, are in fact, the top selling item (most of the time) in the infield at Phoenix, not beer or cigarettes. Fundamentally, data has become the most valuable asset on the face of the
earth. Now the ability to analyze data quickly and redefine an offering to consumers on the basis of the data is more important than water. The set of capabilities described in this article and the ability to combine these capabilities to recreate value is more valuable than any modern institution, infrastructure, mechanism for distribution, or brand.

The internet and cloud computing has created a low cost, flexible environment where distribution and reaching a customer with something of value is simplistic in nature. Furthermore, accessing diverse and detailed data sets on behavior through an acquisition or partnership can help you create value for customers at a very low cost that historically was unimaginable. Not only was this unimaginable, but creating new value for a group of customers has been called a “moment of intuitive genius.” We believe that generating “moments of intuitive genius” can now be operationalized to occur more often. However, the leaders driving this outcome must truly be risk takers that are unafraid to challenge historical norms and the basis of the industry structures that they work with in.

We believe that investors should begin to understand how their investment strategies are giving them exposure to firms and business leaders that focus on acquiring data sets on consumers’ (businesses or individuals) wants, needs, and behaviors. The data itself is the vehicle that facilitates air travel. Secondly, investors should focus on the firms and business leaders that are monetizing data by locking that data down on blockchain powered infrastructure and are using machine learning, robotic process automation, autonomous systems, and AI. This is the jet fuel used to analyze the data with a focus on creating business processes and redefining value exchange with their customer base.

The decentralized creation and delivery of value or the inversion of existing business models associated with both products and services is the future. In other words, blockchain technology can help fuse or, better said, provide insight into many decentralized unrelated data sets and rebuild business processes and value exchange in a risk controlled manner leveraging small services, or “micro-services,” off of the blockchain, to disrupt and transform the function of an existing industry. This approach allows a company to decentralize decision making and processes which inherently makes a company more agile in a risk controlled manner. These micro-services include prediction models based on AI, machine learning, chatbots, and eventually, AR/VR solutions.

Blockchain technology utilizes a distributed ledger to ensure a redundant secure data set that is shared in a newly established blockchain ecosystem. This ecosystem of
“nodes” receive a copy of the full data set history, in the form of a ledger. Different approaches can be used to control what is available for each node to access from an information and data perspective. The blockchain itself does not store or house the data; rather it stores the encrypted keys that provide private keys access to certain sets of data based on their level of authority. At least this is the premise, perspective, and approach we are writing from to describe what we believe is the investment opportunity. In this way, all data modifications are visible to all parties involved based on level of access written to the chain and assigned to each private key. An ecosystem of nodes is superior to regular CRUD (create, read, update, delete) databases and is operationally much more secure and functional at a significantly lower cost. Blockchain databases utilize cryptographic processes to secure the data from outside intervention, a threat that could prove disastrous.

It is important to note that the advantages of blockchain technology are realized when there are multiple actors, individuals, companies, agencies, data sets involved, each with their own node. Most business are built on a series of databases that are established to support business functions and use third party reconciliation functions powered by databases to create trust and determine if the data in transit was accurately recorded.

Apart from security benefits, blockchain ecosystem allows for the construction of micro-services over the blockchain data layer. These may include automation, greater insights about the data from AI and machine learning technology, or more efficient data collection and distribution.

**Example of Federal Blockchain Implementation**

Another example of blockchain technology as applied to the Federal government process comes from thought-leaders Michael Curtis and Dov Levy. GrantSolutions.gov, in partnership with Dovel Technologies, have launched the first working blockchain solutions for the Federal grants industry that ingests real-time grants award data and brings that data up to the blockchain data layer. All this is accomplished in the cloud environment for maximum scaling of operations. Additionally, GrantSolutions lab, the AI and blockchain think-tank residing inside of GrantSolutions.gov, has begun adding AI microservices to help make predictions about grantee organizations audit risks. Initial results look extremely promising, with prediction models reaching 96% accuracy in identifying a future audit event.\(^{14}\)

ICOs in 2018

There is important background information that we need to understand regarding the explosion of interest in ICOs over the past 5 years. Before we delve into numbers, however, we must keep in mind that different sources report total ICOs and their funding differently based on factors such as completion.

ICOdata has tracked a multitude of ICO statistics since 2014, and their data has been cited in a myriad of publications, from the New York Times to Forbes. According to ICOdata, there were only 2 and 3 ICOs in 2014 and 2015, respectively, raising about $22 million total. This number escalated to $90 million in 2015 for 29 ICOs, then really took off in 2016. That year, over $6 billion was raised for 875 ICOs, and as of late September 2018, over $7 billion has been raised for over 1100 ICOs. These statistics reflect completed ICOs. If one were to take into account ongoing and incomplete ICOs, the amount of funds raised in 2018 so far doubles to about $14 billion worldwide.\textsuperscript{15}

The data show an exponential growth in both funding and quantity of ICOs since 2014. However, it is critical to note that the majority of funding is concentrated in a small set of coins. For example, the top 5 ICOs this year, including Dragon Coins, Hdac, Filecoin Futures, Tezos, and EOS raised over a billion dollars as a group.

The government and technology communities have had much to say about the rise of ICOs over the past couple years. Over the summer, the SEC insisted that most ICOs are, in fact, securities, rather than utility tokens.\textsuperscript{16} Many cryptocurrency advocates pushed for the latter classification in order to remain loosely regulated. Despite this setback, some argue that the ICO is not dead, but is evolving through this rough patch. In 2017, investors were drawn to the young technology's stellar returns and promise.\textsuperscript{17} As the ICO “grows up,” they may begin to act more like traditional equities; that is, regulated and experiencing “normal” returns.

**Blockchain the Disruptive Platform, No Not Really - Blockchain the Disruptive Operating System!**

Let us step back for a moment to better understand the actual blockchain technology fueling the ICO markets. Blockchain is a distributed ledger that is shared across a network of peers. The ledger is immutable; the ledger can only be appended to and nothing can be deleted from the ledger. The ledger will show every transaction or record. Moreover, the system is shared across peers so everyone has the same data, which eliminates the need to reconcile data (data reconciliation is necessary only when mistakes are made in the data records, typically by human entry error). The blocks that are chained together contain the hash of the previous block, as well as other meta data, such as a time-stamp for the block and index number of the block. In BTC, the block also contains a Merkle Tree Root of all the transaction in that period or block creation. Note that the Merkle Tree Root is, basically, a fingerprint summary of all the transactions because all the transaction data is not stored in the blockchain; there is separation of the actual transaction data and the blockchain.

In general, the utility of the blockchain is that it provides users an ability to check to see if their data matches the data held by others in the network in an efficient way. By employing hashing algorithms, this check can be very quickly verified without the need to compare each data element by element.

The unique benefits of the blockchain are its immutability, transparency, and trust. The trustworthiness of the blockchain arises from the fact that the ownership of the data comes from the ability of everyone with a computer to quickly and easily create a public-private key pair. The blockchain leverages this security feature by employing a simple innovation in cryptography, allowing the digital identity to be created by anyone. The democratization of unique identify, and thus ownership, is one of the most important and popular features of the blockchain. Digital assets that are owned by Alice can now be documented, and through the blockchain Alice can now transfer the digital asset to Bob, in a secure and verifiable manner.

But can a distributed ecosystem be enough to unleash all the value? We believe that only using the blockchain is not sufficient. We postulate that for maximum value to be unleashed, the blockchain must be used in conjunction with AI, Machine Learning (ML), Autonomous Systems (AS), and Robotic Process Automation (RPA). The blockchain allows government agencies and businesses to layer upon the existing business a mechanism to bring data up and out of data silos onto the blockchain data layer. This lift is technically straightforward and, best of all, can be executed without disrupting the prior business processes. Upon this blockchain-data layer, micro-services can be
created with AI algorithms. Since technology advances rapidly in the AI industry, it is ideal to allow for advancement in AI to be swapped out for better AI algorithms, meaning allow for flexibility on the micro-service layer on top of the blockchain data-layer.

**The Pelé Multiplier**

Blockchain, on its own, is only a dynamic ecosystem that is shared across the network. In isolation, this dynamic peer-to-peer, append-only database does not manifest its full potential for business organizations. In order for organizations to most effectively use blockchain technology, it needs to employ blockchain with AI, ML, RPA, and AS. AI can be used for analysis and insights while ML can be used to establish an understanding of behavior on the network and RPA to automated basic business processes. The combination will unlock new value and we believe that nobody has attempted to actually measure this value. The blockchain data-layer would then act as fuel for the AI, ML, RPA, AS micro-services, which then provides the ideal mix that would yield the Pelé Multiplier.

If the blockchain can bring siloed data up onto the blockchain data-layer and on top of that layer we add micro-services, the potential implications are tremendous. Existing business like GE, which is struggling to survive, can feasibly leverage all the legacy systems and rich historical data and construct new businesses on top of the old legacy business. While each business will have different results and metrics. We believe that the successful organizations will implement blockchain and micromanage how they invest to recreate value and measure return on investment. Furthermore, the power of blockchain is also the ability to micro manage investments. Investments and the savings from technology modernization (moving to the cloud), process improvement (automating business processes), and providing machine learning support and insight to enhance decision making and calibrate those decisions over time based on results.

We hypothesize that the gains could be an estimate of 10x. The equation below roughly summarizes the idea:

Blockchain + Micro-Services (AI, ML, RPA, AS) = Pelé Multiplier Effect (10x)

10x more revenues could justifiably be achieved since upon the existing business data sets we now have combined other data to create even better predictive models. Additionally, new businesses and services could be birthed with very little to low interference of the existing business. If company data goes on the blockchain, the
needs of audits across divisions would be eliminated because the sharing of the data would provide transparency across the organization and time would be saved from reconciling data and processes.

We hypothesize that these gains could represent up to 10x any given companies revenues and reduce expenses by (1/10)x. Moreover, business processes could be reduced in time by 10x. Overall, we believe that 10x is a conservative estimate when you consider the transformative nature of the capabilities described above and the fact that getting to market quickly at a low cost is not only reasonable but has been proven within the Federal Government.

At the beginning of this article, we discussed the interesting statistics and findings on ICOs. The ICO market, however, has been a cookie cutter industry thus far, compared to what we have described as the possible future for blockchain technology. In closing, one can disagree with outcomes and possibilities described in this article and that is fair. However, irrelevant is the reader that does not see the possibilities associated with the technologies described throughout this document. As practicing institutional investors, which in fairness we are not, being irrelevant is kind of like sitting on the bench or not taking any swings. In a world where the market is being created as we speak. It is better to be up swinging than warming the bench. This in all fairness is our first swing. Thank you for taking the time to read this. It’s time to play ball!
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The rise of the crypto asset investment fund: An overview of the crypto fund ecosystem

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Introduction

Cryptocurrency has emerged as a lucrative financial asset class that has captured the attention of investors around the world. Together with its rise as an asset class, investor interest in cryptocurrency has led to the creation of a variety of investment vehicles dedicated exclusively to crypto asset investment. These crypto assets include cryptocurrencies and non-cryptocurrency, blockchain technology-based assets, such as digital tokens generated through initial coin offerings (“ICOs”) and pre-ICO token sales, as well as traditional equity investments in blockchain technology startup companies.

Crypto asset investment funds (“crypto funds”) have intrigued both private and public sector investors around the world due, in part, to the colossal returns that some crypto fund managers captured in 2017 when Bitcoin reached its all-time high market price of $19,783.06 per coin. Some crypto funds continue to raise significant levels of capital in 2018 despite Bitcoin’s price slump. Crypto funds have also attracted international criticism due to extreme volatility, cybersecurity risk, illicit activity, and concern over potential systemic risk that crypto funds could “spawn” in mainstream financial markets.

With the launch of over 100 crypto funds in 2017, and the projected launch of over 150 new crypto funds in 2018, challenging questions arise from regulatory and operational perspectives, as well as from the perspective of legal service providers who will service the emerging international crypto fund market. This chapter will provide an overview of the crypto fund ecosystem, as well as a close look at select crypto investment funds, some of which are projected to become dominant players in the crypto fund market.

Market overview

Terminology

Crypto funds and the crypto assets in which they invest come in a variety of forms. As a preliminary matter, crypto funds (also referred to as cryptocurrency funds, digital asset funds or blockchain funds) can be defined as investment vehicles that raise capital from investors in order to invest in crypto assets for profit. Crypto assets, in turn, can be defined as “digital
assets recorded on a distributed ledger”.

These digital assets include cryptocurrencies and non-cryptocurrency, blockchain technology-based assets, such as digital tokens generated through ICOs and pre-ICO token sales, as well as traditional equity stakes in blockchain technology startup companies. Although there is no universally accepted definition of cryptocurrency (also referred to as virtual currency or digital currency), a cryptocurrency can be conceptualised as an electronic medium of exchange that operates independent of any central or commercial bank.

In contrast to cryptocurrencies, which are intended to serve as a medium of exchange across blockchain applications, digital tokens are intended to provide financing for an early-stage blockchain company’s projects by providing investors with future access to that blockchain company’s projected goods or services. These tokens can be issued by way of a crowdfunding-style fundraising campaign known as an ICO (also known as an initial token offering), or by way of a pre-ICO token sale, which is generally targeted to specific “angel” investors.

It is worth noting that, to date, there is no harmonised international standard for the treatment and characterisation of crypto assets or related crypto asset transactions, such as ICOs and pre-ICO token sales. Instead, there are conflicting classifications both domestically and internationally. In the U.S., for example, digital tokens have been categorised by federal and state agencies as either securities, commodities, currency or property. Outside of the U.S., financial regulators have taken a variety of approaches to crypto regulation, ranging from complete bans on ICOs in China and South Korea to more permissive forms of regulation, such as that in existence in Switzerland and Singapore. Notwithstanding the current state of international legal fragmentation with respect to crypto assets, private and public sector institutions from around the world are collaborating vigorously to develop international norms that will enhance, rather than hinder, the growth of the crypto ecosystem.

Market size

At the time of writing, it is estimated that over 460 crypto funds exist worldwide, collectively managing between $7.5–10bn in assets. This figure does not include cryptocurrency investment trusts, such as Grayscale’s Bitcoin Investment Trust, or Bitcoin futures traded on Bitcoin futures exchanges, such as the Chicago Mercantile Exchange and Chicago Board Options Exchange, which would otherwise add approximately $2–4bn of crypto fund exposure to crypto assets. The largest crypto funds have over $100m in assets under management (“AUM”), including Arrington XRP Capital, BlockTower Capital and the Logos Fund. Polychain Capital, founded and led by early Bitcoin investor Olaf Carlson-Wee, is estimated to control $1bn in AUM according to recent filings with the U.S. Securities & Exchange Commission (“SEC”). Other large crypto funds include Brian Kelly Capital Management, the Galaxy Digital Assets Fund, MetaStable Capital and Pantera Capital. The majority of crypto funds, however, have less than $10m in AUM and fewer than 10 employees.

The crypto fund sector has grown rapidly due, in part, to inflows of investment from institutional investors. Reputable venture capital firms, such as Andreessen Horowitz, Sequoia Capital and Union Square Ventures, have invested heavily in crypto startups, including early-stage crypto funds. Polychain Capital, for example, raised $10m in a round led by Andreessen Horowitz and Union Square Ventures in December 2016. Grayscale Investments has reported that 56% of its incoming capital in the first half of 2018 derived from institutional investors. In addition, research from the Tabb Group indicates that sovereign wealth funds and pension funds have expressed significant interest in
cryptocurrency investment. Universities are reportedly also investing in crypto assets with the goal of increasing revenue for their endowments.

Geographic location

More than half of all crypto funds are domiciled in the U.S., with the largest concentration located in California and New York. The most favoured cities for crypto funds are San Francisco, New York, London, Singapore, Hong Kong, Zurich and Chicago, all of which have established investment fund communities. Although most crypto funds are U.S.-based, the crypto fund phenomenon is global in nature. As of August 2018, the following number of crypto funds exist in the following jurisdictions: Argentina (1), Australia (12), Bahamas (1), Bermuda (1), Brazil (1), British Virgin Islands (1), Bulgaria (1), Canada (17), Cayman Islands (6), China (16), Cyprus (2), Denmark (1), Estonia (2), Finland (1), France (5), Germany (14), Hong Kong (15), India (4), Isle of Man (1), Israel (3), Japan (4), Jersey (1), Kenya (1), Liechtenstein (1), Lithuania (1), Luxembourg (2), Malta (1), Mexico (2), Monaco (1), Netherlands (2), Nigeria (1), Portugal (2), Puerto Rico (2), Russia (3), Singapore (22), South Africa (1), South Korea (2), Switzerland (19), Taiwan (1), The Netherlands (4), Tortola (2), Turkey (3), United Arab Emirates (1), Ukraine (1), United Kingdom (30), and United States (250). While many crypto funds are privately held, others have significant levels of public sector involvement. The $1.6bn Xiong’An Global Blockchain Innovation Fund, for example, was launched in April 2018 by Chinese venture capital firm Tunlan Investment, with $400m provided by the Hangzhou city government. In addition, the 10bn yuan Nanjing Public Blockchain Fund, which was launched by the Chinese city of Nanjing in July 2018 to spur public blockchain projects and the development of a “token economy” in China, is believed to have received 30% of funding from the Nanjing government. In addition, the Chinese city of Shenzhen has setup its own 500m yuan blockchain investment fund to invest in local blockchain startups, with 40% of funding provided by the Shenzhen municipal government and the remainder provided by the private sector.
Fund investment strategies

The crypto fund market can be divided into segments based upon the multiple investment strategies that are executed by crypto fund managers. London-based fintech research firm Autonomous NEXT has divided the crypto fund market into seven such segments: (1) liquid venture funds, which invest in early stage blockchain companies, cryptocurrencies and digital tokens; (2) trading funds, which actively trade cryptocurrencies using buy-and-hold, long-short and long-only approaches; (3) artificial intelligence-driven quant funds, such as San Francisco-based Numerai, which use machine learning algorithms to execute statistical arbitrage strategies; (4) token basket funds, in which fund managers invest in baskets of crypto assets (i.e. cryptocurrencies and/or digital tokens), which can be purchased by way of a single basket token, such as the Daily Crypto Basket offered by Flipside Crypto; (5) passively managed index funds, such as Bitwise Asset Management’s HOLD 10 Private Index Fund and the Coinbase Index Fund, which invest in indices of top performing cryptocurrencies in exchange for 2–3% annual management fees; (6) crypto funds of funds, such as the Apex Token Fund and Protocol Ventures, which invest in other crypto hedge funds; and (7) crypto credit funds, such as SALT Blockchain Asset Management and Genesis Global Capital, which offer investors crypto asset-backed loan products. As illustrated below, crypto venture funds and crypto trading funds (i.e. crypto hedge funds) are the most popular category of crypto fund and hold the most in AUM, with crypto venture funds holding 56% and crypto hedge funds holding 20% of all crypto fund AUM, respectively. As between crypto venture capital funds and crypto hedge funds, more crypto hedge funds have been launched in 2018 than crypto venture capital funds.
Crypto asset hedge funds

Overview

Crypto asset hedge funds (“crypto hedge funds”) can be defined as open-ended private investment vehicles that actively invest in crypto assets, including both cryptocurrencies, as well as non-cryptocurrency, blockchain technology-based crypto assets, such as digital tokens generated through ICOs or pre-ICO token sales, as well as equity investments in blockchain technology startup companies.39

Blockchain technology-based trading of crypto assets is considered revolutionary to the traditional hedge fund industry from an investment standpoint because of the opportunities that crypto investments afford to traditional fund managers from a returns and portfolio diversification perspective.40 Cryptocurrency-focused hedge funds generated nearly 900% year-to-date returns in 2017, for example.41 Although crypto hedge fund returns declined by approximately 50% in the first half of 2018,42 many crypto fund managers remain bullish on crypto asset markets, particularly as certain crypto hedge funds, such as Altana Digital Currency Fund and Amber AI Pivot Digital Trading-2, performed well notwithstanding Bitcoin’s price slump.43 Crypto hedge funds, moreover, are considered to be the fastest-growing segment of the hedge fund industry as a whole.44 As of August 2018, there are over 250 crypto hedge funds in existence worldwide, with approximately 60 crypto hedge funds launched in 2018.45

Multi-asset traditional hedge funds, which are reported to have captured higher net inflows in 2017 than those engaging in single-asset strategies,46 are the most likely to see crypto assets become an increasingly important component of their multi-asset investment strategies. In this regard, there is growing evidence of increased appetite on the part of traditional hedge fund managers for crypto asset investment. Northern Trust Hedge Fund Services has publicly announced, for example, that it is providing three unnamed “mainstream” hedge funds that have been investing in cryptocurrencies with crypto fund administration services, including crypto asset valuation, anti-money laundering compliance and digital asset validation.47

In addition, BlackRock, which is widely regarded as the largest asset manager globally with $6.3tn in AUM as of March 2018,48 has set up an internal working group to analyse potential future investment into crypto assets.49 Although BlackRock CEO Larry Fink has publicly stated that he does not foresee massive investor interest in cryptocurrency strategies,50 major traditional hedge funds like BlackRock can more likely than not be expected to engage in some form of experimentation with crypto asset investment in the near future. In addition, continued interest in crypto asset investment from senior hedge fund managers, such as Steven A. Cohen, who recently invested in crypto hedge fund Autonomous Partners by way of his family office’s venture capital division, Cohen Venture Partners,51 provides further evidence of a growing crypto investment trend in the traditional hedge fund community.

Categories of crypto hedge funds

Broadly speaking, crypto hedge funds can be divided into at least three categories: (1) active trading crypto hedge funds; (2) buy-and-hold crypto hedge funds; and (3) blockchain ecosystem crypto hedge funds.52

Active trading crypto hedge funds, such as Arrington XRP Capital, MetaStable Capital and Polychain Capital, trade cryptocurrencies and employ long-only and/or long-short approaches.53

Buy-and-hold funds can be divided into public buy-and-hold funds and private buy-and-hold funds.54 Public buy-and-hold funds include both exchange traded notes (“ETNs”)
and exchange traded funds (“ETFs”). Examples of ETNs include Grayscale’s Bitcoin Investment Trust (symbol: GBTC) and Ethereum Classic Investment Trust (symbol: ETCG), both of whose shares are publicly quoted on the OTC Markets Group’s OTCQX market, as well as Jersey-based Global Advisors’ Bitcoin Tracker One (symbol: BITCOIN XBT), Bitcoin Tracker Euro (symbol: Bitcoin XBTE), Ether Tracker One (symbol: ETHEREUM XBT) and Ether Tracker Euro (symbol: ETHEREUM XBTE), all of which are listed on the NASDAQ/OMX in Stockholm.55 Several cryptocurrency ETFs have been proposed to the U.S. SEC for regulatory approval, such as the Winklevoss Bitcoin Trust ETF (symbol: COIN) and VanEck SolidX Bitcoin Trust (symbol: XBTC), but none have received approval to date.56 Unlike public buy-and-hold funds, private buy-and-hold funds are not listed on publicly traded exchanges. One example of a private buy-and-hold fund is Pantera Capital’s Pantera Bitcoin Fund.

Blockchain ecosystem crypto hedge funds invest in non-cryptocurrency assets related to blockchain ecosystem infrastructure, such as emerging blockchain protocols. These funds, which appear to resemble venture capital funds in terms of their early-stage investment targets, invest in ICOs, pre-ICO token sales and/or directly into blockchain startups through equity investments.57 Pantera Capital’s Pantera ICO Fund, for example, was created to invest solely in tokens that power public blockchain protocols.58 Pantera Capital has also invested in blockchain startup companies including 0x, Abra, Augur, OmiseGO and Ripple.59

**Crypto venture capital funds**

**Overview**

Venture capital interest in crypto assets has surged in 2018 as a result of the exponential returns that continue to be generated from ICOs.60 PwC Switzerland, in collaboration with the Swiss Crypto Valley Association, has recently reported that 537 ICOs closed successfully in the first five months of 2018, generating a total of $13.7bn in funds raised, thereby exceeding all pre-2018 ICO fundraising levels combined.61 The largest ICOs in 2018 have so far included Telegram’s $1.7bn ICO and Block.one’s $4.1bn EOS protocol ICO.62 In addition, as illustrated below, annual venture capital activity in the crypto asset market has shown a consistent upward trend in deal flow, amounting to 187 deals closed with a total value of $1.7bn through late-June 2018:

![Annual VC Activity in Crypto/Blockchain](image)

*Source: PitchBook*
While there has been much debate as to whether or not the ICO model would replace the traditional venture capital fundraising process, it is clear that many traditional venture capital firms have paid close attention to the rapidly evolving crypto asset market and have adapted their strategies accordingly. Union Square Ventures and Andreessen Horowitz, for example, have both made long-term decisions to enter the “potential trillion-dollar” crypto asset market. The Rockefeller family’s venture capital firm Venrock Partners has also recently announced that it is entering the crypto startup investment market through a partnership with CoinFund, a New York-based crypto fund. Some traditional venture capital firms, moreover, have been described as “crypto unicorn hunters” due to their investments in several fintech and blockchain startups whose valuations now exceed $1bn, such as Coinbase, Robinhood and Revolut. Ribbit Capital, for example, which is ranked by CB Insights as the most active venture capital fintech unicorn investor, manages a portfolio of 10 fintech unicorns, three of which are crypto unicorns.

**Crypto venture capital investment**

Venture capital firms that invest in crypto assets do so in at least one of three ways: (1) investment through pre-existing internal funds that are not focused exclusively on crypto assets; (2) investment through separate funds dedicated exclusively to crypto asset investment; and (3) investment into external crypto funds managed by other crypto investment firms.

**Dedicated crypto venture capital funds**

A crypto venture capital fund can be defined as an investment vehicle dedicated exclusively to investment in crypto assets (“crypto venture fund”). Some traditional venture capital firms in the U.S. have decided to launch separate, dedicated crypto venture funds in order to overcome regulatory obstacles that would otherwise limit the amount of crypto assets that they can invest in and hold. More specifically, U.S.-based venture capital funds that are structured as “Exempt Reporting Advisers” (“ERAs”) under the rubric of the Venture Capital Fund Advisers Exemption to registration requirements under the Investment Advisers Act of 1940 can hold no more than 20% of aggregate capital contributions and uncalled capital commitments in “non-qualifying investments”, which include liquid assets, such as cryptocurrencies and digital tokens. In order to avoid this 20% limit on crypto asset holdings, crypto venture funds have been structured as “Registered Investment Advisers” (“RIAs”), similar to hedge funds. One preeminent Silicon Valley venture capital firm that has launched a crypto venture fund in this way is Andreessen Horowitz.

In June 2018, Andreessen Horowitz launched a $300m crypto venture fund known as a16z crypto, which is designed to be a long-term, “all weather” fund that will invest aggressively in crypto assets irrespective of their stage of development or geographic location, even if there is another so-called “crypto winter” characterised by extreme price fluctuations. Recognising that crypto is a rapidly evolving open source software movement, a16z crypto was structured as an RIA so as to hold crypto asset investments of greater than 20% for over 10 years. A16z crypto is unique in that it will invest at all stages of the crypto business lifecycle, from pre-launch and seed rounds to investments in later-stage mature blockchain companies. It also will provide operational support to its crypto portfolio companies, including participation in corporate and blockchain network governance, similar to the levels of operational support that it has historically provided to its traditional early stage portfolio companies. With its base of pre-existing equity investments in leading crypto businesses, such as Coinbase, Ripple and Polychain Capital, as well as its current ability to acquire larger crypto asset holdings through its RIA structure, a16z crypto is projected to become one of the largest and most influential investors in the emerging crypto fund market.
Conclusion

The explosive growth of crypto funds in 2017 and 2018 is expected to deepen the existence of the crypto ecosystem by augmenting the ability of investors to trade crypto assets and provide financing to crypto startups. As crypto fund-backed startups, in particular, develop into mature enterprises, these enterprises and their investors will seek to expand through traditional exit strategies, such as merger and acquisition transactions and initial public offerings. The future of the crypto asset market is likely to be one of expansion and increased deal activity, calling for specialised legal services from attorneys who understand the intricacies of the industry and its underlying technologies. Similar to blockchain-based securitisation, which is already recognised as a growth area by major law firms, there is likely to be an increased demand for attorneys who are able to service crypto funds and subsequent transactions involving their portfolio companies. As a result, transactional and regulatory law practitioners should pay close attention to developments in this space.

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Acknowledgment

The author would like to thank the Information Society Project at Yale Law School, the Stanford/Vienna Transatlantic Technology Law Forum, and the Stanford CodeX Blockchain Working Group for their encouragement in the undertaking of comparative and international academic research on blockchain technology and cryptocurrency regulation. The author would also like to thank Preqin, PitchBook, Crypto Fund Research and the Tabb Group for providing access to their high-quality data on cryptocurrency market trends and cryptocurrency investment funds.

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The Information Society Project (“ISP”) is an intellectual centre at Yale Law School, founded in 1997 by Professor Jack Balkin. Over the past 20 years, the ISP has grown from a handful of people gathering to discuss internet governance into an international community working to illuminate the complex relationships between law, technology, and society.

Endnotes


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5. Grayscale Investments raised $250m in new assets during first half of 2018. See Business Insider, “Bitcoin may be down 45% this year, but money is pouring into one crypto fund manager at the fastest clip in its history,” 18 July 2018. Available at: https://finance.yahoo.com/news/bitcoin-may-down-45-money-120000293.html [Accessed 14 August 2018].


11. Ernst & Young (2018), IFRS (#) Accounting for Crypto-Assets.


17. Id.


20. Id.


22. Id.

23. Id.


34. Autonomous NEXT (2018), #CRYPTO UTOPIA.


37. Autonomous NEXT (2018), #CRYPTO UTOPIA.
50. Id.


57. Hedge Fund Research (2018), HFR Blockchain Indices Defined Formulaic Methodology.


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Fintech and Private Equity: Blockchain Technology Use Cases

Yale Law School

Jonathan Cardenas

1. Introduction

Blockchain-enabled financial services technology is at the top of the agenda in 2018 for public and private sector actors around the world. Together with artificial intelligence, blockchain is increasingly recognised as a technology that has the potential to permanently disrupt the financial services industry. Blockchain, in particular, is gaining an increased level of attention as a technology that has the potential to transform the status quo in the private equity and venture capital ("PE&VC") industry. This chapter briefly outlines select publicly known use cases of blockchain technology that have been implemented into the operations of established players in the PE&VC industry. It also discusses some of blockchain’s potential impacts on the provision of legal services to the PE&VC industry.

2. Fund Administration

2.1 Overview

PE&VC fund managers have historically addressed their fund administration needs internally. In recent times, however, PE&VC funds have increased their use and reliance upon third-party service providers for fund administration, and the trend is projected to continue. Due in part to post-financial crisis regulation, including the Foreign Account Tax Compliance Act, the EU Alternative Investment Fund Managers Directive and cross-border anti-money laundering rules, as well as increased demand from institutional investors for transparency with respect to management fees and disclosure of expenses paid to General Partners, PE&VC funds of all sizes have begun to outsource their fund administration needs in order to avoid audits, regulatory compliance violation sanctions, and related litigation. The types of fund administration matters that have been outsourced to third-party administration service providers include accounting, calculation of capital calls and distributions, investor relations and regulatory compliance. Given the increased pressure on PE&VC fund managers to outsource fund administration to increase transparency, as well as the proliferation of new technologies available to make fund administration and operational processes more efficient, fund administration has been a prime target for experimentation with blockchain technology.

2.2 Fund Record Keeping

The first publicly known application of blockchain technology to private equity fund administration was launched in February 2017 by Northern Trust Corporation, in collaboration with IBM and Geneva-based asset management firm Unigestion. Using the Hyperledger Fabric blockchain platform (a collaborative open source software research and development project hosted by the Linux Foundation that consists of a permissioned blockchain system, which among other things, allows for the execution of smart contracts), Northern Trust developed a pilot blockchain system for managing the record keeping functions of a Guernsey-domiciled Unigestion fund. The Northern Trust private equity blockchain system, which operates as a cloud-based private permissioned blockchain that is secured by hardware-assisted cryptography, provides fund managers, investors, service providers and regulators with a shared and immutable record keeping platform upon which authorised users can upload and transfer fund transactional documents in real time throughout the lifecycle of an investment, rather than rely upon e-mail or written correspondence.

With the Northern Trust blockchain system, a fund’s contractual, financial and regulatory records can be accessed and managed directly by authorised users, each of which is provided with a unique node. Once authorised users upload data on the blockchain, the data is recorded on the immutable blockchain ledger and, as a consequence, users are provided with a single “shared golden source” of transactional data upon which fund administration matters, such as capital calls and transfers of ownership, can be managed. In other words, rather than having multiple versions of fund documents located in multiple locations (including, potentially, multiple jurisdictions) and edited separately by multiple parties at separate times (sometimes leading to competing versions of the same document), the blockchain system eliminates this inefficient fragmentation of data by providing authorised fund users with a single encrypted “version of the truth” for each document that is uploaded to the distributed database.

2.3 Impact on Legal Services to the PE&VC Industry

The Northern Trust private equity blockchain system is considered disruptive to the PE&VC fund administration business because of the time efficiencies and cost savings that the system offers. It is also considered disruptive to the PE&VC legal services industry because it could replace “process level” legal documentation management, which is routinely handled by law firms, with an online system in which changes to transactional and/or regulatory documents can be made and shared instantaneously with all permissioned parties. As a result of the low cost and high speed with which information can be shared and modified between fund managers, investors, administrators and regulators on the blockchain system, there is projected to be less of a need in the future to “funnel” data through law firms or other third parties. This provides PE&VC fund managers with a reduced time to market, which includes less time and less
cost associated with traditional legal services. Although some opine that a more wide-scale adoption of blockchain technology by the PE&VC industry “will not necessarily cut out lawyers when needed for more value-added input”, the overall potential for disruption to the PE&VC legal services industry is significant, and law firms should prepare to adapt to these changes accordingly.

2.4. Fund Audit Services

Building upon its experience with blockchain-based private equity fund administration, Northern Trust has recently expanded its private equity blockchain system to the private equity audit domain. Working in collaboration with IBM, PwC and an undisclosed Guernsey-based audit firm, Northern Trust has enhanced its private equity blockchain system by allowing audit firms to have their own node on the Northern Trust blockchain system, thereby enabling auditors to directly access a “golden copy” of fund data and carry out audits of specific private equity lifecycle events in real-time, rather than on a periodic basis. Fund auditors can choose to either import fund data directly from the blockchain into their existing audit applications or can perform audits on the blockchain itself in conjunction with smart contract technology that is currently being developed by Northern Trust. Northern Trust is expected to expand its private equity blockchain system to other functions and to other existing clients by mid-2018 or early 2019.

3. Fund Distribution

Cross-border private equity fund distribution is another area in which there has been a significant level of PE&VC industry experimentation with blockchain technology. In December 2016, a blockchain-enabled fund distribution platform known as FundsDLT was created in Luxembourg through a collaborative initiative between Fundsquare (a wholly-owned subsidiary of the Luxembourg Stock Exchange), InTech (an information technology consulting division of Luxembourg’s state-owned POST Luxembourg telecommunications corporation), and KPMG Luxembourg. The FundsDLT platform was designed to reduce costs associated with cross-border fund distribution transaction settlement processes by creating direct links on a blockchain between various actors in the fund distribution supply chain. It enables fund shares to be issued directly to investors, for example, by way of a secure distributed ledger that uses smart contract technology to generate an immutable and searchable record of transactions, thereby eliminating the time and cost associated with obtaining approvals from multiple actors in what would otherwise be a fragmented supply chain. European fund managers have been quick to experiment with the FundsDLT platform.

In July 2017, Natixis Asset Management, an affiliate of Paris-based Natixis Global Asset Management, became the first global asset management firm to execute a fund distribution transaction using the FundsDLT platform.

In January 2018, BNP Paribas Asset Management experimented with blockchain-driven fund distribution by executing an end-to-end fund distribution transaction using both the FundsDLT platform and Fund Link, BNP Paribas’ own blockchain-enabled fund distribution platform, which it co-developed with AXA Investment Management. The BNP Paribas transaction, which included “each part of the fund trade process, from the delivery of the order to the processing of the trade,” is regarded as a milestone in the development of blockchain-enabled fund distribution because it demonstrates the interoperability of various blockchain fund distribution platforms. The recent success of the FundsDLT platform has led to increased demand for experimentation with the technology, and fund managers from the U.S., UK and Germany are said to be in discussions with FundsDLT to test the platform in the future.

4. Fund Payments & Digital Identity Security

In addition to fund administration and fund distribution, blockchain technology has been experimented with in the context of fund payments and digital identity security. In September 2017, Partners Group, a Zug, Switzerland-based private equity firm, acted in cooperation with inacta AG, a Zug, Switzerland-based information technology consulting firm, to implement an Ethereum blockchain-based smart contract system to verify the authenticity of documents exchanged between fund counterparties in the execution of payment orders. The Partners/inacta document verification system was designed to increase the security and process efficiency of electronic payment order requests, which are typically exchanged between fund counterparties in the form of PDF files and Excel spreadsheets sent via vulnerable electronic means, such as email. In order to verify the identity of fund bankers who request payment from Limited Partners, for example, the system utilises timestamping and digital fingerprinting using cryptographic hash values. Only after their identity is authenticated can fund counterparties gain access to the ledger in order to obtain confidential details needed to execute payment orders. This helps to ensure that a mega fund payment of over $1 billion USD, for example, is not sent to the account of a cybercriminal posing as a legitimate fund counterparty. According to Partners Group, the document verification system is being used for various transactions per day and is being tested for future smart contract-based use cases in other areas of their private equity business. The Partners/inacta document verification system is a key example of the many financial services-related blockchain technology use cases that are being developed in Switzerland’s Crypto Valley ecosystem.

5. Conclusion

PE&VC fund managers around the world are experimenting with blockchain technology to increase the efficiency, transparency and security of their operations. From fund administration to fund distribution and payments, blockchain is clearly regarded as a technology that has the potential to disrupt the status quo in the PE&VC industry. Like any other area of technology, only some blockchain technology use cases will reach fruition. Nevertheless, the potential for a long-term transformation of the PE&VC industry is real, and law firms, in particular, should pay close attention to how blockchain-driven PE&VC disruption could lead to blockchain-driven PE&VC legal services disruption.
Endnotes


xii Id.


xxii Id.


The Information Society Project ("ISP") is an intellectual centre at Yale Law School, founded in 1997 by Professor Jack Balkin. Over the past 20 years, the ISP has grown from a handful of people gathering to discuss internet governance into an international community working to illuminate the complex relationships between law, technology, and society.

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Acknowledgment
The author would like to thank the Information Society Project at Yale Law School and the Center for Law & Economics at the Swiss Federal Institute of Technology ("ETH Zürich") for their encouragement in the undertaking of comparative and international academic research on FinTech and blockchain technology.

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Crypto-Currency Investing Examined

Version 1.5
April 2018

By Jim Kyung-Soo Liew¹, Richard Ziyuan Li², and Tamas Budavari³

Abstract

In this work we examine the largest 100 crypto-currency returns ranging from 2015 to early 2018. We concentrate our analysis on daily returns and find several interesting stylized facts. First, principal components analysis reveals a complex daily return generating process. As we examine data in the most recent year, we find that surprisingly more than one principal component appears to explain the cross-sectional variation. Second, similar to hedge fund returns, crypto-currency returns suffer from the “beta-in-the-tails” hidden risk. Third, we find that predicting cryptocurrency movements with machine learning and artificial intelligence algorithms is marginally attractive with variation in predictability power per crypto-currency. Fourth, lower volatile cryptocurrencies are slightly more predictable than more volatile ones. Fifth, evidence exists that efficacy of distinct information sets varies across machine learning algorithms, showing that predictability may be much more complex given a set of machine learning algorithms. Finally, short-term predictability is very tenuous, which suggests that near-term cryptocurrency markets are semi-strong form efficient and therefore, day trading cryptocurrencies may be very challenging.

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Keywords: Bitcoin, Cryptocurrencies, AI, Machine Learning, PCA, Beta-in-the-Tails

1 Introduction

1.1 Cryptocurrency

Cryptocurrency is a digital asset designed to work as a store of value and a medium of exchange. As of February 28th 2018, the total market capitalization of the cryptocurrency market stood at $448 billion and consists of 1,524 types of currencies. Amongst the many controversies surrounding cryptocurrencies, a popular topic of debate is whether it should be classified as a commodity, investment, property, currency or digital currency. Bitcoin puts cryptocurrencies center stage in the popular press and with the recent painful pull back in early 2018, the interest in Bitcoins in particular continues to hold. Bitcoins started 2017 at $998.33 and grew 14x to finish the year at $14,156.40, as is shown in Figure 1. As of February 28th, the price was $10,559.20.

![Bitcoin price from Jan 1, 2017 to Feb 18, 2018](image)

Figure 1: Bitcoin price from Jan 1, 2017 to Feb 18, 2018

Bitcoin, the first successful cryptocurrency, was created in January 2009, in the aftermath of the financial crisis of 2008, by an unknown person or a group of people under the Japanese name of Satoshi Nakamoto. Bitcoin utilizes a technology called blockchain, which is a combination of cryptography, consensus algorithms, economic incentives and distributed ledger to secure its transactions. While the technical discussion of blockchain is beyond the scope of this work, this technology has endowed Bitcoin with many important characteristics, such as

1. Decentralization,
2. Trusted network built upon potentially untrustworthy nodes,

---

(3) Transparency, and
(4) Immutability history, etc.

Many cryptocurrencies were invented after Bitcoin, but Bitcoin continues to be the most popular, as evidenced by its having the largest market capitalization and trading volume, shown in Exhibit 1 below. Subsequently, our investigation primarily focuses on Bitcoin prices in this research.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Price</th>
<th>Market Cap ($Billion)</th>
<th>Volume (24 hrs $Billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bitcoin</td>
<td>$10,559.20</td>
<td>$178.4</td>
<td>$6.9</td>
</tr>
<tr>
<td>2</td>
<td>Ethereum</td>
<td>$869.63</td>
<td>$85.1</td>
<td>$2.0</td>
</tr>
<tr>
<td>3</td>
<td>Ripple</td>
<td>$0.921</td>
<td>$36.0</td>
<td>$0.33</td>
</tr>
<tr>
<td>4</td>
<td>Bitcoin Cash</td>
<td>$1,223.85</td>
<td>$20.8</td>
<td>$0.38</td>
</tr>
<tr>
<td>5</td>
<td>Litecoin</td>
<td>$208.43</td>
<td>$11.6</td>
<td>$0.78</td>
</tr>
<tr>
<td>6</td>
<td>NEO</td>
<td>$135.27</td>
<td>$8.8</td>
<td>$0.33</td>
</tr>
<tr>
<td>7</td>
<td>Cardano</td>
<td>$0.317</td>
<td>$8.7</td>
<td>$0.12</td>
</tr>
<tr>
<td>8</td>
<td>Stellar</td>
<td>$0.346</td>
<td>$8.2</td>
<td>$0.037</td>
</tr>
<tr>
<td>9</td>
<td>EOS</td>
<td>$8.64</td>
<td>$6.0</td>
<td>$0.38</td>
</tr>
<tr>
<td>10</td>
<td>IOTA</td>
<td>$1.89</td>
<td>$5.3</td>
<td>$0.044</td>
</tr>
</tbody>
</table>


While participants of the Bitcoin blockchain can transfer Bitcoins with each other directly, most investors have to go to cryptocurrency exchanges if they want to purchase Bitcoins with U.S. dollars or other traditional currencies. While the quoted prices from different exchanges can vary largely, arbitrage was very difficult due to the lack of easy access to short Bitcoins, until CBOE and CME introduced Bitcoin futures in December 2017.

1.2 Artificial Intelligence (AI)
Similar to cryptocurrency, AI is another increasingly intriguing technological development. AI represents a broad range of techniques including machine learning, deep learning, natural language processing, etc. Its application is rapidly penetrating every aspect of human society - e-commerce, autonomous vehicles, image recognition, to name a few. A detailed discussion of AI techniques and their application, unfortunately, is beyond the scope of this paper.

Financial institutions are increasingly testing and deploying AI techniques to obtain an edge in their business, such as in trading. Money managers have been employing thousands of quantitative experts to develop sophisticated AI models for predicting prices, identifying signals, monitoring sentiment, etc. While the efficacy of these efforts is still debatable, AI models and strategies are prevailing in every market (equity, commodity, FX, etc). It is, therefore, only a matter of time before practitioners and academic researchers begin using AI techniques to analyze cryptocurrency markets. We hope our findings herein will serve as an important contribution to this growing field.

1.3 Our Research Results

In this paper, we first analyze the top 100 cryptocurrencies using correlation analysis and principal component analysis (PCA). Daily returns reveals that in some period there exists a single dominant component however, in the most recent prior year there appears to be two components that help explain the variation of the cryptocurrency returns. Next, we compare cryptocurrencies with traditional assets. We also perform Liew (2013)’s beta-in-the tail analysis to examine potential hidden risks. We find some evidence that similar to hedge funds, cryptocurrencies may suffer from this hidden risk.

Finally, we conduct rolling prediction analysis on 57 cryptocurrencies with 11 AI algorithms. Our results show that predictability may be difficult and there are many heterogeneous effects here. Some information sets perform better with some family of algorithms, and larger cryptocurrencies with lower volatility maybe more predictable than smaller cryptocurrency with higher volatility.

The remainder of this paper is organized as follows: Section 2 reviews prior literature, Section 3 presents our data and preliminary analysis, Section 4 describes the methodology, Section 5 provides the results and Section 6 summarizes and concludes.

2 Literature Review
While there are many cases and projects about Bitcoin price predictions online, scarce academic research presently exists regarding Bitcoin price predictability. We review the most important prior research in this subject by aggregating them into three different groups.

The first group attempts to predict Bitcoin prices with information about the Bitcoin blockchain network. For example, Madan et al. (2014) from Stanford use three machine learning algorithms to predict the sign of daily price change of Bitcoin based on data about the Bitcoin blockchain network, including average confirmation time, block size, hash rate, etc. They report a highest accuracy of 98.7%. Another group of Stanford researchers, Greaves et al. (2015) perform similar analysis, getting a classification (sign of hourly price change) accuracy of 55%. In addition to information about the blockchain network, McNally (2016) adds daily open, high, low, and close prices as explanatory variables, reporting a classification (signs of daily price changes) accuracy of 52%. El-Abdelouarti Alouaret (2017) moves further by including the S&P 500 index and EUR/USD rate, as well as a variable named bitcoins days destroyed. Similar to sentiment analysis, it also includes a variable representing daily page view on the Wikipedia item “Bitcoin”. It also uses vector autoregression and recurrent neural network to conduct price prediction instead of classification.

The second group of studies focus on the relationship between social media data and Bitcoin performance. For instance, Mai et al. (2015) analyze Bitcoin-related user posts from a forum and Twitter, and demonstrate that more bullish posts are associated with higher future Bitcoin returns. They also conclude that the social media effects on Bitcoin performance are driven by the “silent majority”, and the impact of forum posts is larger than that of tweets. Stenqvist et al. (2017) try to predict Bitcoin price (up/down) using sentiment analysis on Twitter, and report that the sentiment change over a 30-minute period is useful for predicting price movement of 2 hours later, resulting in an accuracy of 79%. Instead of performing sentiment analysis on all social media content posted, Kim et al. (2017) extract the most hot topics on a Bitcoin-related forum and define a time series score to represent the “strongness” of each topic. While these scores are not significant in Granger causality tests, a deep learning model with these scores as inputs leads to prediction (for price and transaction volume) accuracies ranging from 50%+ to 80%+. Interestingly, Kaminskt (2014), by analyzing Twitter posts, claims that social media sentiments mirror the Bitcoin market activity, rather than being predictive.

Instead of Bitcoin blockchain network data and social media data, some papers examine the performance of Bitcoin in other ways. Chu et al. (2015) fits log returns in fifteen popular parametric distributions in finance and find that the generalized hyperbolic distribution is the most appropriate. Balcilar et al. (2017) perform causality-in-quantiles tests and point out that Bitcoin trading volume can predict price returns but fail to predict volatility. Indera et al. (2017)
use Multi-layer Perceptron (MLP) to predict Bitcoin price based on historical open, high, low, and close, as well as the moving average technical indicators, reporting significant results (in MSE).

The third group of research comprises of researchers attempting to use every factor to predict Bitcoin price. Georgoula et al. (2015) and Garcia et al. (2015) contribute their work in this way. As they provide many conclusions, we are not summarizing here.

3 Data and Preliminary Analysis

3.1 Cryptocurrency

As we mentioned above, there are 1,524 different cryptocurrencies as of February 28, 2018, and they are traded at many different exchanges (markets). Fortunately, CoinMarketCap.com collects transaction data of these cryptocurrencies from various exchanges and publishes both up-to-date and historical data for free, which can be obtained through their API. Taking advantage of this resource, we scrap the historical data of the top 100 cryptocurrencies, in terms of market capitalizations as of February 18, 2018. Before selecting the top 100, we remove those with relatively short history. Therefore, all selected cryptocurrencies date back to at least January 1, 2017, and Figure 2 shows the number of cryptocurrencies under analysis over time. The data includes close price, trading volume, and market capitalization during the period of January 1, 2015 to December 31, 2017.

Figure 2: Number of cryptocurrencies under analysis (Jan 2015 - Feb 2018)

---

5 We judge the length of the history based on data from coinmarketcap.com, thus it may not be the exact lengths of history for some cryptocurrencies.
3.1.1 Price returns

We calculate daily, weekly, and monthly returns for each cryptocurrency as (holding period returns):

\[ R_t = \frac{P_t}{P_{t-1}} - 1 \]  (1)

We conduct normality tests on all returns series and find that during Jan 1, 2015 to Feb 18, 2018, none of the daily price returns of any cryptocurrency is normal at the significance level of 95%. For weekly returns, two cryptocurrencies yield normal returns. And ten of them have normal monthly returns. Therefore, we think it is more appropriate to use holding period returns rather than log returns.

Table 2, Table 3, and Table 4 provide statistics summary of price returns of Bitcoin (BTC), Ethereum (ETH), and Ripple (XRP), respectively, which are the top 3 cryptocurrencies in terms of market capitalization, as of February 18, 2018. All the three have an average daily returns of less than 1% as well as single-digit weekly returns.

Table 5 presents the average statistics summary for the top 100 cryptocurrencies. On average, these cryptocurrencies have an average history of 30 months. Due to some volatile cryptocurrencies, the average returns and average standard deviations are larger than those for the top 3 shown above.

| Table 2: Statistics summary for price returns of Bitcoin (Jan 2015 - Feb 2018) |
|---------------------------------|--------|--------|-----------|--------|--------|--------|
|                                | Count  | Mean   | Standard deviation | Minimum | Median | Maximum |
| Daily                          | 1144   | 0.0039 | 0.0403              | -0.2115 | 0.0026 | 0.2525  |
| Weekly                         | 163    | 0.0268 | 0.1053              | -0.2834 | 0.0187 | 0.5097  |

Notes: the “Count” means the number of daily returns and etc. This note applies to the next three tables.

---

6 The average history is calculated using the data for only 2015 to 2017, thus it is not the exact length of average history. But as most of the top 100 cryptocurrencies came into being after 2015, this calculation approximates the real length of average history.
Table 3: Statistics summary for price returns of Ether (Aug 2015 - Feb 2018)

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>926</td>
<td>0.0097</td>
<td>0.0798</td>
<td>-0.7280</td>
<td>-0.0002</td>
<td>0.5103</td>
</tr>
<tr>
<td>Weekly</td>
<td>132</td>
<td>0.0682</td>
<td>0.2514</td>
<td>-0.3394</td>
<td>0.0098</td>
<td>1.4227</td>
</tr>
</tbody>
</table>

Table 4: Statistics summary for price returns of Ripple (Jan 2015 - Feb 2018)

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>1144</td>
<td>0.0065</td>
<td>0.0914</td>
<td>-0.4600</td>
<td>-0.0035</td>
<td>1.7937</td>
</tr>
<tr>
<td>Weekly</td>
<td>163</td>
<td>0.0494</td>
<td>0.2808</td>
<td>-0.3311</td>
<td>-0.0169</td>
<td>1.9992</td>
</tr>
</tbody>
</table>

Table 5: Average statistics summary for price returns of the Top 100 cryptocurrencies (Jan 2015 - Feb 2018)

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>962</td>
<td>0.0452</td>
<td>0.4701</td>
<td>-0.5580</td>
<td>-0.0009</td>
<td>9.0874</td>
</tr>
<tr>
<td>Weekly</td>
<td>137</td>
<td>0.1636</td>
<td>0.9940</td>
<td>-0.5356</td>
<td>0.0064</td>
<td>9.2084</td>
</tr>
</tbody>
</table>

Notes:
1. First, we calculate the statistics summary for each cryptocurrency, including count, mean, standard deviation, minimum, median, and maximum. Then, we calculate the averages of these statistics of all cryptocurrencies.
2. Not all cryptocurrencies have history back to January 2015. The missing values are dropped before calculating the statistics.

3.1.2 Correlations

7 The data of Ethereum provided by coinmarketcap.com starts on Aug 7, 2015.
To reveal the relationship between various cryptocurrencies, we calculate the correlations of price returns between the top 100 of them. Figure 3 presents the heatmaps of the correlations of daily returns. And Table 6 provides statistics summary for the correlations across all top 100. Obviously, most of the cryptocurrencies are positively correlated and correlations are getting higher when the time frame becomes larger. Another interesting finding is that correlations between large market-cap cryptocurrencies are higher than correlations between smaller market-caps. Therefore, we can conclude that most cryptocurrencies are moving in herds with lower double-digit correlations, and this phenomenon is stronger between large market-caps.

Finally, to find out how correlations among cryptocurrencies develop over time, we perform a rolling analysis as is shown in Figure 4. On each day, we calculate the correlations based on daily returns of the preceding 60 (180) days, and then we use the arithmetic mean as the average correlation for that day. That said, the statistic represents the level of correlation of the overall cryptocurrency market during the past 60 (180) days. Obviously, an interesting finding is the spike of market correlation in the second half of 2017, which was exactly accompanied with the rising hotness of cryptocurrencies.

![Cryptos daily return correlations](image)

**Figure 3: Correlations of daily price returns between top 100 cryptocurrencies (Jan 2015 - Feb 2018)**

| Table 6: Statistics summary for correlations of returns between top 100 cryptocurrencies (Jan 2015 - Feb 2018) |

---

8 For horizontal axis, cryptocurrencies are ranked by market capitalizations from the right (large) to the left (small). For vertical axis, they are ranked by market capitalizations from the top (large) to the bottom (small).
To have a closer look at Bitcoin, we summarize the statistics of its correlations of price returns with other cryptocurrencies in Table 7. On average, Bitcoin has a correlation of price returns (daily, weekly) of about 0.20 with other cryptocurrencies. In addition, Table 8 lists the most and least correlated cryptocurrencies with Bitcoins. One interesting cryptocurrency stood out upon a quick inspection - Litecoin (LTC) is highly positively correlated with Bitcoin in both time frames.

We also examine the autocorrelation of Bitcoin, as is shown in Figure 5. The autocorrelations for daily returns fall between -0.05 and 0.05, implying a low autocorrelation nature.

**Table 7: Statistics summary for correlations of between Bitcoins and other cryptocurrencies (Jan 2015 - Feb 2018)**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>0.1210</td>
<td>0.0522</td>
<td>0.0052</td>
<td>0.1290</td>
<td>0.2289</td>
</tr>
<tr>
<td>Weekly</td>
<td>0.1569</td>
<td>0.0659</td>
<td>0.0036</td>
<td>0.1729</td>
<td>0.2855</td>
</tr>
</tbody>
</table>

Notes:
First, for each cryptocurrency, we calculate the mean of its correlations with other cryptocurrencies. Then, we calculate these statistics of the means of correlations.
<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>0.2211</td>
<td>0.1158</td>
<td>-0.0140</td>
<td>0.2225</td>
<td>0.5035</td>
</tr>
<tr>
<td>Weekly</td>
<td>0.1897</td>
<td>0.1382</td>
<td>-0.1135</td>
<td>0.1962</td>
<td>0.4976</td>
</tr>
</tbody>
</table>

Notes: These statistics are calculated based on the correlations of price returns between Bitcoins and the other 99 cryptocurrencies.

Table 8: Most and least correlated cryptocurrencies with Bitcoins (Jan 2015 - Feb 2018)

<table>
<thead>
<tr>
<th></th>
<th>Daily returns</th>
<th>Weekly returns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Symbol</td>
<td>Correlation</td>
</tr>
<tr>
<td>Most correlated</td>
<td>PPC</td>
<td>0.5035</td>
</tr>
<tr>
<td></td>
<td>LTC</td>
<td>0.5006</td>
</tr>
<tr>
<td></td>
<td>DOGE</td>
<td>0.4740</td>
</tr>
<tr>
<td></td>
<td>NMC</td>
<td>0.4678</td>
</tr>
<tr>
<td></td>
<td>WAVES</td>
<td>0.4401</td>
</tr>
<tr>
<td>Least correlated</td>
<td>PASC</td>
<td>-0.0140</td>
</tr>
<tr>
<td></td>
<td>PURA</td>
<td>0.0029</td>
</tr>
<tr>
<td></td>
<td>NYC</td>
<td>0.0244</td>
</tr>
<tr>
<td></td>
<td>MOON</td>
<td>0.0248</td>
</tr>
<tr>
<td></td>
<td>EXP</td>
<td>0.0306</td>
</tr>
</tbody>
</table>

Notes: the ranks are based on magnitudes of correlations.
3.1.3 Principal Component Analysis (PCA)

To uncover the common drivers of price returns, we employ a popular dimensionality reduction techniques -- PCA. The starting time of each cryptocurrency varies, thus to avoid artificially creating biasedness by filling backward on the missing leading values, we select three subsets of time for our PCA analysis and only employ overlapping series. First, we select the 59 cryptocurrencies which have full history back to January 1, 2015. Second, we select the 74 cryptocurrencies with full history back to January 1, 2016. Finally, we select the 100 cryptocurrencies which have returns back to January 1, 2017. We perform PCA for our three periods employing daily price returns.

Figure 6, Figure 7, and Figure 8 present the results for 2015 to Jan 2018, 2016 to Jan 2018, and 2017 to Jan 2018, respectively. In the first and second case, the first principal component captures the majority of the variance, with less variation explained by the other four principal components. In the third case, the period from 2017 to February 2018 the daily returns appears to differ in their structure. Figure 8 displays that the variation explained by the second principal component gains significantly as the first principal component fall to less than 60%.

Clearly, 2017 was a banner year for cryptocurrency and the addition of more retail investors could be one of the explanation of why this period may have a different underlying structure in the return generating process compared to the two other periods. Retail investors became more heavily involved purchasing cryptocurrencies as evidenced by CoinBase having more accounts than Charles Schwab in November 27, 2017. This changing investor base could possibly bring in more of a herding and momentum behavior if these retail investors are susceptible to known biases similar to those affecting stock retail investors.

---

3.2 Traditional assets

Recent literature (Liew and Hewlett, 2017) shows that Bitcoin provides diversification to portfolio comprised of traditional assets. We dig in and investigate the the cross-market relationship between the top 100 cryptocurrencies and traditional assets. Daily prices of following assets are downloaded from Bloomberg Terminal:

- S&P 500 index (SPX Index): It is a capitalization-weighted index of 500 stocks trading in the U.S. stock market.
- MSCI World Index (MXWO Index): It is a free-float weighted equity index covering stocks trading in developed markets.
- MSCI Emerging Markets Index (MXEF Index): It is a free-float weighted equity index covering large and mid cap stocks trading in emerging markets.
- US Dollar Index: a measure of the value of the U.S. dollar relative to the value of a basket of currencies of the majority of the U.S.’s most significant trading partners.
- Gold spot price (in US$)
- Bloomberg Commodity Index (BCOM Index): It is an index reflecting commodity futures price movement.
- VIX Index: The measure of volatility implied by S&P 500 index options, calculated and published by CBOE.

Table 9 presents the correlations between Bitcoin, other cryptocurrencies, and traditional assets, calculated in terms of daily returns. Obviously, Bitcoin is barely correlated to any traditional assets at the daily level (absolute correlations < 0.1). It exhibits a slightly positive correlation to S&P 500, MSCI, USD, Gold, and Commo, while demonstrating a negative correlation to Emg and VIX. Not surprisingly Bitcoin is positively associated with the first PCA component and very highly correlated to the market capitalization weighted cryptocurrency returns.

<table>
<thead>
<tr>
<th></th>
<th>BTC</th>
<th>VW</th>
<th>SP500</th>
<th>MSCI</th>
<th>Emg</th>
<th>USD</th>
<th>Gold</th>
<th>Commo</th>
<th>VIX</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTC</td>
<td>1.0000</td>
<td>0.9416</td>
<td>0.0441</td>
<td>0.0232</td>
<td>-0.0212</td>
<td>0.0134</td>
<td>0.0419</td>
<td>0.0351</td>
<td>-0.0921</td>
</tr>
<tr>
<td>VW</td>
<td>0.9416</td>
<td>1.0000</td>
<td>0.0538</td>
<td>0.0316</td>
<td>-0.0204</td>
<td>-0.0049</td>
<td>0.0526</td>
<td>0.0359</td>
<td>-0.0975</td>
</tr>
<tr>
<td>SP500</td>
<td>0.0441</td>
<td>0.0538</td>
<td>1.0000</td>
<td>0.9093</td>
<td>0.4480</td>
<td>0.0831</td>
<td>-0.1674</td>
<td>0.2967</td>
<td>-0.7880</td>
</tr>
<tr>
<td>MSCI</td>
<td>0.0232</td>
<td>0.0316</td>
<td>0.9093</td>
<td>1.0000</td>
<td>0.6587</td>
<td>-0.0413</td>
<td>-0.1262</td>
<td>0.3836</td>
<td>-0.7283</td>
</tr>
<tr>
<td>Emg</td>
<td>-0.0212</td>
<td>-0.0204</td>
<td>0.4480</td>
<td>0.6587</td>
<td>1.0000</td>
<td>-0.0426</td>
<td>-0.0053</td>
<td>0.3641</td>
<td>-0.3848</td>
</tr>
<tr>
<td>USD</td>
<td>0.0134</td>
<td>-0.0049</td>
<td>0.0831</td>
<td>-0.0413</td>
<td>-0.0426</td>
<td>1.0000</td>
<td>-0.4070</td>
<td>-0.2427</td>
<td>-0.0828</td>
</tr>
<tr>
<td>Gold</td>
<td>0.0419</td>
<td>0.0526</td>
<td>-0.1674</td>
<td>-0.1262</td>
<td>-0.0053</td>
<td>-0.4070</td>
<td>1.0000</td>
<td>0.2441</td>
<td>0.1365</td>
</tr>
<tr>
<td>Commo</td>
<td>0.0351</td>
<td>0.0359</td>
<td>0.2967</td>
<td>0.3836</td>
<td>0.3641</td>
<td>-0.2427</td>
<td>0.2441</td>
<td>1.0000</td>
<td>-0.2224</td>
</tr>
<tr>
<td>VIX</td>
<td>-0.0921</td>
<td>-0.0975</td>
<td>-0.7880</td>
<td>-0.7283</td>
<td>-0.3848</td>
<td>-0.0828</td>
<td>0.1365</td>
<td>-0.2224</td>
<td>1.0000</td>
</tr>
</tbody>
</table>
3.3 Beta-in-the-Tails Analysis (BTA)

In this section we estimate the potential hidden risks in the cryptocurrency markets. In particular, we examine the stability of their betas for Bitcoin and the VW index with respect to the market, which we employ the S&P 500 as a proxy. Edwards and Caglayan (2001) document changes in hedge fund correlation in bull and bear markets. Liew (2003) introduces the beta-in-the-tail analysis for hedge funds and documents the vanishing diversification benefits as a hidden risk for hedge fund investors. In down periods the beta associated to hedge fund increases and thus decreasing the perceived diversification benefits. Similarly we find such an occurrence for cryptocurrencies and warn potential investors to be vigilant with regards to the beta-in-the-tail risk.

Upon visual inspection we document the increasing betas in down S&P 500 daily return periods. We argue that beta-in-the-tail is a significant hidden risk for cryptocurrency investors when employing daily returns.

The methodology for daily beta-in-the-tail analysis follows: First, order all the daily returns on the S&P 500 from least to greatest. Associated to each S&P 500 day period we link both the Bitcoin return and MarketCap Weighted Index return for that day. Next we anchor the worst daily returns for the S&P 500 and use thirty days of returns to run our regressions. That is, we estimate the beta associated with the worst thirty days in our sample period. At this point, it is important to note that the time dimension has been compromised with this sorting of the daily returns.

The regression is the crypto-returns regressed on the S&P 500 returns. Assuming that the risk-free daily returns are zero yields the CAPM’s beta of Sharpe (1964) and Lintner (1965) for the given cryptocurrency index. By anchoring the worst return day for the S&P 500 and expanding the window of daily returns we plot the slope coefficients with inclusion of another daily return. When the window has been expanded to include all the daily returns then the finally regression corresponds to the beta for the whole period period.

The Betas are reported in the left y-axis and the average daily returns for the window period is reported in the right y-axis on the black dashed line. Standard deviation bands surround the beta estimates. Notice that as more observations are included the standard deviation of the
beta estimates reduces. The beta-in-the-tails based on daily returns reach above 1.0 compared this to the whole period beta of close to zero for Bitcoin and VW Index, respectively, as seen on the furthest left bottom corner of Figure 9.

![Figure 9: Beta in the Tails (daily)](image)
Notes: Calculated based on daily returns from April 2013 to Feb 2018.

![Figure 10: Beta in the Tails (daily, excluding weekends)](image)
Notes: Calculated based on daily returns from April 2013 to Feb 2018.

Given that cryptocurrencies trade seven days a week and twenty-four hours a day in contrast to stocks which typically trade only five days a week and six and a half hours a day, we repeat the analysis excluding the weekend in Figure 10, Beta in the Tail Excluding the Weekends. We arrive at a similar pattern with an increase in the beta in down S&P 500 days. Beta-in-the-tails appears robust to non-trading weekdays.
4 Methodology - Rolling Prediction Analysis

In this section, we firstly give a brief introduction to the 11 machine learning algorithms we tested. Next, we describe the way we roll the prediction analysis. Finally, we present our data.

4.1 Algorithms

In this subsection, we introduced the 11 machine learning algorithms. Our problem can be easily described with linear models – we have a set of variables \( x \), a matrix with each column being a variable and each row being value for the corresponding day such as historical returns, volatility and etc, and a target variable \( y \), a column vector; and we want to train a model that predicts \( y \) with out of sample input \( x \).

There are three strands of algorithms in our analysis: 1) linear models, including LASSO, ElasticNet, Stochastic Gradient Descent, and Bayesian Regression; 2) tree based models, including Decision Tree, Extra Tree Random Forest, AdaBoost, and Gradient Tree Boosting; 3) other models, including KNN, Support Vector Machine, and Multi-layer perceptron. We briefly introduced each of the algorithms as below.

A typical objective function of linear models is as below:

\[
\min_{\omega} \frac{1}{n} \sum_{i=1}^{n} L(y_i - f(x_i)) + \alpha R(\omega)
\]  

(1)

where \( L \) is loss function, \( R \) is regularization term, \( f \) is the fitted function.

**(1) Least Absolute Shrinkage and Selection Operator (LASSO):** scikit-learn page.

LASSO is a linear model that performs both variable selection and regularization. In contrast to simple linear regression, its objective function is as below. We use the scikit-learn default parameters: squared loss function and L2 regularization with \( \alpha = 1.0 \).

\[
\min_{\omega} \frac{1}{2} \frac{1}{n} \|X\omega - y\|_2^2 + \alpha \|\omega\|_1
\]  

(2)

**(2) ElasticNet (EN):** scikit-learn page.
EN is a linear model that performs regression with both L1 and L2 regularization. This gives it the property of both LASSO and ridge regression, and the objective function is as below. We use the scikit-learn default selection of $\alpha = 1.0$.

$$\min_{\omega} \frac{1}{2} \frac{1}{n} \|X_\omega - y\|_2^2 + \alpha \rho \star \|\omega\|_1 + \frac{\alpha * (1 - \rho)}{2} \|\omega\|_2$$

(3) Stochastic Gradient Descent (SGD): scikit-learn page.

SGD is an efficiency method to fit linear models. It searches for minima or maxima through iterations. We use the scikit-learn default parameters: squared loss function and L2 regularization with $\alpha = 0.0001$.

$$\min_{\omega} \frac{1}{n} \|X_\omega - y\|_2^2 + \alpha \|\omega\|_2$$

(4) Bayesian Regression (BR): scikit-learn page.

BR provides another way of performing linear regression, where linear model can be written as below:

$$y_i = \alpha + \beta \star x_i \text{ with } y_i \sim N(\mu_i, \sigma)$$

That is, $y$ follows a normal distribution with mean $\mu$ and $\sigma$, while $\mu$ is a linear function with parameters $\alpha$ and $\beta$. In this way, the model can be estimated using maximum likelihood function instead of minimizing squared errors:

$$\max_{\alpha, \beta, \sigma} \prod_{i=1}^{n} N(y_i; \alpha + \beta \star x_i, \sigma)$$

(5) Decision Tree (DT): scikit-learn page.

DT is a non-parametric method that can be used for both classification and regression. The tree is built for classifying or predicting test points based on several rules. For classification problems, the leafs of the tree are the classification labels, and for regression problems, the leafs are continuous values. We use the default parameters provided by scikit-learn: using mean square error as splitting criterion, and without max depth of trees.

(6) Extra Tree Random Forest (ETRF): scikit-learn page.
Random forest is an ensemble method built on many trees, and each tree is built through training on a sample of the entire train set with replacement. In addition, when splitting a node during the construction of trees, the best split is measured among a random subset of features rather than all features. This randomness leads to lower variance and larger bias. On the other hand, ETRF moves even further regarding randomness in splitting the nodes – splitting thresholds are randomly assigned instead of searching for the most discriminative thresholds. We use the default parameters provided by scikit-learn: 10 trees without max depth of trees, and using mean square error as splitting criterion.


AdaBoost is an ensemble algorithm that fits a sequence of relatively weak models with repeatedly modified data. More specifically, it firstly train on the original train set and assesses the errors. Then it modifies the train set by assigning more weights to poorly modeled points. The processes are repeated for multiple times. Decision Tree is usually used as the base model in AdaBoost. We use the default parameters provided by scikit-learn: 50 Decision Tree models as base estimators.

(8) Gradient Tree Boosting (GTB): scikit-learn page.

Gradient Boosting is another ensemble algorithm that also fits a sequence of relatively weak models with repeatedly modified data. More specifically, it firstly train on the train set and the original predicted targets. Then it modifies the predicted targets to be certain type of residuals between the true values and the predicted (trained) values. The processes are repeated for multiple times. GTB is the combination of Decision Tree and Gradient Boosting. We use the default parameters provided by scikit-learn: 100 Decision Tree models as base estimators and without max depth.


Typically, KNN method is designed for classification, where discrete labels are determined by the majority of certain amount of nearest data points. However, KNN can also be used for regression where the labels are continuous. The label assigned to a test point is determined based on the mean of the labels of its nearest data points. Scikit-learn provides three methods of searching for nearest neighbors: 1) brute force – compare distances of all pairs of data points; 2) K-D tree – use tree-based structures to reduce the calculations of distances; and 3) ball tree – partition data in a series of nesting hyper-spheres when constructing trees. As scikit-
learn supports auto method selection based on input data, we use this option. Also, we use the default parameters provided by scikit-learn: 5 nearest neighbors and uniform weights.

(10) **Support Vector Machine (SVM):** [scikit-learn](https://scikit-learn.org) page.

For regression, SVM finds the classifiers represented by hyperplanes that separate the different groups as wide a margin as possible. The hyperplanes are represented by the normal vector $v$ and the bias $b$, which can be found by solving a constrained optimization problem:

$$\min_{\omega} \| \omega \|^2 \quad A = \pi r^2 \quad (7)$$

$$s.t. \ y_i \ast (\omega'X_i - \beta) \geq 1, \ i = 1, ..., n$$

SVM can also be used for regression, where similar kernel method is applied. A detailed introduction: [link](https://scikit-learn.org).

(12) **Multi-layer Perceptron (MLP):** [scikit-learn](https://scikit-learn.org) page.

Given a set of features and a target $y$, MLP can learn a non-linear function estimator for either classification or regression. It trains using backpropagation with no activation function in the output layer, which can also be seen as using the identity function as activation function. Therefore, it uses the square error as the loss function, and the output is a set of continuous values. We use the default parameters of scikit-learn: one hidden layer with 100 hidden units and “relu” as activation function.

**4.2 Rolling Methodology**

We perform rolling prediction analysis. That is, we train our models based on prior historical data and predict future returns. The procedure then rolls forward by expanding the train set by one day and then repeating the training and prediction procedure. A detailed description is as below.

Suppose we stand on day $D_t$, and we want to predict the $n$-day ($n>=1$) price returns ahead. To allow the prediction to take place at any time of day $D_t$, we only refer to information up to the previous day $D_{t-1}$. There are two important considerations:

(1) Our predicted variable ($y$) is calculated as: $R_{t,t+n} = P_{t+n} / P_{t-1}$
(2) and our explanatory variables (X), we can only use variables up to day $D_{t-1}$.

For example, the $m$-day historical return on $D_t$: $HR_{t-m, t-1} = P_{t-1} / P_{t-m-1}$. Table 10 provides an example of our data structure.

<table>
<thead>
<tr>
<th>Date</th>
<th>Predicted variable (y)</th>
<th>Explanatory variables (X)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n-day returns</td>
<td>Historical m-day returns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Historical k-day moving averages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>...</td>
</tr>
<tr>
<td>$D_t$</td>
<td>$P_{t+n} / P_{t-1}$</td>
<td>$P_{t-1} / P_{t-1-m-1}$</td>
</tr>
<tr>
<td>$D_{t+1}$</td>
<td>$P_{t+n+1} / P_{t+1-1}$</td>
<td>$P_{t} / P_{t-1}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SUM($P_{t+k}$, ..., $P_{t}$)/k</td>
</tr>
<tr>
<td></td>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

Another problem concerning time series rolling analysis is time series leakage. More specifically, standing on day $D_t$ though we have access to historical information (X) up to the previous day ($D_{t-1}$), but we do not have the predicted variable ($y$), whose calculation involves the close price on day ($t+n$). That said, standing on day $D_t$, if we want to train a model and predict the $n$-day returns ahead, the train set can only be constructed based on data from day $D_0$ to $D_{t-n}$ (the predicted variable for $D_{t-n}$ is $R_{t-n} = P_{t-1} / P_{t-1-n-1}$).

Finally, we repeat our rolling method with a specific example. Suppose we have constructed a time series data set of 1,000 days: the $y$ is a series of 30-day returns and X is a matrix of size 1,000 by 20 (20 explanatory variables). We want to experiment a rolling prediction of 30-day returns. We set the minimum train set size as 100. First, we train a model based on the data from $D_0$ to $D_{99}$ (the predicted variable for $D_{99}$ is $R_{99} = P_{128} / P_{98-1}$); then we use the trained model to predict the $R_{130} = P_{159} / P_{129-1}$ based on $X_{130}$ (a 1 by 20 row vector) which contains information up to day $D_{129}$. Next, we expand the train set to include data from $D_0$ to $D_{100}$ and repeat the training and prediction. The analysis is rolled until we get $R_{1000}$.

### 4.3 Explanatory variables
Table 11 shows the explanatory variables in our rolling prediction analysis (predicting 30-day returns for Bitcoin). Based on the preliminary analysis above, we decide to exclude USD index, gold, and VIX, due to their relatively low correlations with Bitcoin. The variables are constructed in the abovementioned rolling way and standardized using StandardScaler in scikit-learn, which centers the data with sample mean and the scales them into unit variance.

In addition, we categorize these variables into eleven “information sets”. In the later sections, we will examine the relative importance of each information set for Bitcoin, in terms of their contribution to the performance of our machine learning algorithms.

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Information set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Price_ret10</td>
<td>Historical 10-day price returns</td>
<td>Historical price returns</td>
</tr>
<tr>
<td>2 Price_ret30</td>
<td>Historical 30-day price returns</td>
<td></td>
</tr>
<tr>
<td>3 Price_momentum_MA10</td>
<td>The ratio of price to 10-day moving average minus 1</td>
<td>Price momentum</td>
</tr>
<tr>
<td>4 Price_momentum_MA30</td>
<td>The ratio of price to 30-day moving average minus 1</td>
<td></td>
</tr>
<tr>
<td>5 Volume_momentum_MA10</td>
<td>The ratio of trade volume to 10-day moving average minus 1</td>
<td>Volume Momentum</td>
</tr>
<tr>
<td>6 Volume_momentum_MA30</td>
<td>The ratio of trade volume to 30-day moving average minus 1</td>
<td></td>
</tr>
<tr>
<td>7 Price_volatility15</td>
<td>The standard deviation of the daily price returns over the past 15 days</td>
<td>Rolling volatility</td>
</tr>
<tr>
<td>8 Price_volatility30</td>
<td>The standard deviation of the daily price returns over the past 30 days</td>
<td></td>
</tr>
<tr>
<td>9 SP500_ret15</td>
<td>S&amp;P500 historical 15-day price returns</td>
<td>S&amp;P 500</td>
</tr>
<tr>
<td>10 SP500_momentum_MA15</td>
<td>The ratio of price to 15-day moving average of S&amp;P500 minus 1</td>
<td></td>
</tr>
<tr>
<td>11 Developed_ret15</td>
<td>MSCI developed equity market historical 15-day price returns</td>
<td>Developed equity market</td>
</tr>
<tr>
<td>12 Developed_momentum_MA15</td>
<td>The ratio of price to 15-day moving average of MSCI developed equity market minus 1</td>
<td></td>
</tr>
</tbody>
</table>
5 Model Results

5.1 Rolling prediction analysis (30-days) for Bitcoin

We recalculate predicted prices based on predicted 30-day returns, as is shown in Figure 11. As the ill-performance of Multi-layer perceptron during the second half of 2017 leads to poor readability, we present results of the top 3 algorithms (in terms of accuracy) from Jan 2017 to Jan 2018 in Figure 12. Obviously, none of them successfully forecasted the big price crash in Jan 2018. On the other hand, Figure 13 and Figure 14 show the accuracy and RMSE, respectively, both of which are calculated in a cumulative way (expanding the data by one prediction for
each time). As the number of predictions increases, accuracy of all algorithms stabilizes in the range of 50 to 65 percent.

Figure 11: Predicted price v.s. Real BTC price (predicting 30-day returns)

Figure 12: Predicted price v.s. Real BTC price (predicting 30-day returns)

Notes: This figure shows results from Jan 2017 to Feb 2018 for the top 3 algorithms (in terms of accuracy).
5.2 Important information sets for Bitcoin

As stated above, to reveal the potentially useful information sources in predicting Bitcoin prices, we categorize all variables into 10 information sets: 1) price returns, 2) price momentum, 3) rolling volatility, 4) volume, 5) S&P 500, 6) Developed equity market, 7) Emerging equity market, 8) commodity, 9) market capitalization weighted returns of cryptocurrencies (crypto VW), and 10) the 30-day rolling correlation of the overall cryptocurrency market (rolling volatility).

We first run the rolling prediction analysis with all information sets as input, and next, we repeat the analysis for 10 times by removing one information set each time. The “relative importance” of each information set is measured as the difference between the accuracies with and without the corresponding information set as input. That is, a positive difference indicates positive contribution of the information set and negative difference implies the opposite.

Figure 15 shows the heatmap presenting the relative importance of each information set for each algorithm. Overall speaking, none of the information sets has significant impact on any algorithms, as the relative importances fall in the range between -0.05 and 0.05. However, a closer inspection would reveal that, on average, rolling volatility (past 15 days and 30 days) and correlation among cryptocurrency market (past 30 days) are useful information for most algorithms, while the market capitalization weighted historical returns (15-day and 30-day) and emerging equity market are the least beneficial.
5.3 Rolling prediction analysis for other Cryptocurrencies

We also examine the analysis for the 57 cryptocurrencies with available data back to January 1, 2015. Many cryptocurrencies are slightly predictable if the algorithms with the highest accuracies are chosen. Bitcoin yields the highest best accuracy as displayed in Figure 14 below. Another finding is that higher prediction accuracy is associated with larger market capitalization and lower volatility. But we also see that higher predictability is accompanied by larger dispersion among different algorithms.
Figure 14: Summary of rolling prediction results (predicting 30-day returns)

Notes:
1. The volatility is calculated by annualizing the daily volatility over the sample period (Jan 1, 2015 - Feb 18, 2018). We limit the range of x-axis to be [0, 6] for the purpose of readability, and as result 8 cryptocurrencies are removed from the figure.
2. The highest accuracy: we run 11 algorithms for each cryptocurrency and pick the one with highest accuracy.
3. The size of dots is based on the market capitalization of each cryptocurrency, i.e., Bitcoin is the largest.
4. The color of dots is based on the standard deviations of accuracies generated by 12 algorithms (algo dispersion).

Figure 15 presents a performance summary of the 12 algorithms. LASSO dominates in predicting the 30-day returns of cryptocurrencies. And one average, all algorithms generate accuracies in the range of 50 to 60 percent, which is above random guess but still far from accurate prediction.
Figure 15: Summary of algorithm performance (predicting 30-day returns)

Notes:
1. The frequency is the times an algorithm performs the best among the 11 algorithms plus random guess.
2. The mean accuracy is calculated by averaging the accuracies when the corresponding algorithm performs the best.

6 Conclusion

Cryptocurrencies have captured the attention of many investors across the spectrum from retail to institutional (see Liew and Hewlett, 2017). In this work we extend our understanding of the behavior of cryptocurrencies. We document several interesting findings. First off, we find that PCA reveals that the return generating process is much more complex than that for stock returns. Generally speaking, the financial community agrees that the “market” is the first dominant PCA in stock returns. However, for cryptocurrencies daily returns reveals that in some period there exists a single dominant component however, in the most recent prior year there appears to be two components that help explain the variation of the cryptocurrency returns. Next, we document a strong beta-in-the-tails hidden risk associated with Bitcoin daily returns. Similar to hedge fund cryptocurrencies may have some unstable tail behaviors.

Our analysis of machine learning algorithms applied to the data from cryptocurrencies hints that predictability may be difficult and there are many heterogeneous effects here. Some information sets perform better with some family of algorithms, and larger cryptocurrencies...
with lower volatility maybe more predictable than smaller cryptocurrency with higher volatility. Some care should be taken given the many moving parts across the cryptocurrency industry. The complexity will lead to possible risks of overfitting machine learning algorithms.

Reference


http://trap.ncirl.ie/2496/


Appendix
The Case for Bitcoin for Institutional Investors: Bubble Investing or Fundamentally Sound?

By: Jim Liew, Ph.D.¹ and Levar Hewlett, MSF²

Abstract

In this work we assume the institutional investor role and analyze a possible investment in bitcoin (BTC). We document several salient features of BTC employing monthly returns over the period from August 2010 to October 2017. First, it provides unique diversification benefits for traditional institutional portfolios. This diversification benefit appears to be stable over our sample period. Second, bitcoin is very volatile, indeed, but the historical return to risk ratio appears attractive with a Sharpe Ratio of 1.176. Finally, using standard portfolio optimization tools we find that the optimal allocation to BTC is 1.3% over the sample we examined. We present controversial empirical evidence that institutional investors are under allocated to BTC.

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² Levar Hewlett, MSF, is a Quantitative Risk Management Associate at the Maryland State Retirement and Pension System and a recent graduate from the Johns Hopkins Carey Business School.
Introduction

The current size of the cryptocurrency market stands at $247 billion, with over 1,300 different cryptocurrencies traded as of November 25, 2017, according to Coinmarketcap.com. While interest in cryptocurrencies has exploded with the recent headline grabbing gains in Bitcoin (BTC), the largest cryptocurrency with a market capitalization of $144 billion, there is very sparse analysis available regarding the issues an institutional investor faces when investing in Bitcoin. In this work, we attempt to enlighten the institutional investor community with a lively discussion of our thoughts on BTC and the future of the broader cryptocurrency industry. We assess the merits of BTC as an investment from an empirical vantage. Whether we consider BTC as a currency, a commodity, or a bubble that may burst, we apply the standard financial tools readily used by investors.

We examine BTC risk return characteristics with respect to several other investments typically available and well-known to institutional investors. While using the term “standard asset classes” may be debatable for purpose of this work, we will refer to them all as investments. We find that BTC appears surprisingly interesting from a diversification perspective because the return generating process shows to be unrelated to the other investments returns. Moreover, this process appears to be stable in our rolling correlation analysis. Although BTC has a high degree of volatility, its returns compensate accordingly, yielding the investment with the highest Sharpe Ratio.

Are we proposing that institutional investors should allocate 100% to BTC, to the exclusion of other investments? From the mean-variance framework, the answer is a resounding no. In our sample, therefore, the optimal portfolio consists of 48.82% equity, 49.88% bonds, and 1.30% BTC. We are proposing that BTC should be included in institutional portfolios and we fully appreciate the controversy of our position, as it will expose many who implement our recommendation to “career risk”. We invite others to undertake their own analysis and present counter arguments, which will provide the investment community as a whole with a deeper understanding and open dialogue relating to this fascinating financial innovation.

Background Information

Ray Dalio states that there are two purposes of any valid currency:

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3 Interestingly enough the origins of Bitcoin started with Satoshi Nakamoto’s white paper in 2008. Currently, the actual identity of Nakamoto remains a mystery, some believe Nakamoto may be a group of people tainted by the events that occurred in the 2008 financial crash and seeking for an alternative solution for financial transactions.

In the country of Venezuela, citizens have lost confidence in their local currency, the Bolivar, and as such, many have been attempting to exchange their Bolivars for BTC. Due to the inflation having increased over 4,000%\(^5\), the Bolivar’s purchasing power has substantially weakened and continues to decrease in value, leading to citizens substituting away from the depreciating Bolivar to buy and hold BTC, which has been appreciating in value. This is a clear example of investors seeking storehold of wealth. It can be argued, therefore, that for emerging markets, the advent of BTC, allows citizens to protect their wealth against surging inflation and employ BTC as an alternative to the domestic currency to store value.

Now, let us consider BTC as a medium of exchange. One simple example would be when a tech savvy entrepreneur travels to another country and purchases a cappuccino with her BTC on her iPhone X. Indeed, more traditional companies, such as Microsoft, Intuit, Overstock.com, and DISH Network\(^6\), have and announced their acceptance of BTC. Additionally, consider the recent activities in Initial Coin Offerings (ICOs). Speculators are investing in startups through exchanging their crypto-currencies for tokens which provide exposure to the economic upside in these new businesses. Investors are exchanging their crypto-currencies for upside in startup ideas based on nothing more than, at times, a white paper and pseudo code on GitHub. For ICOs, BTC has proved to be a solid medium of exchange.

We organize our paper as follows: First, we present the historical performance of BTC and discuss the views from several notable industry veterans. Next, we examine the standard statistics for all our investments by presenting annualize returns and standard deviation estimates. Following that, we examine the correlation structure across our investments and document that BTC has low correlation to other investments and this correlation appears stable over time. Finally, we present asset allocation analysis with respect to including and excluding BTC, and find that the optimal portfolio consists of 1.3% in BTC.

### Historical Price Behavior

We find that BTC has the longest track record with respect to the other cryptocurrencies through our examination of BTC’s historical data obtained from CoinDesk. In our first observation, BTC

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had a price of $0.09 on July 18, 2010, and at the end of our data series, the prices as of November 22, 2017 was $8.262.59. This is indeed a dramatic run up in value, which brings many respectable professionals to call it an outright bubble. In the bubble camp resides Ray Dalio, Jamie Dimon, and Nobel Prize-winning Professor Robert Shiller.\(^7\) However, there is substantial legitimacy in the other camps, such as Lloyd Blankfein of Goldman Sachs, who tweeted that he has:

“No conclusion—not endorsing/rejection. Know that folks were skeptical when paper money displaced gold.” - Lloyd Blankfein CEO Goldman Sachs

Other notable individuals have gone so far as to praise this new currency.

Recently, the Managing Director of the International Monetary Fund (IMF), Christine Lagarde, stated:

“It may not be wise to dismiss virtual currencies. Instead, citizens may one day prefer virtual currencies.” Christine Lagarde, Managing Director of IMF

Additionally, recently CBOE announced that they would create futures contracts (XBT\(^8\)) on BTC. Although the debate over BTC’s destiny rages on publicly, in this work, we focus on examining the empirical data to support our position.

Exhibit 1: Historical Price of Bitcoins

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In Exhibit 1, BTC has had several booms and busts in its short life. In February 2014 the leading BTC exchange at the time Mt. Gox accounted for up to 80% of trading volume was hacked and 744,000 BTC, 6.0% of all BTC in existence ($6.6B in today’s value) were stolen\(^9\). In the beginning of February 2014 BTC was trading at $853.0. By the end of February, the price had dropped by over 36.0% to $543.0. From January 2014 to December 2014 BTC dropped by 60% to $319.0.

Some warned about the dangers of such risks prior to the theft. At the time Mt. Gox knew about and issue with in the Bitcoin protocol known as “transaction malleability” which prevented users from withdrawing BTC stored by the exchange. Other exchanges knew about the property issues of BTC since 2011 which could have been avoided with coding working arounds. This “transaction malleability” contributed to the 774,000 bitcoin being taken from both Mt. Gox’s active accounts and its reserve storage. It should be noted that the blockchain was not hacked, but rather the computers that held the private keys the exchange used to verify internal and external trades.

After the hacking of Mt. Gox, BTC suffered two large pull backs of 36.0% over the period 06/11/2016 to 07/16/2017 and 34.0% over the period of 09/01/2017 to 09/14/2017. During the months of June and July the pullback was due to normal market factors such as profit taking, rumors and technical issues within the BTC community. All these variables contributed to the price decreasing. However, the technical debate over whether BTC will “Hard fork or Soft fork” (split in to two blockchains with two separate coins) and uncertainly of Bitcoin’s development roadmap contributed the most to price pull back. A hard fork is a radical change to the protocol that makes previously invalid blocks or transaction valid (or vice-versa) and as such requires all nodes or users to upgrade to the latest version of the protocol software\(^10\). This is different from a soft fork. Where changes to the software protocol where only previously valid blocks/transaction are made invalid. The difference is this kind of fork requires the majority of miners to upgrade to enforce the new rules of blockchain, as oppose to a hard fork which requires all nodes to upgrade and there need to be an agreement from the majority on the new version\(^11\).

After the summer sell off during the June and July months, BTC when on another run up until the start of September climbing up to $5,000 before the before plunging 34.0% over the period of

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09/01/2017 to 09/14/201. The prime reason for the selloff was China. The Chinese decided to crack down on “Initial Coin Offerings” or ICOs. In addition, there were rumors that the Communist government was going to ban trading crypto-currency altogether.

In recent years, we have witnessed extreme movement in BTC prices.

In this section we present the annualized returns, annualized standard deviation and correlation based on our monthly returns. Our sample period for our analysis covers the period from August 2010 to October 2017. We have 87 monthly observations and we compute the Annualized Returns by taking the monthly returns and multiplying by twelve. Similar, we annualized our monthly standard deviation by multiplying by square-root of twelve. Our sample size is limited given that BTC has a relatively short history.

We examine the following investments in addition to BTC: Large Stock, Small Stock, Treasury Bills, Long-term Corporate Bonds, Long-Term Government Bonds, Intermediate-term Government Bonds, NAREIT, CS Hedge Funds, CS Managed Futures, TIPs, MSCI EAFE, GSCI, and Gold. Gold data was obtained from Quandl and represents data from the London Bullion Market Association. All the other investment data was pulled from MorningStar and originates from stand sources such as Ibbotson, MSCI, S&P, and Credit Suisse. BTC was obtained directly from Coindesk.com.

Exhibit 2: Summary Statistics: Annualized Returns, Annualized Standard Deviation, and Sharpe Ratios for our sample of Investments

<table>
<thead>
<tr>
<th>Candidates</th>
<th>Ann.Ret</th>
<th>Ann.Std</th>
<th>Sharpe (Rf=1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTC</td>
<td>298%</td>
<td>253%</td>
<td>1.176</td>
</tr>
<tr>
<td>US Large Stock</td>
<td>14.5%</td>
<td>11.3%</td>
<td>1.197</td>
</tr>
<tr>
<td>US Small Stock</td>
<td>15.4%</td>
<td>16.4%</td>
<td>0.873</td>
</tr>
<tr>
<td>US 30 Day TBill</td>
<td>0.1%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>US LT Corp</td>
<td>7.2%</td>
<td>8.3%</td>
<td>0.749</td>
</tr>
<tr>
<td>US LT Govt</td>
<td>5.8%</td>
<td>10.3%</td>
<td>0.466</td>
</tr>
<tr>
<td>US IT Govt</td>
<td>2.1%</td>
<td>3.0%</td>
<td>0.361</td>
</tr>
<tr>
<td>FTSE NAREIT</td>
<td>12.2%</td>
<td>14.3%</td>
<td>0.784</td>
</tr>
<tr>
<td>CS Hedge Fund</td>
<td>4.6%</td>
<td>3.9%</td>
<td>0.924</td>
</tr>
</tbody>
</table>
Above in Exhibit 2 we display our summary statistics. Clearly BTC is an outlier with almost 300% returns in this period with 253% volatility. The Sharpe Ratio computed as the annualized excess returns divided by the annualized standard deviation shows that BTC has had the highest Sharpe Ratio in this period. Note that we assumed that the risk-free rate was 1% over this period. Closely behind BTC was the Sharpe Ratio of the Large Stock. The investment with the worst Sharpe Ratio over this period was GSCI which measures the commodities market with a heavy weight towards energies. Additionally, this period covered a period of strong stock market returns as seen by both large caps and small cap had strong performance of 14.5% and 15.4%, respectively. Real estate as proxied by NAREIT also had good performance over this period as well.

In the correlation table above, we notice that large cap stocks, hedge fund and managed futures had the highest correlation to BTC, with correlation of 0.18, 0.25, and 0.21, respectively. BTC appears to have very little to no correlation with the other investments. Clearly, if the large caps, hedge fund and managed futures cannot explain the variation in BTC, then BTC would have a correlation structure that would make it a strong candidate with diversification benefits.

**Multiple Regression**

In the results below in Exhibit 4, we run a multiple regression of BTC with monthly returns regressed onto large cap, hedge funds, and managed futures monthly returns. We see that the
coefficient of determination or $R^2$ is 7.88%, which says that less than 8% percent of variation in BTC returns can be explained by variations in the other three investments returns. Although the slope coefficient on the three other investments have a positive relationship with BTC, further examination of their t-statistics on the slope coefficient yields non-statistically significant results with t-stats ranging from 0.26 to 1.10. None of the null hypothesis tests that states that the slope coefficient are equal to zero can be rejected. This shows, therefore, that BTC does not have a statistically significant relationship with these three investments.

Exhibit 4: Multiple Regression Analysis – BTC regressed on stocks, hedge funds, and managed futures

<table>
<thead>
<tr>
<th>BTC Regressed on Stocks, HFs, MF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUMMARY OUTPUT</strong></td>
</tr>
<tr>
<td><strong>Regression Statistics</strong></td>
</tr>
<tr>
<td>Multiple R:  28.06%</td>
</tr>
<tr>
<td>R Square:  7.88%</td>
</tr>
<tr>
<td>Adjusted R Square:  4.55%</td>
</tr>
<tr>
<td>Standard Error:  71.36%</td>
</tr>
<tr>
<td>Observations:  87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ANOVA</strong></th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Significance F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3</td>
<td>3.61</td>
<td>1.20</td>
<td>2.37</td>
<td>0.08</td>
</tr>
<tr>
<td>Residual</td>
<td>83</td>
<td>42.26</td>
<td>0.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>86</td>
<td>45.87</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Coefficients</strong></th>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.19</td>
<td>0.08</td>
<td>2.31</td>
<td>0.02</td>
<td>0.03</td>
<td>0.35</td>
<td>0.03</td>
<td>0.35</td>
</tr>
<tr>
<td>Ibbotson US Large Stock TR USD</td>
<td>1.02</td>
<td>3.99</td>
<td>0.26</td>
<td>0.80</td>
<td>-6.92</td>
<td>8.95</td>
<td>-6.92</td>
<td>8.95</td>
</tr>
<tr>
<td>Credit Suisse Hedge Fund USD</td>
<td>10.53</td>
<td>12.65</td>
<td>0.83</td>
<td>0.41</td>
<td>-14.63</td>
<td>35.69</td>
<td>-14.63</td>
<td>35.69</td>
</tr>
<tr>
<td>Credit Suisse Managed Futures USD</td>
<td>3.29</td>
<td>2.98</td>
<td>1.10</td>
<td>0.27</td>
<td>-2.63</td>
<td>9.21</td>
<td>-2.63</td>
<td>9.21</td>
</tr>
</tbody>
</table>

Correlation Analysis

One question that remains is whether the co-relationship between BTC monthly returns and the other investment returns are stable over time. In this section, we run simple rolling correlations using BTC monthly returns and each of our investment universe. We plot these rolling correlations and what we see is strong stability in the correlation structure over time. That is, the rolling correlation tends to stay within the 0.4 and -0.2 band over the time period we examine. This results give us some comfort that the diversification benefits of BTC will be there going forward. Some notable correlation changes are for NAREIT which changes from -0.2 to +0.1 between the 2016 and 2017 period.

Exhibit 5: Rolling Correlations 36-monthly Window on Monthly Returns
Asset Allocation Analysis

In this section we examine the historical performance had we included BTC at a very minimal level to several asset allocations. First, we plot the historical performance of investing in all our investments in an equally weighting scheme. That is, each investment gets the same weight each month. This is accomplished by taking the monthly returns across all candidate investment and averaging their returns each month. By performing this calculation each monthly we generate a time-series of portfolio returns. These monthly portfolio returns are then employed to create an equity curve that show how $1,000 would have grown over time in this portfolio. The assumption is that dynamic trading occurs since each month the weights have to be slightly readjusted to equal weights.

Exhibit 6: Equally Weighted Portfolio without and with BTC
In Exhibit 6 above, we plot the equity curves for two portfolios: One that invests equally across the traditional investments with and one without BTC. A $1,000 investment made at the end of July 2010 and in the beginning of August 2010 would have grown to $1,586 without BTC and $6,801 by October 2017. Note that the weights are slightly different as without BTC, we have 12 traditional investments, so the weights are 1/12 (=8.33%) each month on each investment. With BTC, we now have 13 investments, so the weights are 1/13 (=7.69%) each month on each investment. In any case, visually, we clearly see the benefits of adding BTC to an equally weighted portfolio. The Green line definitively shows the potential benefits of BTC, which should not be surprising given the summary statistic above.

Very few, if any, institutional investors are equally weighted in their asset allocation. Also, we seriously doubt any institutional committee would allow for a large allocation to BTC on the order of 7.69%, given its risks. However, what would happen if a traditional portfolio of 60% large cap stocks and 40% long-term bonds were compared to a very small allocation to BTC? In the graph below, we compare the 60%/40% vs the 59%/39%/2%, with 2% of the portfolio in BTC.

Exhibit 6: 60/40 versus 59/39/2
Interestingly enough, even a very small allocation to BTC would have been beneficial to a portfolio, giving an increase from $1,000 to $2,192 for the 60/40 allocation to a more interesting $1,000 to $3,278 for the 59/39/2 allocation. For those CIOs who are lagging behind industry peers and need to add riskier, and thus more rewarding, investments to their portfolio, crypto currencies are an investment worth considering.

**Portfolio Optimization**

Markowitz’s [1952] mean-variance analysis is one of the most foundational finance tools taught in business schools. In this section, we employ this analysis to examine the optimal allocation across our investments with the focus on the exclusion and inclusion of BTC.

Edwards and Liew [1999] applied Markowitz [1952] technique to hedge fund and managed futures. They found that hedge fund and managed futures both enter the optimal portfolio. In this paper, we employ a similar methodology, but this time for potential inclusion of BTC. It can be shown that when the goal is maximizing a portfolio’s Sharpe Ratio, the optimal allocations can be obtained by solving:

\[
\max \gamma_p = \frac{R_p - R_f}{\sigma_p}
\]  

Subject to

\[
R_p = \sum_{i=1}^{N} \omega_i R_i, \quad \sum_{i=1}^{N} \omega_i = 1, \omega_i \geq 0 \forall i
\]
With the following:

\( \gamma_p = \) the Sharpe Ratio of portfolio \( p; \)
\( R_p = \) the expected rate of return on portfolio \( p; \)
\( R_f = \) the risk–free rate of return;
\( \sigma_p = \) the standard deviation of monthly rates of return on portfolio \( p; \)
\( \omega_p = \) the weight on investment \( i \) in portfolio \( p; \) and
\( R_i = \) the expected rate of return on asset \( i. \)

Below contains the results of optimal allocation based on our three scenarios:

(1) Optimal long-only allocations excluding BTC
(2) Optimal long-only allocation including BTC
(3) Optimal long-only allocations including BTC, but limiting Bonds to 40%

In Exhibit 7 below, we report the optimal portfolio allocations for our three scenarios. We find that the optimal portfolio for our sample period that excludes BTC consists of 52.81% in equities, which breaks down into large cap stocks at 44.29% plus small cap stocks at 8.51%, and 47.19% in long-term government bonds. The optimal allocation for this scenario (1) are in the first column after the Investment column. This portfolio results in a Sharpe Ratio of 1.76 with an annualized performance of 10.5% and annualized standard deviation of 5.4%. This is inarguably a respectable risk-return profile.

Now, if we allow for the inclusion of BTC into our investment opportunity set as reported in the next column (scenario (2)), we notice something surprising. Instead of a majority of the total allocation, rather only a small allocation is optimal for our total portfolio in BTC. We were astonished to find that the optimal allocation to BTC is only 1.30%. BTC appears to slightly reduce our equity allocation from 52.81% to 48.82%, down 3.99% and increase our bond allocation from 47.19% to 49.88%, up 2.69%. However, given the strong historical performance of BTC, we find that the annualized returns to this portfolio is 13.9% with standard deviation of 6.4% and yielding a Sharpe Ratio of 2.03.

Finally, we examine limiting our bond allocation to 40% in the final column (scenario (3)) and obtain similar results to the optimal BTC allocation. The long-term corporate bond allocation appears to substitute for the reduction in the bond position 9.88% and the allocation to long-term corporates increases to 10.12%.

Exhibit 7: Optimal Allocations Results
Caution should be observed with these results for several reasons. First, mean-variance optimization has been notoriously sensitive to the expected return computation. As such, different period of time and sample of data would change the allocations. Secondly, we have employed past returns as estimates of future returns. If the past does not represent the future, then this analysis may become suspect. Finally, we have chosen the crypto-currency BTC, which is the biggest and the one that has survived the longest. Embedded in our choice is a pre-selection bias because we used the benefit of hindsight to select the surviving crypto-currency, which happens to be the biggest and most popular crypto-currency. These are only some of the issues that institutional investors should be wary about in this analysis. Other issues that we don’t fully examine here but certainly need to be analyzed and addressed are time horizon bias (only looking at monthly horizon returns), publishing bias (presenting only interest results so that the paper could possible get published), researcher bias (using prior experience of the researcher), etc.

Even with all the usual caveats, some useful observations can be gleaned from this analysis. First, BTC appears to have a distinct correlation structure that allows it to be a solid candidate for diversification benefits to traditional investments. Second, the optimal allocation to an institutional portfolio is a moderate 1-2%. The optimal allocation is not significant in terms of
percentage of the portfolio, however, given the strong prior returns and volatility overall, and the Sharpe Ratio does increase with the inclusion of BTC. Finally, if this new FinTech innovation shows to have longevity, it will change the way institutional investor allocate their investments.

Our Thoughts and Recommendations for Institutional Investors

Recommendation #1: Learn more about blockchains, bitcoins, and crypto-currencies. Educate your staff and support their desire for knowledge.

With any investment, knowledge is key to understanding and making sound investment decisions. As Warren Buffett advised, never invest in anything that you do not know. In this paper, we only scratched the surface of the innumerable layers of BTC, and left untouched the more advanced topics in cryptograph and information theory because it is beyond the scope of this paper. Based on the compelling data contained in this paper, nonetheless, it is apparent there is real return potential existing in this market.

Recommendation # 2: Learn and fully understand most, if not all, of the underlying risks associated with investing in this asset class.

1. **Extreme volatility:** As you can see from the chart in exhibit 1, investing in BTC can subject investors to extreme volatility. It isn’t uncommon to have prices swing north of 30.0%. Although the CME Group (NASDAQ:CME) provides another investment product (Future contracts) around BTC, which in turn provide additional liquidity, it still brings with it added risk with margin calls.

2. **Forks:** As mentioned previously above, there are two types of forks, soft and hard. The hard fork has the deepest impact on the currency. A hard fork is a change to the protocol that makes previously invalid blocks or transactions valid (or vice-versa) and as such, requires all nodes or users to upgrade to the latest version of the protocol software. The risk to investors is, if there isn’t an agreement between miners and developers, then the currency splits into two separate coins with two separate blockchains. This could potentially cause investors to choose one version of the coin over the other, subsequently reducing the price.

3. **Government regulation:** Government regulation in large countries like China was the major driving factor in price decrease during September. If governments decide to ban Bitcoin, for reasons such as it could have a direct impact on government issued currencies, investors will witness own investments take a hit. On the other hand, there are other places in the world where the government is embracing the asset class and has even hinted at the future of a country-specific cryptocurrency. It’s critical to note, however, that BTC is too decentralized to be controlled by any one person, government or entity.

4. **Competition:** Other cryptocurrencies, known as alt-coins, could offer better blockchains that allow for faster transactions, storage space, complete anonymity and other improvements that could lower bitcoin market share. Although there is plenty of present competition, BTC has the resounding advantage of being first to the space. Currently, BTC possesses half the world market share of the cryptocurrency asset class.
5. **Safety issues:** In the past, major exchanges have been susceptible to hackers that have stolen coins from exchange storage wallets, as well as individual wallets. The same measures someone would take to secure their bank account or email login, however, would apply to their crypto wallet as well. As it stands, you typically get a private key that protect your wallets. If you lose that key, you essentially have lost your funds. The counter risk is you have the option to back up your private key to multiple places.

Recommendation #3: *Gain exposure to the cryptocurrency industry through more than just one cryptocurrency, but not all of the; Don’t hold all your eggs in one basket.*

Just including BTC in one’s portfolio may be a dangerous fix. Remember the rise and fall of AOL? While BTC appears to be the dominant player right now, just as AOL was dominating the internet industry in the early days, once AOL started to face substantial competition, it lost its dominate position. AOL fell in the shadow of the rise of other tech giants such as Amazon, Facebook and Google; so too may BTC could suffer such a fate. The monitoring of thousands of other cryptocurrencies and understanding why they may possibly de-throne BTC for supremacy is critical. There are many young smart entrepreneurs trying to create the uber-cryptocurrency. One must be vigilant and monitor the market caps, volumes, and their blockchains. For example, other cryptocurrencies that are moving to challenge BTC are Ethereum, Litecoin, Ripple, Dash, Monero, NEO, and ZCash.\(^\text{12}\)

Recommendation #4: *Avoid paralysis in the face of new FinTech innovations, namely cryptocurrencies.*

Some institutional investors discount the cryptocurrency industry because they may superficially view it as riddled with fraud and danger. This judgment has fueled grave misconceptions about the crypto-currency market in general, and bitcoin in particular. It is critical that institutional investors undertake their own research to accurately understand crypto-currencies and how they are shifting the paradigm of commerce on the internet. The initial indication of crypto-currencies influence was in its power to move information around the internet. The internet set down optimal protocols for moving information; however, it was not optimal for paying for goods and/or services.

The current infrastructure that powers the internet has also created the “double-spend” problem. Consider the following problem: When you send a file, you still have a copy of it on your local machine. What assurance can be given that when you paid for something, that you deleted that copy off your machine? The solution to the double-spend problem is to record transactions on a ledger. This is the solution implemented by banks, which records transaction on its ledger or client’s account. The client’s is in their account and each transaction debits or credits their

\(^{12}\) [https://coinmarketcap.com/all/views/all/](https://coinmarketcap.com/all/views/all/) List of top cryptocurrencies.
account. The financial market meltdown understandably sparked a heightened level of suspicion and distrust towards the financial industry. During this time, the distributed ledger idea was birthed; a ledger that is held by people, not banks or other financial institutions, on the internet. If this distribute ledger could be held by the masses on the internet, then it could document all transactions and solve the double spend problem. This simple idea has birthed many other FinTech innovations, such as Ethereum, which allows for more general transactions to be recorded into its blockchain. These truncations include smart contracts and are only limited by the imagination of the creators.

Conclusions

In conclusion, whether cryptocurrencies are the biggest bubble of our generation or the next technological revolution will resolve over time. One fact not in dispute is that this technology is disruptive not only to governments but also to incumbent financial institutions. The critical question for institutional investors is: What does an empirical analysis reveal about bitcoin? We document several salient features of BTC. First, it provides unique diversification benefits for traditional institutional portfolios. This diversification benefit appears to be stable over the period that we have examined. Second, bitcoin is very volatile but the historical returns to risk appear attractive. Finally, using standard portfolio optimization tools we find that the optimal allocation to BTC is 1.3% over the sample we examined.

If markets are efficient in the long-run, the initial perception of BTC as overly risky will preclude some investors from this opportunity, perhaps hampered by their lack of knowledge about this new investment. This work attempts to provide some insight into this industry and provide some empirical evidence that BTC can be quite attractive for the institutional investor. We argue that the institutional investor should seriously consider cryptocurrencies for inclusion into their portfolios at the 1-2% allocation range. As such, we add our positive findings to the growing debate on BTC. Although this market is relatively small, with less than $300 billion in market capitalization and has many other weaknesses that investors must take into full account, we believe in the long run that the early institutional adopters will benefit.

Bibliography


Cryptocurrency Investment Fund Industry Overview

Crypto funds go by many names – cryptocurrency funds, blockchain funds, or digital asset funds. Whatever you call them, the number of crypto funds is on the rise. With rising prices and rising public awareness, there were more than 100 crypto funds launched in 2017. For comparison, there were about 700 total hedge funds launches in this same time. While accounting for 14% of new hedge fund launches may not seem like much, consider that crypto funds have less than .1% of total hedge funds assets. In fact, crypto hedge funds are the fastest growing segment of the hedge fund industry, by number of new funds. In addition, several of the top performing hedge funds in 2017 were cryptocurrency funds.

We expect more than 150 crypto fund launches in 2018, based on the pace throughout the first part of the year. Total cryptocurrency fund assets could easily double over the course of the year. Below we use charts and graphs to examine the cryptocurrency investment fund industry in greater detail.

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<td># of Cryptocurrency Funds</td>
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There are currently more than 400 cryptocurrency/blockchain investment funds. The majority are set up as hedge funds, while a large number are venture capital funds. There are also a handful of crypto ETFs and crypto private equity funds.
Hedge funds are the most common type of digital asset fund, but venture capital crypto funds are launching quickly, and existing tech/FinTech VC firms are expanding investments into blockchain startups and launching their own blockchain funds. As some blockchain companies mature, private equity funds are beginning to get involved. Hybrid funds – those funds investing in cryptocurrencies as well as initial coin offerings, are listed above as hedge funds although they take on some characteristics of venture funds.
2017 was a record year for the launch of new cryptocurrency funds with over 150 new funds including hedge funds and venture capital. This was more than triple the number of funds launched in 2016. It’s quite possible there will be over 150 crypto fund launches again in 2018 based on the current pace. In addition to the launch of new VC and crypto hedge funds, we expect existing hedge funds to incorporate cryptocurrencies in their portfolios. Likewise, existing VC firms will continue to add blockchain investments as well as launch separate blockchain funds.

The vast majority of crypto investment funds are small. Half have less than $10 million in assets under management (AUM). However, there are a number of crypto funds with over $100 million in assets.
including Pantera Capital, Galaxy Digital Assets, Alhpabit Fund, and Polychain Capital, among others. We expect digital asset funds to increase in size in 2018 due to inflows as well as the formation of new funds. However, thus far, the depreciation of portfolio assets has been a headwind.

Current crypto fund assets are still quite small. All crypto funds combined have less than 10% of the assets of the largest traditional hedge fund managers.

The overall crypto fund industry has been growing rapidly. Changes in assets are a result of three primary factors: the launching of new crypto funds, net inflows to existing funds, and changes in the value of portfolio assets. The latter factor was particularly prevalent in the last half of 2017 when Bitcoin, for example, increased in value nearly fourfold. It’s possible there could be continued contraction in total crypto assets during parts of 2018 as cryptocurrency prices fell off of the all-time highs reached in the beginning of 2018.
Most blockchain/crypto investment funds are small. Many are run by their founder and one or two additional professional staff. Most crypto funds have between five or fewer employees. Only about 6% have more than 25 employees (these are generally VC funds that do not exclusively invest in digital assets/blockchain companies).

Over half of all cryptocurrency investment funds are based in the United States. The United Kingdom, China/Hong Kong, Singapore, Switzerland, Canada, and Germany all have a significant number of funds. New crypto funds are also beginning to pop up in Eastern Europe and Russia, as well in offshore jurisdictions.
The top cities for crypto funds are mostly cities that have significant existing hedge fund and venture capital industries. Topping the list of cities with the most digital asset funds are San Francisco, owing largely to its already dominant venture capital industry, and New York, the undisputed hedge fund capital of the world. London, Singapore, Hong Kong, Zurich, and Chicago all also have a significant number of crypto funds. Chicago, in particular, could see significant growth in new funds as commodity exchanges begin to allow trading of cryptocurrency options and futures.
Most US-based crypto funds are not registered with the SEC. Some will file a form D, but not be required to file for an SEC registration number under The Investment Company Act of 1940. Since most crypto fund launches have been small, most qualify as an exempt advisor and are not required to register. Additionally, the CFTC has given guidance that it considers cryptocurrencies like Bitcoin and Ethereum to be commodities and may therefore have certain jurisdiction over crypto funds. Such funds may not have SEC registration requirements. The SEC has also suggested it considers most IPOs, security tokens, and even utility tokens to be securities. It is likely there will be more guidance in 2018 and 2019 with greater oversight and registration of cryptocurrency funds.
Blockchain, Tokens, and Mutual Funds—We’re Not There Yet

By Molly Moynihan and Dana Syracuse

Recent buzz around cryptocurrency, initial coin offerings (ICOs), and blockchain technology has sowed confusion among many market participants about the impact of this new technology on the asset management industry. This article discusses the current regulatory state of play and how this innovative technology is likely to play out in the registered funds space. In particular, it discusses the current barriers to investment in cryptocurrencies, tokens, and ICOs by registered investment companies. It also addresses several of the questions posed by regulators as they seek to wrestle this rapidly innovating and disruptive technology into conformity with existing law. At the current time, none of these instruments are viable investments for registered investment companies. The underlying technology, however, has been used by some fund families and will likely continue to be adopted across the industry.

A Quick Primer on Blockchain and Tokens

Numerous recent articles have described blockchain and its underlying technology. It is perhaps best understood as a means of exchanging and tracking value. A blockchain itself is simply a shared, immutable ledger that records the history of transactions in separate but linked blocks of data. Others have described it as a database that operates through consensus on transactions between participants without the need for an intermediary. A blockchain can be permissioned (in which case only certain users may validate the transactions on the blockchain) or permissionless (in which case anyone may enter and validate transactions on the blockchain), and it may have various degrees of autonomy—from systems that are still in development to private blockchains to systems that once created function entirely based on the instructions embedded in the software, with no centralized authority. Currently, developers of blockchain projects will either use existing blockchain protocols—for example, the Ethereum protocols—or develop a custom protocol on which their platforms or applications will operate.

Tokens are not little round objects but typically 30 lines of code. They can exist on base protocols, separate networks, platforms built on protocols, and applications that have both a mix of on-chain and off-chain elements. For example, the Bitcoin network is the host platform for Bitcoin, and the Ethereum network is the host platform for Ether. Although the industry is still trying to classify the different types of tokens, they may be roughly categorized into native tokens and tokens that enable various functions. In this sense, it is important to understand that because blockchain is intended to
be decentralized, it must use a form of game theory to incentive participants to participate cooperatively so that the distributed system operates as intended. Tokens, and their design, play a key role in this, insofar as they may incentivize participants to produce (or mine) more tokens, use the platform, or otherwise perform tasks of value to the network.

A native token operates directly on the blockchain. Bitcoin and Ether are both native tokens, although Bitcoin must be mined and Ether has been pre-mined. Functional tokens may enable transactions on a blockchain, permit the holder to gain access to services, pay for services, run applications, or be linked to particular assets. Asset-based tokens, for example, are functional tokens that may be linked to gold or a particular diamond that can be tracked from its mining to an engagement ring—and entitle the holder to the asset. App (short for application) tokens can be issued on the application layer of the Ethereum blockchain through smart contracts. Overall, tokens serve as a kind of fuel that is required for and rewards participants for accessing and performing services on the network.

In the current state of play, as discussed below, a critical issue for regulatory analysis is whether a protocol, platform, or application has reached a stage of development where the token can actually be used for its intended purpose. The intended purpose of a token is essentially static from a functional perspective, that is, if a token’s programming calls for it to do a certain thing, then that is the thing that it does. What can change is whether the ecosystem is sufficiently developed for the token to actually do that thing. Once the token can actually be used for its intended purpose, it is said to have utility. As discussed below, this concept of utility is key to current discussions on the regulatory status of the token.

Within this general ecosystem there are multiple variations, and given that this is a rapidly evolving technology it is likely that there are many variations still to come. For purposes of this discussion, it is important to distinguish among three different concepts—cryptocurrency, tokens and related ICOs, and blockchain technology itself—and to understand their interrelationship. At this stage in the development of the technology, all the plumbing is out in the open. If blockchain continues to develop and thrive, however, within a few short years, it is likely that much of this technical infrastructure will become invisible. Just as one no longer types in code to perform tasks on a computer, but instead can swipe or speak to effectuate the desired action, it is likely that the underlying blockchain transactions will become invisible to most users employing the technology. It is possible that in the world of the future, while millions of people will regularly effect transactions using cryptocurrency, Bitcoin will be as antiquated as Pong.

**Cryptocurrencies, ICOs, and Blockchain**

**Cryptocurrencies**

In October 2008, the Bitcoin whitepaper introduced a new currency based on distributed ledger technology, also known as the Bitcoin Blockchain. Several years after Bitcoin first burst onto the scene, the US Commodity Futures Trading Commission (CFTC) concluded that Bitcoin should be treated as a commodity trading in a spot market. Currently, Bitcoin and other cryptocurrencies are tradeable on the peer-to-peer networks or exchanges. As the price of these cryptocurrencies has exploded, even relatively unsavvy investors became familiar with the terms “wallets” and “keys.” Cryptocurrencies are fungible tokens that have no other marketed functionality than use as a medium of exchange or stored value. There continues to be uncertainty as to whether tokens functioning as currencies should all benefit from the CFTC’s original determination with respect to Bitcoin.

**ICOs**

In 2012, a young technologist, enamored with Bitcoin, but not interested in giving up control to venture capitalists, had the ingenious idea that a
software developer, interested in developing a new protocol on the Bitcoin Blockchain, could simply ask people to send Bitcoins to a wallet in exchange for an interest in the protocol. His idea lead to the first ICO in 2013, Mastercoin, but it took a while for the concept to really get going. By 2017, however, ICOs had raised $5.6 billion in capital in a runaway speculative rush that knocked regulators on their heels and left securities lawyers trying to explain the significance of a 1946 case on orange groves to twenty-something software developers in a big rush to launch their own ICOs.

Most of these software developers were initially unaware that an innovation as interesting as blockchain fell squarely in the middle of one of the most regulated sectors of the US and global economies. They modelled their early sales on the crowdfunding used by funding sites such as Kickstarter.

Relatively quickly, however, it was apparent to all concerned that most of the tokens being sold in ICOs met the definition of an “investment contract” and hence were a security within the meaning of Section 2(a)(1) of the Securities Act of 1933, as amended (the Securities Act). In SEC v. W. J. Howey Co. and its progeny, the US Securities and Exchange Commission (the SEC) and the courts have laid out the characteristics of an “investment contract.” After some initial delay, the SEC released the so-called DAO Report in July 2017, which laid to rest any idea that tokens were something different or new that fell outside the federal securities laws. In strong language, the Report stated:

The Commission deems it appropriate and in the public interest to issue this report of investigation (“Report”) pursuant to Section 21(a) of the Exchange Act to advise those who would use a Decentralized Autonomous Organization (“DAO Entity”), or other distributed ledger or blockchain-enabled means for capital raising, to take appropriate steps to ensure compliance with the U.S. federal securities laws. All securities offered and sold in the United States must be registered with the Commission or must qualify for an exemption from the registration requirements.

This Report reiterates these fundamental principles of the U.S. federal securities laws and describes their applicability to a new paradigm—virtual organizations or capital raising entities that use distributed ledger or blockchain technology to facilitate capital raising and/or investment and the related offer and sale of securities. The automation of certain functions through this technology, “smart contracts,” or computer code, does not remove conduct from the purview of the U.S. federal securities laws. [Citations Omitted.]

The DAO report thus established that tokens and ICOs fell squarely within the ambit of the federal securities laws. It did not, however, stem the tide of ICOs. While a certain percentage of the ICO markets likely involves fraudulent enterprises, the fundraising model has continued to be used. Similarly, blockchain developers have used other methods, such as airdrops, to place tokens in the hands of potential users as a way to jumpstart a community. While ICOs face many regulatory hurdles, as discussed below, they can increase transparency in the projects and technology through the publication of so-called White Papers that describe the technology and use case and offer the possibility of an effective financing mechanism for bona fide blockchain projects.

As discussed in detail below, however, and as with cryptocurrency, for practical purposes, registered mutual funds are currently unable to invest in these token offerings.

Blockchain Technology

One of the best use cases for blockchain technology is the financial services industry. Blockchains
can be very slow, but they can offer several significant advantages over traditional settlement systems, in particular, immutability and elimination of an intermediary. Many asset managers are actively exploring the use of the technology in their business lines. To take just a few examples:

- IBM has introduced blockchain banking solutions that reduce settlement times and lower costs for global payments.¹²
- Fidelity Investments has been researching and experimenting with blockchain technology since 2014. In 2014, Fidelity started using its internal research and development department, Fidelity Labs, to look into blockchain technologies. In 2015, Fidelity established the Fidelity Blockchain Incubator, which dedicated a team to experiment with blockchain technologies and a number of digital currencies. Also in 2015, Fidelity Labs created Fidelity’s Bits and Blocks Club to be an internal learning program for all Fidelity employees. Since 2014, Fidelity has entered into various collaboration relationships with Ideo Co-Lab, the Institute for the Future, Harvard University, University College London, the MIT Media Lab, and IC3. In addition, Fidelity Labs has built pilot programs around the blockchain. For instance, Fidelity built a protocol to accept Bitcoin in its employee cafeteria. It also allowed for donors to its charitable fund, Fidelity Charitable, to contribute Bitcoin or Ether. Finally, Fidelity has taken steps to integrate its products with existing products in the blockchain space, such as its integration with Coinbase.¹³
- In December 2017, Vanguard announced a pilot program to use blockchain technology for sharing and using index data. In a partnership with the Center for Research in Security Prices (CRSP®) and Symbiont, Inc., Vanguard’s pilot program uses index data from CRSP® and Symbiont’s blockchain technology to allow investment managers to instantly distribute, receive, and process index data. The Vanguard pilot program aims to improve benchmark tracking, automate workflows with smart contracts, and eliminate the need for manual updates.¹⁴
- T. Rowe Price announced a pilot program that uses “Bankchain,” a post-trade settlement platform powered by blockchain. The Bankchain system has the potential to streamline the post-trade process.¹⁵
- Fidelity, Putnam Investments, Schroders, and SEI have created “incubation” programs for start-up companies. These arrangements can include a mix of physical workspace, access to executives, working with in-house tech teams, and financial support. For instance, SEI uses its “Codify” incubator to focus on companies developing technologies to support compliance or regulatory reporting.¹⁶
- Several asset management firms in addition to Fidelity have established labs. In February 2018, BlackRock announced that it had created an innovation lab focused on artificial intelligence, similar to RBC Global Asset Management, which had previously announced its own lab. In 2015, State Street created its own lab to explore blockchain technology.¹⁷
- Although the project itself has stalled, Eaton Vance, AB, KKR, and Credit Suisse had previously collaborated to create a blockchain-based tool to streamline the operations requirements to trade syndicated loans.¹⁸

In the coming years, it is very likely that blockchain technology and applications will be used increasingly by financial institutions.¹⁹

**Tokens and Cryptocurrencies in Mutual Funds—Regulatory Roadblocks**

Currently, regulators from the SEC to the CFTC to the Office of the Comptroller of the Currency (OCC) to regulators around the globe are trying to come to terms with how to regulate cryptocurrency...
and token sales. A threshold question that regulators are seeking to address is the status of tokens under the US securities laws. The ultimate determination of the regulatory status of tokens will affect every element of how this technology will fit into the US securities markets: Can tokens be offered and sold to the public? Can tokens be traded on an exchange? What information must be publicly available? And, for purposes of this discussion, could tokens and cryptocurrencies become viable assets in which registered investment companies may invest?

For now, that answer appears to be “not yet.” In January 2018, Dalia Blass, the Director of the Division of Investment Management of the SEC issued a public letter that concluded, among other things, “[W]e have, at this time, significant outstanding questions concerning how funds holding substantial amounts of cryptocurrencies and related products would satisfy the requirements of the 1940 Act and its rules.”

Blass posed a series of questions touching on the following topics: valuation, liquidity, custody, arbitrage (for exchange traded funds), and potential market manipulation. Blass and other regulators, including SEC Chairman Jay Clayton, have also raised key issues with respect to accounting, audit, reporting, and general concerns over asymmetry of information between investors and the developers and founders of tokens and blockchain tokens. A fuller discussion of overcoming certain of those regulatory hurdles is below.

**ICOs and Tokens**

As alluded to above, the SEC and state regulators have made it abundantly clear that state and federal securities laws apply to token offerings. As SEC Chairman Clayton recently stated, “When investors are offered and sold securities, whether through traditional channels or through an ICO on a sales-oriented website, state and federal securities laws apply. These laws have applied to our securities markets for over 80 years. At their core, these laws require full and fair disclosures of material information about both the securities and the venture being funded. Unfortunately, some market participants seem to believe that the use of new technology provides a basis for ignoring the core principles of our securities laws.”

Thus, the fact that the securities laws apply is settled. The application of those laws, however, remains unsettled on several critical points.

Most legal professionals and industry participants agree that, based on application of the Howey test, in the early stages, most tokens should be considered to be securities and hence subject to all of the requirements of state and federal securities laws. The question arises not on that easy case but on a much harder question that occurs later in the development stage. At a certain point in time, a token becomes functional on the base protocols, separate networks, platforms built on protocols, or applications for which it is designed. So, while initially tokens may be sold as a means of financing the growth of the blockchain project for which they are designed, at some point, their value ceases to rely “on the efforts of others” and becomes a function of the value of the service that they perform. At that juncture, not only would Howey no longer seem to apply, but it would be impractical to seek to impose security-type restrictions on the transfer of the tokens. Practitioners refer to tokens at this stage as “utility” tokens and have sought to advance an argument that, following utility, the tokens should cease to be treated as securities.

If a token is a security prior to utility, its offer and sale is very difficult to effectuate in a manner that complies with federal and state securities laws. For a variety of reasons, registration of token offerings has not been pursued in the market. Available exemptions generally require that the token be legended and that its offer and sale be restricted for the applicable period of time. The peer-to-peer networks on which tokens trade and other features of the market make legending and imposition of lock-ups impractical, if not impossible. As
a result, the industry migrated to use of a variation on an instrument commonly used for early stage companies called a Simple Agreement for Future Equity and created a new instrument referred to as a Simple Agreement for Future Tokens or SAFT.25 SAFTs are acknowledged to be securities and sold in offerings generally complying with Regulation D or other available exemptions. SAFTs allow for legending and lock-ups as required under the applicable exemptions. While the offering and sale of the SAFTs comply with federal securities law, they pose two distinct issues. First, as securities, they typically are sold only to accredited investors, who likely are purchasing as investments, not with the intention to use the tokens as intended at the time of utility. Thus, this early token distribution may not put tokens in the hands of those who are mostly likely to use them.26 More importantly, the SEC has not endorsed the view that a token delivered in connection with a SAFT, at the time that the token reaches utility, would be freely transferable. While strong arguments exist in support of the mutability of the token, supporting a position that it could change its regulatory status, at this time there is no clear resolution of the issue.27 An additional problem is how to define a level of utility sufficient to conclude that the value of the token would no longer depend upon the “efforts of others.” While some token sellers have released the tokens “at utility,” other have not, in consideration of the regulatory risk, resulting in a chokepoint where early capital may be indefinitely locked up. This is an important issue that may require some form of no-action or other regulatory relief to resolve. Regulators have also pursued regulatory actions against some participants in these offerings. Resolution of those actions may also provide some insight into the problem, although overriding issues of fraud in those cases may cloud the other legal issues.

Custody

The greatest current impediment to mutual funds interested in participating in the investment opportunities presented by blockchain technology is the paucity of options to custody tokens and cryptocurrencies in a manner that complies with the Investment Company Act of 1940, as amended (the 1940 Act). Currently, purchasers of tokens must open an account on one of the various wallet services that is accessed through a personal code, referred to as a key. A common practice is to print the code to ensure its safekeeping and to remove it from computers or other internet-connected devices to avoid hacking.28 For mutual funds to invest in tokens or cryptocurrencies, they must be able to custody the tokens in a manner that is far more robust than existing wallet services.

Section 17(f) of the 1940 Act provides that a registered fund must “maintain its securities and similar investments in the custody of [, among certain other kinds of entities,] a bank or banks having the qualifications prescribed in [Section 26(a)(1) of the 1940 Act].”30 Various market participants are working toward establishing a financial institution able to meet this definition and with internal operations able to hold blockchain assets. One promising option is a state-chartered trust company. The 1940 Act defines “bank” in a manner that incorporates both federal and state concepts. As defined in Section 2(a)(5) of the 1940 Act, a “bank” includes, among other things, any “trust company, whether incorporated or not, doing business under the laws of any State or of the United States, a substantial portion of the business which consists of receiving deposits or exercising fiduciary powers similar to those permitted to national banks under the authority of the Comptroller of the Currency, and which is supervised and examined by state or federal authority having supervision over banks or savings associations, and which is not operated for the purpose of evading the provisions of this title . . . .”31

In assessing whether a trust company could qualify as a custodian, therefore, it is necessary to consider whether the trust company exercises fiduciary powers similar to national banks under the authority of the OCC.
That particular analysis requires a review of federal banking law and regulation that turns on the meaning of “fiduciary powers” and the interplay between state and federal regulation with respect to what states consider to be a fiduciary power for purposes of the state's banking oversight function.

In New York State, a New York State-chartered limited purpose trust company would appear to exercise fiduciary powers. Consistent with that interpretation, NYDFS has publicly stated that it intends that any limited purpose trust company charter that it grants should be for “the sole purpose of exercising fiduciary powers.” That suggests that all or virtually all powers exercised by a New York State-chartered limited purpose trust company would be considered fiduciary powers, whether expressly enumerated under state law or not. Further among the powers that New York state law expressly includes in the term “fiduciary powers” are “custodial services.” Of note, to be a “bank,” a trust company may not operate for the purpose of evading the purposes of the 1940 Act. A trust company seeking to custody crypto assets would have to be established for purposes wholly unrelated to evading the purposes of the 1940 Act. Instead, it would seek to facilitate investment companies' compliance with the full requirements of Section 17(f) and the rules thereunder.

Market Manipulation

A frequently expressed concern of SEC officials relates to the asymmetry of information that may exist in a token market. Whereas the federal securities laws have established robust procedures to ensure fair markets, through a disclosure-based system and limitations on trading while in possession of material non-public information, the application of all elements of this regime are not apparent in the crypto markets. For example, under certain blockchain protocols, founders retain substantial amounts of the tokens, with various methodologies for releasing the tokens at later points into the ecosystem. It is not hard to imagine how this could affect price, especially where a speculative market exists. What is harder is to take the steps needed to develop a system to limit opportunities for manipulation. In addition to adopting traditional disclosure regimes (possibly using as models streamlined reporting options), such a system could be built into the programming or could lever the generally higher degree of transparency available over a blockchain. Without resolution of this issue, the SEC may be unwilling to proceed with providing no-action or other regulatory relief to address other pressing issues.

Valuation

Mutual funds holding crypto assets must be able to value them in accordance with the requirements of the 1940 Act. This raises numerous questions, but may be one of the easier issues to solve, because to some degree the problem is similar to issues that arose in valuing dot.com stocks during the early years of the internet and valuing privately held companies in today’s world of unicorns where companies with substantial market floats do not trade publicly. The combination of the availability of trading markets for many tokens and fair valuation options, should allow for the development of viable and robust valuation methodologies.

Conclusion

In sum—blockchain represents an explosive and disruptive technology—the technology has moved as fast as the iPhone, which was developed at about the same time, in a regulatory space that moves much more slowly. Blockchain itself continues to transform and develop, even as regulators and lawyers seek to refine their understandings and analysis. Mutual funds, with their many investor safeguards, could become an important vehicle for investors to benefit from likely capital appreciation in this market, once the regulatory hurdles are overcome.

At the same time, blockchain has gripped the popular imagination and taken on a life far beyond what is actually possible. Its ultimate role in the industry may be more as a mundane processing method than the road to riches.
Molly Moynihan is a Partner and firmwide co-chair of the Investment Management Practice at Perkins Coie LLP. Dana Syracuse is a Senior Counsel in the blockchain and fintech practices at Perkins Coie LLP. The authors thank Thomas Ahmadifar, an associate in the Investment Management Practice at Perkins Coie LLP.

NOTES

1 In this article, we use the term “token.” Tokens and coins in blockchain vernacular are interchangeable.


6 See, e.g., Gary Gensler, Fmr. Chairman, Commodity Futures Trading Comm’n, Remarks at the MIT Business of Blockchain Event (Apr. 23, 2018) (“When investing in any form of financing, whether an ICO, or in traditional forms, such as stocks or bonds, the public benefits from full and fair disclosure.”), available at https://www.media.mit.edu/posts/remarks-at-blockchain-event/.


8 328 U.S. 293 (1946) (hereinafter, Howey).


11 In an airdrop, a project creator takes a snapshot of a public blockchain, such as Bitcoin’s or Ethereum’s, and distributes tokens to all wallet addresses based on some pre-existing criteria. See Brady Dale, So Long ICOs, Hello Airdrops: The Free Token Giveaway Craze is Here, CoinDesk (updated Mar. 17, 2018 5:41 A.M.), https://www.coindesk.com/long-icos-hello-airdrops-free-token-giveaway-craze/ (explaining the practice of airdrops).


13 Hadley Stern, Fidelity’s Proof of Work: Our Bitcoin and Blockchain Journey, Medium (Feb 16, 2018), https://medium.com/@hadleystern/fidelitys-proof-of-work-our-bitcoin-and-blockchain-journey-5ad94d6a787a; Fidelity Labs (last visited May 24, 2018), https://www.fidelitylabs.com/. More recently, it has been reported that Fidelity is exploring the development of in-house custody solutions and development of a crypto exchange. Fidelity, a household name in American investing is plotting a big move into cryptocurrency trading, Business Insider (June 6, 2018), http://www.businessinsider.com/fidelity-a-household-name-in-american-


17 Id.


19 Some of the major patent holders in blockchain technology are Fidelity and Banc of America.


23 This discussion is obviously based on blockchain activities in the United States. While it may be possible to conduct an offering outside of the United States, it appears to be very difficult to restrict these activities to non-US persons.


25 In light of the regulatory uncertainty around SAFTs, some practitioners have changed the name of a functionally similar arrangement to express that they are merely sale agreements prior to utility or to provide the option to receive equity in lieu of tokens.

26 See In re Munchee Inc., Securities Act Release No. 10445 (Dec. 11, 2017) (finding that one reason an ICO token was a security under the Securities Act was that it was marketed towards people interested in purchasing tokens rather than to people who might have wanted to use the expected utility of the token), available at https://www.sec.gov/litigation/admin/2017/33-10445.pdf.

27 At its simplest, the argument asserts that it is possible to have an investment contract that is separate from the underlying object of the contract, which may not itself be a security. The case law is replete with products that provide the basis for an investment contract without qualifying as securities themselves. See, Stephen G. Christianson, What is “Investment Contract” within Meaning of § 2(1) of Securities Act of 1933 (15 U.S.C.A. § 77b(1)) and § 3(a)(10) of Securities Exchange Act of 1934 (15 U.S.C.A. § 78c(a) (10)), Both Defining Term “Security” as Including Investment Contract, 134 A.L.R. Fed. 289 (1996), §10[b] (citing cases involving dental care products, foxes, beavers and master tapes) and §14[a] (citing cases involving whisky, personal and home care products, oil, chinchillas and earthworms).
Gabriel T. Rubin and Dave Michaels, “Silicon Valley Is Into Bitcoin. It Wants to Keep Washington Out.” Wall St. J. (April 19, 2018 5:30 A.M.), https://www.wsj.com/articles/cryptocurrency-firms-investors-seek-exemption-from-sec-oversight-1524130200. Public statements of SEC Staff and commissioners have also questioned an over-reliance on “utility”—a concept that has only had limited application in securities laws to date. See, e.g., Nikhilesh De & Mahishan Ganaseharan, SEC Chief Touts Benefits of Crypto Regulation, CoinDesk (updated Apr. 6, 2018), https://www.coindesk.com/sec-chief-not-icos-bad/ (reporting that in a speech by Chairman Jay Clayton at Princeton University on April 5, 2018, Chairman Clayton discussed the issue of “utility tokens” and those that think labeling them as such releases the token from being regulated as a security); Public Statement, Jay Clayton, Chairman, Sec. & Exch. Comm’n, Statement on Cryptocurrencies and Initial Coin Offerings (Dec. 11, 2017) (“Merely calling a token a “utility” token or structuring it to provide some utility does not prevent the token from being a security.”), available at https://www.sec.gov/news/public-statement/statement-clayton-2017-12-11.


15 U.S.C. § 80a-17(f)(1); see also id. § 80a-26(a)(1).

Id. § 80a-2(a)(5)(C).

This analysis would also apply to a definition of a “qualified custodian” for purposes of the Investment Advisers Act of 1940, as amended. See 17 C.F.R. § 275.206(4)-2(a) (requiring the use of a qualified custodian for the safekeeping of client funds).


Id.
On January 18, 2018, Dalia Blass, the Director of the Division of Investment Management (“DIM”) of the U.S. Securities and Exchange Commission (“SEC”), issued a letter to two industry groups where she laid out DIM’s concerns for an exchange-traded fund (“ETF”) that invests in digital assets like Bitcoin (the “Blass Letter”). The Blass Letter addresses several categories of concerns, one of which is potential manipulation and fraud. This outline attempts to provide a framework to be filled in that addresses the Blass Letter’s concerns relating to the potential manipulation of digital assets and how that relates to the common practices in the digital asset industry.

The Blass Letter: Concerns of Potential Manipulation and Fraud

The Blass Letter raises several reasons why DIM and the SEC are concerned about the risk of manipulation and fraud in the digital asset and digital asset futures markets:

- Cryptocurrency markets, as they are currently operating, feature substantially less investor protection than traditional securities markets. [As mentioned by Chairman Clayton in a public statement on December 11, 2017].

- The denials of cryptocurrency ETF proposals discuss the risk of manipulation in the underlying cryptocurrency markets. [E.g., the SolidX Bitcoin Trust denial on March 28, 2017].

- The possible vectors for potential manipulation of the cryptocurrency markets.

- The pricing, volatility, and resiliency of the cryptocurrency-derivatives markets generally would be expected to be strongly influenced by the underlying markets.

Each of these is discussed below.

Investor protections in cryptocurrency markets

The SEC’s concerns as expressed by Chairman Clayton in his December 11, 2017 public statement:

- Inadequate investor protections from digital assets: the underlying cryptocurrencies/digital assets do not have the same level of investor disclosures as

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registered securities. This is especially true if the cryptocurrency/digital asset is a “security” but is not registered.

- Inadequate investor protections from cryptocurrency markets:
  - Digital assets trading on cryptocurrency markets are not registered securities, and therefore are missing all of the disclosures that would otherwise exist.
  - Markets span national borders and significant trading may occur on systems and platforms outside the United States. An investor’s funds may travel overseas without an investor’s knowledge. As a result, the SEC and other U.S. regulators may not be able to effectively pursue bad actors to recover funds.

- Without greater regulatory oversight or without offering registered securities, cryptocurrency markets may be susceptible to trading by unlicensed traders (non-broker-dealers), and there may be excessive touting in thinly traded and volatile markets (i.e., scalping, or pump-and-dump schemes).

The current state of affairs:

- Chairman Clayton has said publicly that Bitcoin is not a “security.”
- An increasing number of U.S.-based cryptocurrency exchanges are seeking to operate as licensed alternative-trading systems (“ATS”).

How to improve the state of affairs to address the SEC’s concerns:

- Since the Chairman of the SEC has stated that Bitcoin is not a “security,” Bitcoin should not be expected to have any securities-based disclosures that would otherwise exist. As stated in further detail below, a Federal court and the CFTC have found that it is a commodity. The CFTC has authority and mechanisms to prevent manipulation:
  - CFTC has enforcement jurisdiction in the Bitcoin spot markets.
- As more trading occurs in the U.S. on platforms that are registered ATS’s, or are affiliated with registered ATS’s, the SEC will gain more regulatory control over such

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exchanges, and investors will gain more protections through the ATS’s policies and regulatory obligations.

- The SEC has its own tools available to police against manipulation and fraud. To the extent applicable:
  - Exchange Act Section 10(b); Exchange Act Rule 10b-5.\(^6\)
  - Exchange Act Regulation M.\(^8\)

**Manipulation concerns in cryptocurrency ETF rejections**

The SEC’s concerns as expressed in the Order Disapproving the SolidX Bitcoin Trust proposal on NYSE Arca:\(^9\):

- There is not currently a regulatory framework in the United States for detecting and deterring manipulation in the Bitcoin spot markets.

- SEC examples of concerns over manipulation:
  - Potential material non-public information related to the actions of regulators with respect to Bitcoin.
  - Potential material non-public information regarding order flow, such as plans of market participants to significantly increase or decrease their holdings in Bitcoin.
  - Potential material non-public information regarding new sources of demand, such as new ETPs that would hold Bitcoin.
  - Potential material non-public information regarding the decision of a Bitcoin-based ETP with respect to how it would respond to a “fork” in the blockchain, which would create two different, noninterchangeable types of Bitcoin.
  - The manipulation of asset prices, as a general matter, can occur simply through trading activity that creates a false impression of supply or demand, whether in the context of a closing auction or in the course of continuous trading, and does not require formal linkages among markets (such as consolidated quotations or

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\(^{7}\) 17 C.F.R. § 240.10b-5.

\(^{8}\) 17 C.F.R. §§ 242.100-242.105.

routing requirements) or the complex quoting behavior associated with high-frequency trading.

- Although NYSE Arca notes that Bitcoin trades continuously so that there are no opening or closing prices to manipulate, the SEC believes that continuous trading does not necessarily eliminate manipulation risk.

The current state of affairs:

- As stated by the SEC, there is not currently a regulatory framework in the United States specifically designed to detect and deter manipulation in the Bitcoin spot markets.

- The SEC’s concerns over issues relating to material non-public information in the context of cryptocurrency markets is not misguided (see, e.g., Coinbase allegations of insider trading on Bitcoin Cash (BCH)).

- The SEC’s concerns regarding front-running with information about forks is also not necessarily misguided to the extent that anyone with non-public information about an upcoming fork could potentially trade on that information.

How to improve the state of affairs to address the SEC’s concerns:

- The CFTC does prosecute derivative market fraud and manipulation, including misconduct in underlying spot markets for commodities. In addition, virtual currencies such as Bitcoin have been deemed by the Federal courts to be “commodities” under the Commodity Exchange Act (“CEA”). To the extent it feels comfortable relying on a partner agency, the SEC can hope and expect that the CFTC is vigilantly monitoring Bitcoin spot markets for potential enforcement actions.

- The Coinbase allegations have led to several important developments for the maturation of the cryptocurrency markets:


The mere allegations led to wide ranging industry discussion about the need for and the implementation of stronger insider trading policies for cryptocurrencies.\textsuperscript{13}

In the Coinbase example cited above, Coinbase was sued by an aggrieved investor, but Coinbase successfully had the suit dismissed.\textsuperscript{14} The action itself provides an example of how potentially aggrieved parties can seek traditional remedies for alleged harm stemming from digital asset trading and demonstrates that alleged digital asset-defendants are capable of defending themselves. In addition, it is worth noting that Coinbase itself has its own employee trading policy that prevents its employees from using inside, corporate, or proprietary information to trade digital assets.\textsuperscript{15}

A Bitcoin ETP should have robust disclosures for shareholders that address investment strategies and risks, as well as how the ETP would handle “forks” and other intricacies of cryptocurrencies so as to minimize the risk or impact of material non-public information. For instance, in the Form S-1 for the Bitcoin ETP product that Ms. Blass referred to in her letter, the ETP did not address how the ETP would handle a “fork” of Bitcoin.\textsuperscript{16} In particular, it did not address what the ETP would do with forked assets, and it did not state the ETP’s policies to monitor or prevent front-running on material non-public information. It only explained forks in the context of a risk disclosure in that it is a potential risk to the fund and fund shareholders if Bitcoin forks.

The possible vectors for potential manipulation of the cryptocurrency markets

The SEC’s concerns include many reported in media reports:


- \textbf{CBS NEWS (Jan. 18, 2018)}\textsuperscript{18}: The now-dissolved exchange, Mt. Gox, admitted to two bots manipulating the price of Bitcoin on the exchange, despite not owning any Bitcoin.


\textsuperscript{15} COINBASE, LEGAL: COINBASE MARKETS TRADING RULE § 3.3 (last visited Nov. 15, 2018), https://www.coinbase.com/legal/trading_rules?locale=en-US.

\textsuperscript{16} SolidX Bitcoin Trust, Form S-1 (as filed on July 11, 2016), available at https://www.sec.gov/Archives/edgar/data/1668039/000119312516645774/d121870ds1.htm.

At the Mt. Gox trial, the former CEO of Mt. Gox testified that Mt. Gox operated one of the bots. On the days where the bot purchased Bitcoin, the price went up.

- **THE INDEPENDENT (Sept. 6, 2018)**: The lack of market regulation means that a powerful group of traders is able to act with impunity, according to David Drake, founder and chairman of LDJ Capital.

The current state of affairs:

- If a cryptocurrency or token has founders, or disproportionately large token holders, then the trading behavior of these actors could potentially manipulate the price of the asset. For instance, founders of a cryptocurrency could flood the market with tokens to manipulate the price. Likewise, a large token holder could do the same.

- By November 2018, the volume of trading in the underlying *Bitcoin* markets is widely distributed to high number of exchanges around the world.

- As time goes on, there is more trading and pricing data on Bitcoin available to purchasers. There are more institutional-type exchanges in 2018 than in 2014 (e.g., Coinbase) and each now has additional years of trading and pricing data. In addition, the advent of Bitcoin futures increases the types of data for Bitcoin pricing.

How to improve the state of affairs to address the SEC’s concerns:

- The SEC could potentially regulate trader behavior through Regulation M, particularly Rule 104. To the extent it is applicable, the SEC could regulate behavior to ensure that legitimate price stabilization activity may continue, but could also bring enforcement actions against manipulative behavior.

- The dispersed trading of Bitcoin across the world would seem to prevent the type of manipulation by large single traders that the Mt. Gox Bitcoin market experienced.

- The additional trading data makes it harder for “pump-and-dump” schemes to work on Bitcoin, because any narrative efforts by a small group of malevolent traders would have to overcome the raw data available to traders.

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21 17 C.F.R. § 242.104.
The relationship between the cryptocurrency-derivative markets and the underlying cryptocurrency markets

The SEC’s concerns:

• Blass Letter: The pricing of the cryptocurrency-derivatives markets is expected to be strongly influenced by the underlying markets.

• Proshares Bitcoin ETF Rejection Order\(^ {22} \): Because a substantial amount of trading in the underlying bitcoin markets occurs overseas in unregulated venues, any surveillance agreements with other securities exchanges or Bitcoin-futures markets would be inadequate for gaining insight into the identity and activity of Bitcoin traders to the extent necessary to adequately prevent market manipulation.

• ProShares Bitcoin ETF Rejection Order: The CME and Cboe Bitcoin-futures markets are not “markets of significant size.”

The current state of affairs:

• Volume of BTC futures is less than other futures, but not insignificant:
  
  o CME BTC Futures trading total trading volume for the week of October 29-November 2, 2018: 10/29 4,101; 10/30 2,100; 10/31 3,413; 11/1 1,202; 11/2 1,746. Total for the week: 12,562.
  
  o For comparison, CME S&P 500 Futures total trading volume for the week of October 29-November 2, 2018: 10/29 4,139; 10/30 3,766; 10/31 2,535; 11/1 5,024; 11/2 2,805. Total for the week: 18,269.

• Price of Bitcoin over the last 2 months has held relatively stable within a roughly $600 window (9/5/2018 - 11/5/2018) (from Coinbase):
  
  o Low: $6,198.67
  
  o High: $6,707.14

• Price of Bitcoin over the previous month has been even more stable, within a roughly $400 window (10/5/2018 - 11/5/2018) (from Coinbase):
  
  o Low: $6,198.67
  
  o High: $6,587.33

• Some other countries with substantial cryptocurrency trading are increasing their regulation of cryptocurrency markets:
  
  o Hong Kong (as of 11/1/2018): The Hong Kong Securities and Futures Commission announced plans to regulate cryptocurrency exchanges and funds that invest in digital assets to protect investors.

  o Thailand (as of 8/9/2018): The Thailand Securities and Exchange Commission implemented a cryptocurrency exchange license, and a total of 20 cryptocurrency exchanges had registered for the licenses by August 9, 2018.

• In general, token trading platforms do not have a “kill switch” to halt trading, unlike the existing infrastructure for equities trading. In addition, regulators or private actors may have difficulty in bringing a cease-and-desist action against a decentralized network as a means to halt trading.

How to improve the state of affairs to address the SEC’s concerns:

• The current volume of Bitcoin futures trading is at a level that is close to the trading volume of other products, such as S&P 500 futures. As the volume of Bitcoin futures trading continues to grow, the Bitcoin futures markets approach a size that could be deemed to be of “significant market size.” A surveillance agreement with such a market would be a significant step towards satisfying Exchange Act Section 6(b)(5).

• In the most recent quarter of market trading, the price of Bitcoin has been relatively stable. Without prognosticating too deeply about the reasons, the market data on its own demonstrates that volatility in the price of Bitcoin has dramatically decreased over an increasing extended period of time for the first time since 2016. A more stable price of Bitcoin would indicate that it is not being subjected to inappropriate price swings through market manipulation and in turn, is not subjecting inappropriate volatility to the Bitcoin-futures markets.


24 Alice Woodhouse, Hong Kong watchdog outlines plans to regulate cryptocurrency industry, FIN. TIMES (Nov. 1, 2018), https://www.ft.com/content/07142e74-dd93-11e8-9f04-38d397e6661c.


26 See, e.g., Rule 201 of Regulation SHO, 17 C.F.R. § 242.201.

• Trading halts and trading suspensions are an important tool for existing securities markets when the markets experience a very steep decline.\textsuperscript{28} Because of the nature of cryptocurrencies and blockchains, it may be possible for the underlying cryptocurrency exchanges to implement smart contracts into the trading protocol that would trigger trading halts in the event of a drastic price fluctuation. Likewise, a cryptocurrency ETP could be subjected to a security exchange’s circuit breakers if its price begins to violently fluctuate.

• Many other countries around the world are increasing their regulation of cryptocurrencies, in particular their regulation of cryptocurrency exchanges. Many of these countries already have relatively high volumes of cryptocurrency trading. As additional countries continue to increase their own regulation of cryptocurrency markets, the securities exchanges that would list Bitcoin-related ETFs would increase their overall ability to enter into surveillance agreements with markets that can better monitor the identity of traders and the trading in both Bitcoin-futures products and the underlying Bitcoin markets.

\textsuperscript{28} \textit{FIN. INDUS. REG. AUTH., INVESTOR ALERTS: WHEN TRADING STOPS: WHAT YOU NEED TO KNOW ABOUT HALTS, SUSPENSIONS AND OTHER INTERRUPTIONS} (last visited Nov. 6, 2018), \url{http://www.finra.org/investors/alerts/when-trading-stops-halts-suspensions-other-interruptions}.\textsuperscript{28}