MEKETA
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Cryptocurrencies: Bitcoin, Blockchain, and Institutional Investors

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Cryptocurrencies have increasingly attracted the attention of the investing public. This is in no small part due to Bitcoin returning 300% in 2020 and doubling in price again during the first few months of 2021. Bitcoin's stunning performance and resiliency during the global pandemic has sparked new interest from institutional investors in cryptocurrencies.

In this primer, we describe the investible characteristics of cryptocurrencies, including their potential to offer diversification benefits. We offer an overview of investment platforms and vehicles currently available, and we also touch on the current regulatory landscape.

We find that digital currencies potentially offer several attractive characteristics, most notably including the ability to serve as a novel diversifying asset class with some gold-like (e.g., inflation hedging) properties. In addition, the development of investment vehicles, derivatives, trading capacity, and custodial services indicate its potential as an institutional asset class. However, there are several risks currently inherent to cryptocurrencies that are either unique to the asset class or considerably amplified relative to similar assets (e.g., gold). These include exceptionally high volatility, regulatory uncertainty, and rapidly evolving technology and competitors (including central bank digital currency initiatives).

On balance, we find that institutional investors should carefully weigh all of the explicit and implicit risks before investing in cryptocurrencies.

A brief history

The first and most popular cryptocurrency is Bitcoin, which was created in 2009 by a person or group of people under the alias Satoshi Nakamoto. It was designed to be peer-to-peer, anonymous, decentralized, and an alternative to national fiat currencies. Cryptocurrencies such as Bitcoin rely on blockchain technology, a digital, decentralized, and distributed ledger that encodes all transactions within its network through a system of linked and encrypted ledgers, or "blocks," which memorialize all previous transactions. The Bitcoin blockchain was designed to eliminate the verification and physical payment systems that slow the pace of ecommerce transactions.[1]

[1] Please see the appendix for additional information about the introduction of Bitcoin and the uses of blockchain technology.

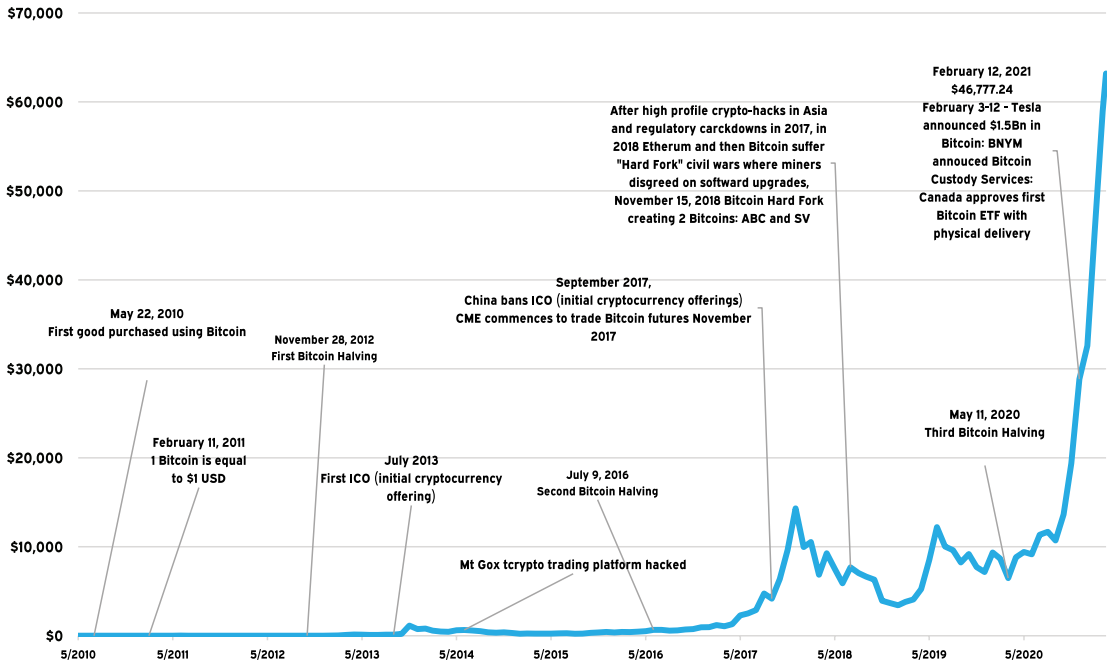

FIGURE 1
Bitcoin Price History and Events: Price USD 2010-4/13/2021

Source: Meketa Research, Bloomberg, and Coinbase.

Currency or commodity

In many ways, Bitcoin and other digital currencies effectively represent a new type of asset. While they have properties of both currencies and commodities, most investors perceive crypto as an alternative currency. However, digital currencies do not meet the traditional requirements for an asset to be considered money (see table below).

Criteria	Current Status
store of value	too volatile
means of exchange for goods and services	minimal acceptance
unit of account that measures value	too volatile

TABLE 1
Digital Currency Asset Requirements

Source: Meketa Investment Group.

The majority of national currencies, including the US dollar, are fiat money. Fiat money is government-issued currency not backed by gold or other commodities. The value of fiat money comes from the faith people hold in that country's government and economy. Like fiat money, Bitcoin is not backed by commodities, and its value is based on the belief people hold that it does in fact have value. However, one of the reasons that Bitcoin is more volatile than fiat money is because there is no government or economy on which to base its stability. Cryptocurrencies do not reflect a fundamental value associated with a national economy and do not have governmental guarantees. The creation of cryptocurrency supply is a reflection of the productivity of blockchain miners' hashing[2] blocks rather than a product of profitable economic growth.

[2] Hashing is a mathematical process whereby a sequence of data of any size is transposed by the mathematical operation into an output of data of fixed size. Hashing ledgers requires that the encryption protocol is rerun until a matching output is achieved verifying the miner's work. At the time of writing the Bitcoin hash requires an output sequence that begins with 18 zeros. Source: https://www.coindesk.com/bitcoin-hash-functions-explained.

Acolytes of cryptocurrencies argue that fiat currencies are vulnerable to government depreciation of currency value through printing money. They point to the limited supply of Bitcoin and government's inability to control the supply. Yet, while there may be limited supply for an individual cryptocurrency, there is an unlimited number of potential cryptocurrencies. In the future, we may witness blockchain/cryptocurrency ghost-towns that have been abandoned for more promising ventures. And while the more popular crypto coins can be used to pay for some goods, they are not nearly as widely accepted as traditional currencies like the Dollar. Some e-payment applications are increasing their functional support of digital wallets to facilitate the use of crypto to buy goods and services, but these have seen limited adoption.

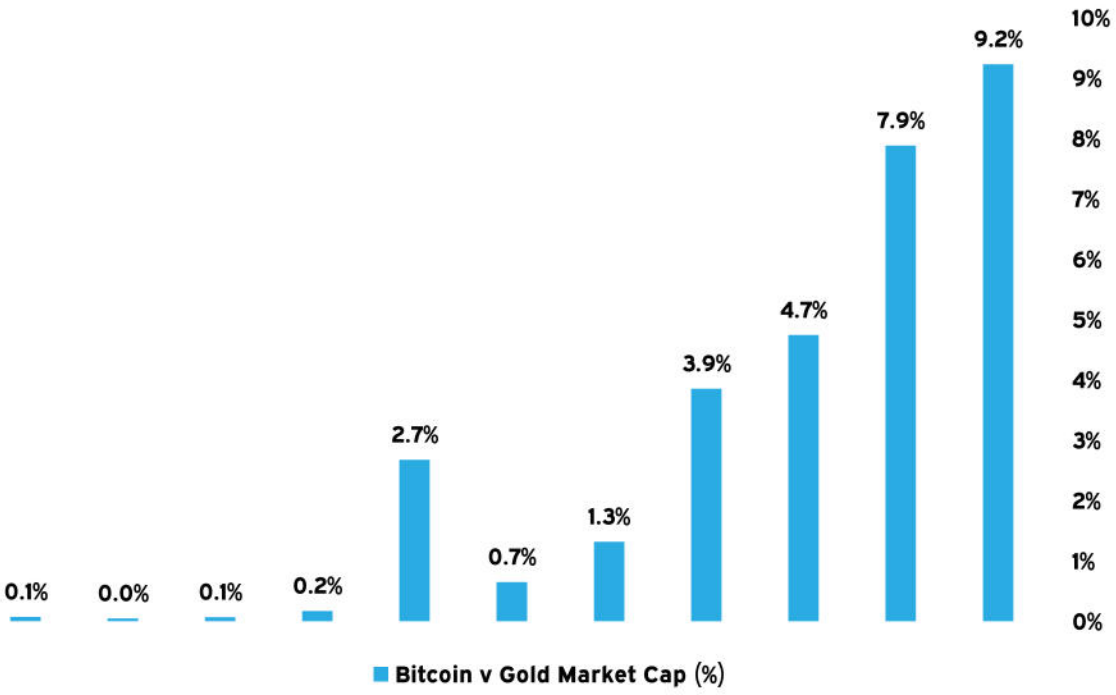

FIGURE 2
Bitcoin Market Capitalization as a % of Estimated Market Capitalization of Physical Gold (USD)

Source: World Gold Council annual physical gold supply and USD price per tonne. CoinMarketCap annual market capitalization for Bitcoin. Between 2013 and 2020, the number of Bitcoins in circulation increased from ~12 million to 18.6 million coins.

The new gold?

Bitcoin and gold share some properties, which has given rise to the view that Bitcoin will act like a digital version of gold in the future. Both have limited supply, and neither can be devalued by a central bank or national government. Both are easily portable and globally accessible, though neither is ideal for exchanging most good and services. Likewise, gold and Bitcoin (thus far) have not demonstrated a high degree of correlation with publicly traded securities.

However, it would be a stretch to consider Bitcoin as a "safe" store of value like gold. Gold has a long history of acting as a store of value and offering a degree of risk protection, by outperforming in times of political and economic uncertainty. Gold has served as a diversifier and an inflation hedge historically. Bitcoin has no such history,

hence its properties as an inflation hedge or a defensive asset are speculative, at best. Moreover, the volatility of Bitcoin is many times that of gold or traditional currencies, though as liquidity and acceptance increase, volatility will probably decline.

Bitcoin is a novel asset that may yet be impacted by regulation or supplanted by a different cryptocurrency. Unlike gold, which is a physical mineral, Bitcoin is a single type of cryptocurrency and there are an unlimited number of types of cryptocurrencies with an infinite number of coins. The physical costs of mining gold and access to gold reserves limit new entry to physical gold production. The physical costs of mining cryptocurrencies and hashing digital ledger blocks are not physically circumscribed, resulting in lower barriers to entry.

Bitcoin performance

In February 2011, the price of a single Bitcoin was equal to $1; by February 2021, a single Bitcoin was worth over $50,000. The total market capitalization of Bitcoin dominates the cryptocurrency markets, comprising approximately two-thirds of the tradable market. Bitcoin is viewed as the premier cryptocurrency, commanding higher prices and higher investor demand.

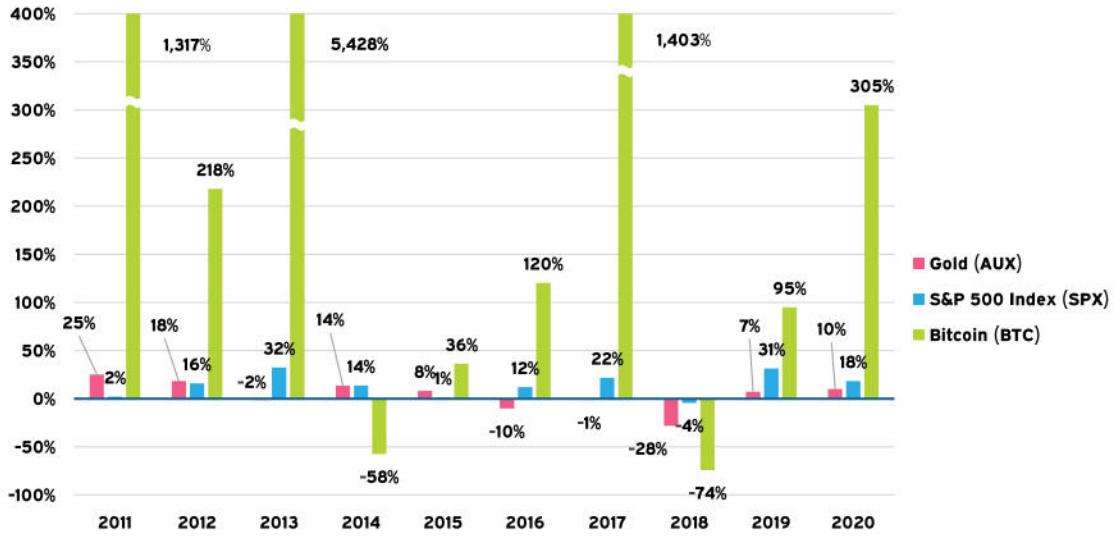

FIGURE 3
Gold, Bitcoin, and S&P500 Index: 2011-2020 Calendar Year Returns (%)

Source: Bloomberg.

While Bitcoin has delivered an annualized return of 215% over the past 10 years, its volatility has been equally spectacular. Bitcoin's annualized 10-year standard deviation is 201.9% or approximately 12 times that of gold. Moreover, in its short history, Bitcoin has already matched the S&P 500's maximum drawdown from 1932.

	Gold	S&P 500 Index	Bitcoin
10-Yr. Annualized Return	2.9%	13.9%	215.2%
10-Yr. Standard Deviation	16.4%	13.5%	201.9%
10-Yr. Skew	0.2	-0.3	4.6
Largest Drawdown	-62.2%	-86.2%	-85.9%

TABLE 2
Historical Performance Characteristics As of December 31, 2020

Source: Bloomberg.

Based on this limited - and quite volatile - history, an investor would be hard pressed to create any kind of reliable long-term capital markets expectations for the asset class. Intuitively, it makes sense that cryptocurrencies would not necessarily be correlated with traditional risk assets, such as equities, or even with rate-sensitive assets, such as bonds.

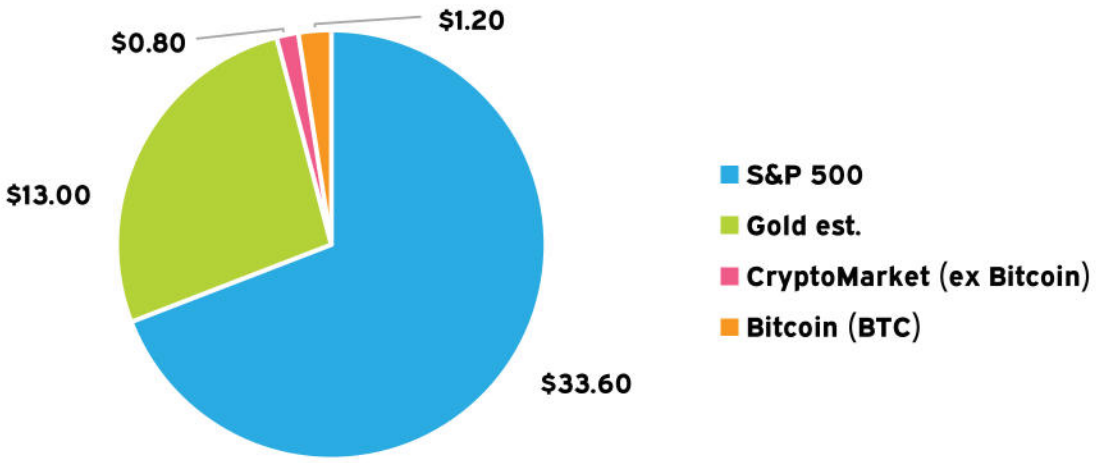

FIGURE 4
Market Capitalizations (USD T.): Comparing Stock, Gold and Crypto Market Capitalizations March 31, 2021

Source: www.yardini.com, Bridgewater and www.coinmarketcap.com as of February 15, 2021.

Future supply

Most digital currencies are designed such that a finite amount of each will ever be produced. For example, the total number of Bitcoins (BTC) that can ever be mined is 21 million BTC. As of December 2020, 18.58 million Bitcoins had been mined. This represents 85% of the total intended supply. The final 15% is expected to be mined by 2140. While the Bitcoin blockchain software has a pre-determined number of Bitcoin, other blockchains may have unlimited number of potential cryptocurrency coins. Moreover, there are very low barriers to entry for new blockchain software offerings. In a wide field of competitors, the certain scarcity of Bitcoin may help support its relative outperformance.

In the early phases of Bitcoin's development, miners were rewarded with 50 coins per block hashed. Over time, the number of coins miners have received has been intentionally diminished through a process known as "halving." Halving reduces the

reward that Bitcoin miners receive by half. Halving has occurred approximately every four years. In May 2020, Bitcoin underwent its third pre-scheduled halving, where the number of coins per block-hashed fell from 12.5 BTC to 6.25 BTC.

Going forward, miners will experience diminishing returns in the form of the number of coins per block hashed. However, if Bitcoin's valuations remain near those of early 2021 (or continue to climb), the incentive may shift to value in US dollars of the coins received rather than the number of Bitcoins delivered per block. The final 15% is expected to be mined by 2140. The Bitcoin blockchain software will pay miners fees for verifying transactions after 2140.

There is no limit to the number of digital currencies that can exist. This includes offshoots, or forks, of existing cryptocurrencies, such as Bitcoin Cash. While users and miners of blockchains are linked through shared software programs that are self-reinforcing and self-validating, users may disagree about potential upgrades or changes to blockchain software. Hard forks are instances where a blockchain's software undergoes changes that result in a bifurcation of the legacy blockchain and creation of a new related cryptocurrency. Bitcoin has undergone several hard forks since 2011, resulting in spin-off versions of Bitcoin such as Bitcoin gold, Bitcoin cash, and Bitcoin classic. Hard forks have had a range of success and adoption.

What began as a unique attempt at distributed digital payment software via Bitcoin, the cryptocurrency marketplace has become a technological innovation with approximately 4,000 blockchain/cryptocurrency configurations, though very few appear to have broad adoption or investor interest. Some blockchain/cryptocurrency systems have very specific e-payment related goals. For example, facilitating the interface between existing e-payment non-block chain applications with blockchain applications. Some blockchain/cryptocurrencies are designed so that retail computers can hash blocks for an unlimited number of coins to foster innovation and participation of individuals. Other blockchains attempt to tie the value of their coins to a fiat currency. For example, Tether promised a 1-to-1 conversion of its coin to a US dollar. Regulators have sanctioned popular cryptocurrencies such as Ripple XRP and Tether for misleading practices, and more oversight may be forthcoming.

It is worthwhile to address a prominent competitor to Bitcoin, Ethereum. Ethereum (ETH) uses Ethereum blockchain technology. It offers users conditionality in transactions and allows users to limit transactions to preapproved users. These features make Ethereum more adaptable to mainline banks and investment firms. The ability to leverage smart contracts and customize transactional pre-conditions may prove to be well suited for further optimizing the global payment system. Plans to upgrade Ethereum capacity – through stacking or sharding - should produce a rate of transaction processing that will be able to scale to rates managed by the likes of Visa or Citibank today. Unlike Bitcoin, whose number of coins are limited, Ethereum and its successors may have an unlimited numbers of coins (see appendix).

Investing in cryptocurrencies

Increasing retail and institutional interest in cryptocurrencies is quickly being met with a wide variety of investment vehicles and platforms. Just as stocks and derivatives are traded on exchanges by brokers, so are digital currencies. A crypto platform, or exchange, is a site for buying and selling digital currencies. These platforms usually offer free digital wallet services so that investors can house their crypto-coins within their platform or freely transfer crypto-coins into the trading platform. Similar to brokerages, crypto-trading platforms offer a wide variety of services including trading on margin and options. Fees and transaction costs may be paid in a cryptocurrency that is proprietary to that platform. The providers may offer lower fees and margin costs for transacting in that currency in order to incentivize its use. For example, Binance has an associated Binance coin (BNB).

Coinbase Platform	→ Most used crypto exchange in the US – wallets offered free of charge → Trading and transaction fees are charged based on estimated network transaction costs → Tiered fee assessment sized to value of transaction; 2% flat fee on credit/margin trading
Binance Platform	→ A focus on Alt Coins (non-Bitcoin cryptocurrencies); free digital wallet services → Charges 0.1% on all transactions with a 50% discount incentive to pay fees with Binance coin → US trading suspended in 2019 – ordered to terminate crypto collateral for trading crypto futures on margin
Kraken Platform	→ Known for advanced market trading, wallet services are free → Spot trading with account is free but with credit card transactions 3.75%, FX trading 0.04% to 0.20%, margin trading 0.01% every 4 hours, 30-day futures tiered fee 0.015% to 0.05%
Cash App	→ Peer to Peer money transfer app (like Venmo for cryptocurrency) → Only offers/accepts Bitcoin → Service fee plus Bitcoin- market price adjustment fee, settles at mid-day price

TABLE 3
Digital Currency Platforms and Their Features

Source: Meketa Investment Group

Investment vehicles

While a few prominent university endowments have disclosed positions in cryptocurrencies, the small size and very limited liquidity in the cryptocurrency markets may prevent large institutional investors from direct ownership of physical cryptocurrencies. However, there are a variety of niche investment opportunities for gaining exposure to the cryptocurrency space.

Institutions could buy directly from an exchange or they could buy futures, but these pose challenges in the form of internal management and custody. There are a small number of long-only commingled vehicles (e.g., trusts, closed-end mutual funds) that are mostly limited to high net worth and institutional investors. Cryptocurrency ETFs are likely to be available soon. The first bitcoin ETF has been approved in Canada. In the US, regulators could approve a bitcoin ETF in 2021. Hedge funds are increasingly active in arbitraging cryptocurrency price movements with over 100 hedge funds actively trading cryptocurrencies.

An alternative route is to invest in the technology and infrastructure related to digital currencies rather than the currencies themselves (i.e., the "pick and shovel" approach). There are a broad array of crypto mining and blockchain stocks, and as of this writing, there were four dedicated blockchain ETFs. Coinbase, the most popular of the crypto-trading platforms was listed on the NASDAQ in April 2021 with an IPO value of $65.4 billion.[3] Venture capital investing has thus far focused on blockchain applications and technologies. The largest segment is in financial services linked to crypto (e.g., decentralized finance). Investments are also being pursued in applications of blockchain in health care, energy, supply chains, and agriculture.[4]

[3] Source: Bloomberg. Coinbase IPO opened at $381 per share and rose to nearly $430 a share before falling to $328 per share and an estimated market value of $65.4 billion. Nearly half of Coinbase's trading revenue is derived solely from trading fees of Bitcoin. For comparison, on the same day, the Chicago Mercantile Exchange was valued at approximately $73 billion.

[4] Source: https://www.coindesk.com/company/mt-gox; see also https://www.reuters.com/investigates/special-report/bitcoin-gox/

Cautionary Tale: Mt. Gox

Mt. Gox was created in 2010 as a Bitcoin exchange platform headquartered in Japan. Four years later, it was the largest Bitcoin exchange and handled 70% of all BTC transactions. However, Mt. Gox had unknowingly been hacked and infected with a bug that over time was stealing coins from users and the company. The hack was discovered in 2014 after a total of 850,000 BTC had been stolen. This represented more than 6% of all Bitcoin in circulation at the time. Mt. Gox filed for bankruptcy several days later.

After two weeks, 200,000 BTC were "found" in an old digital wallet and recovered. Alexander Vinnik, owner of the crypto exchange platform BTC-e, was found guilty of aiding in and laundering the remaining 650,000 stolen Bitcoins. Unrelated to the hack, Mt. Gox's CEO, Mark Karpelès, was arrested on charges of falsifying data to inflate the company's holdings as well as embezzlement. As recently as December 2020, the Mt. Gox trustee submitted a plan to finally refund creditors (including users) using the previously found 200,000 Bitcoins.

Liquidity

Institutional investors generally require the market for a publicly traded asset to be liquid for it to be viable.[5] For example, they want to be able to trade in the asset without significantly affecting its price. Most digital currencies do not yet meet this threshold. Bitcoin is coming the closest, with its liquidity growing rapidly. However, much of the trading volume appears to be more indicative of speculation, not long-term investing.

When compared to other public securities markets, the liquidity of cryptocurrency markets remains quite limited.[6] The US bond market has an estimated daily cash volume of approximately $264 billion, compared to Bitcoin's $6 billion. The CFTC designation of Bitcoin as a commodity has resulted in Bitcoin derivatives listed on the Chicago Mercantile Exchange, and while new OTC and exchange Bitcoin derivatives are being developed, the daily trading volume is approximately $1.4 billion dollars.

[5] If an asset has other major benefits, such as higher expected returns, institutional investors will often accept significant illiquidity.

[6] Table and text; Bridgewater - A Look at the Path for Bitcoin If It Is to Become an Alternative Storehold of Wealth; Rebecca Patterson et al., January 2021.

	Market Capacity (Indexed)	Outstanding (USD, Bn)	Cash Volume (USD, Bn)	Derivatives (USD, Bn)
USA Equities	130	34,629	329	479
USA Bonds	101	6,175	264	434
Gold	11	2,894	39	66
Bitcoin	-62.2%	562	6	1

TABLE 4
Liquidity for Certain Asset Classes

Source: Bridgewater. Gold is amount outstanding in bars, coins, recycled, and mining; Bitcoin volumes use a conservative estimate, attempting to capture flows indicative of real liquidity.

Regulators and Global Central Banks

In the US, the regulatory landscape is in its infancy and will require that investors remain up to date on potential regulatory changes. Given that cryptocurrencies are a new asset, settled law has not yet been achieved. At this time, cryptocurrencies do not have any direct federal or state regulation. Instead, regulators are focused on the stakeholders and vehicles that facilitate the trading and custody of the crypto-coins. The Securities and Exchange Commission (SEC) has refrained from regulating cryptocurrencies that they do not define as securities.[7] The reluctance of the SEC to regulate cryptocurrencies allowed regulatory space for the Commodity Futures Trade Commission (CFTC) to define Bitcoin as a commodity that could be traded on its exchange like other commodities or currencies.[8] The Commission does not regulate cryptocurrencies per se, but regulates the derivative structures used to trade Bitcoin. The Office of the Comptroller of the Currency (OCC) has ruled that state bank regulators have powers to regulate banks' custody and services related to cryptocurrencies.[9]

Global central banks are working diligently to monitor and integrate the rapidly growing peer-to-peer payments systems and are discussing how digital currencies can be integrated into the global settlement system and reserve management. For now, central banks view cryptocurrencies as potential competitors or disruptors of fiat currencies. Importantly, if independent digital currencies become widely accepted and circulated, they might affect central banks' ability to implement monetary policy. This implies there is a substantial risk that national governments and regulators may prohibit or circumscribe the use of cryptocurrencies at some point in the future.

The Bank for International Settlements (BIS) is leading an international, coordinated effort of participating central banks to evaluate how to integrate blockchain technology into their global settlement system and potentially issue Central Bank Digital Currencies (CBDCs). These CBDCs would be different from traditional cryptocurrencies, as they would be issued by national treasuries. Countries such as Sweden and China are already experimenting with their own digital currencies. In 2021, China issued the eYuan in test cities as a pilot program that would operate as a P2P payment app currency that would compete with and eventually displace smart phone payment applications like Alibaba's AliPay and Tencent's WeChat Pay.

[7] Source: https://www.sec.gov/news/public-statement/statement-clayton-2017-12-11. "First, while there are cryptocurrencies that do not appear to be securities, simply calling something a "currency" or a currency-based product does not mean that it is not a security. Before launching a cryptocurrency or a product with its value tied to one or more cryptocurrencies, its promoters must either (1) be able to demonstrate that the currency or product is not a security or (2) comply with applicable registration and other requirements under our securities laws."

[8] Source: CFTC: https://www.cftc.gov/sites/default/files/idc/groups/public/%40customerprotection/documents/file/oceo_bitcoinbasics0218.pdf

[9] https://www.occ.gov/news-issuances/news-releases/2020/nr-occ-2020-98.html

Global central banks recognize that with the potential rise of cryptocurrencies and increasing adoptions of P2P payment, they will need to incorporate digital technologies and decentralized finance into their multilateral systems. For example, blockchain and digital wallets permit international transactions that circumvent traditional bank wire and settlement systems, which may undermine monetary policy and regulatory oversight.

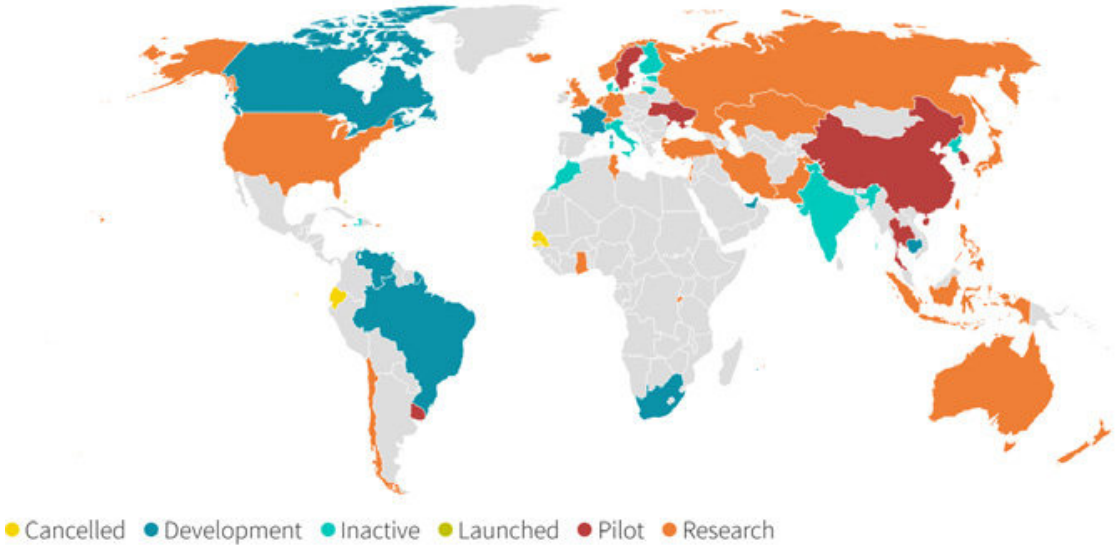

FIGURE 5
Central Bank Digital Currencies Across the World
(CBDC projects are moving ahead across the world - though few have gone past the drawing board.

Note: European Central bank is concucting research for eurozone.

Source: Harvard Kennedy School Belfer Center & Atlantic Council, Reuters research.

Bitcoin and other cryptocurrencies have a reputation for being used by international money launderers and criminals to avoid anti-money laundering regulatory and banking oversight. The percentage of such transactions is small, but in dollar terms, it is meaningful.

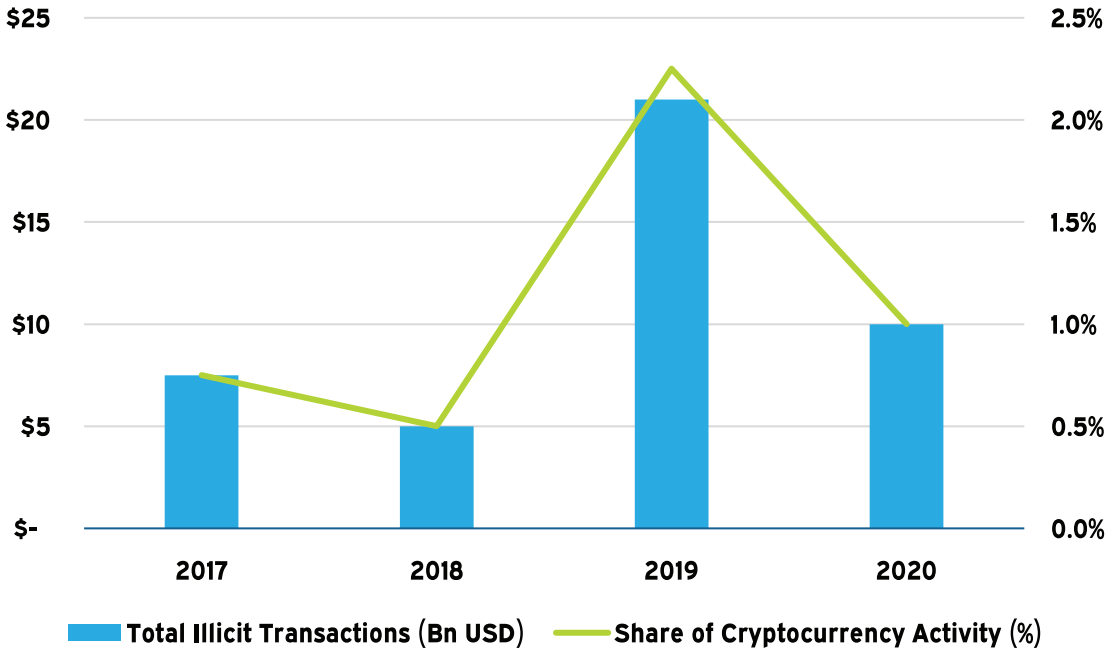

FIGURE 6
Total Cryptocurrency Value Sent & Received by Criminal Entities vs. Criminal Share of All Cryptocurrency Activity

Source: Chainalysis 2021 Crypto Crime Report.

Regulatory authorities around the world are keenly aware of this activity and are likely to take steps to rein in such behavior. The Internal Revenue Service is monitoring cryptocurrency investment gains and payments with increasing scrutiny, and the SEC has obtained injunctions that are pushing crypto-trading platforms toward greater transparency. While the cryptospace is continually evolving, the activity of criminals and money launderers is attracting more scrutiny and oversight. Since 2013, anti-money laundering regulator FinCen has received 70,000 complaints related to digital currencies and over half of these were filed by industry users. US regulators including the SEC and the IRS have been actively filing injunctions and criminal proceedings related to fraud in the blockchain/cryptocurrency industry.

Summary

The cryptocurrency market is rapidly evolving. It is becoming more liquid, and an increasing number of institutions are offering services that cater to institutional investors. An ever greater number of investors are showing interest, not least due to the outsized returns of recent years (presumably they are comfortable with the outsized volatility). The independence of the current generation of cryptocurrencies from central banks makes them attractive to a less speculative group of investors, who perceive crypto as a digital form of gold, with the ability to serve as a store of wealth and an inflation hedge.

Regulators and central banks are likewise exhibiting growing interest, though this perhaps implies greater uncertainty about the future of the cryptocurrency market, and particularly individual digital currencies. While Bitcoin enjoys primacy at the moment, there are low barriers to entry that will allow new, potentially improved digital currencies to be developed. Central banks are evaluating issuing their own central bank digital currencies that could compete with and potentially overwhelm current cryptocurrencies. National governments and regulators may prohibit or circumscribe use of cryptocurrencies in defense of their own fiat currencies, payment systems, and monetary policy.

While Bitcoin appears to have a low correlation with equities and bonds, it lacks a sufficiently long track record for most institutional investors to draw meaningful conclusions about its future return behavior. And despite the aforementioned growth in liquidity and institutional services, there is an insufficient amount of both to meet the needs of most large institutional investors.

Digital currencies and the blockchain technology that underpins them should be taken seriously by institutional investors, as we believe they are here to stay. However, we have a number of concerns about the current state of the cryptocurrency market that should give most institutional investors pause before investing directly.

Appendix

Bitcoin: Origins of Blockchain and Cryptocurrencies

Blockchain is a digital, decentralized, and distributed ledger that encodes all transactions within its network of participating computers through a system of linked and encrypted ledgers, or blocks, which memorialize all previous transactions. Building on previous innovations to reduce costs and frictions in the traditional payment system, Satoshi Nakamoto authored a research paper entitled Bitcoin: A peer-to-peer electronic cash system, which established a framework for a distributed digital payment system that would streamline online payments and circumvent traditional banking and custodial intermediaries through an encrypted open code software called blockchain. The Bitcoin blockchain is designed to eliminate the verification and physical payment systems that slow the pace of ecommerce transactions. The Bitcoin software incentivized participants to build the distributed blockchain ledger system by rewarding the process of mining with the creation of a cryptocurrency called a base-coin.

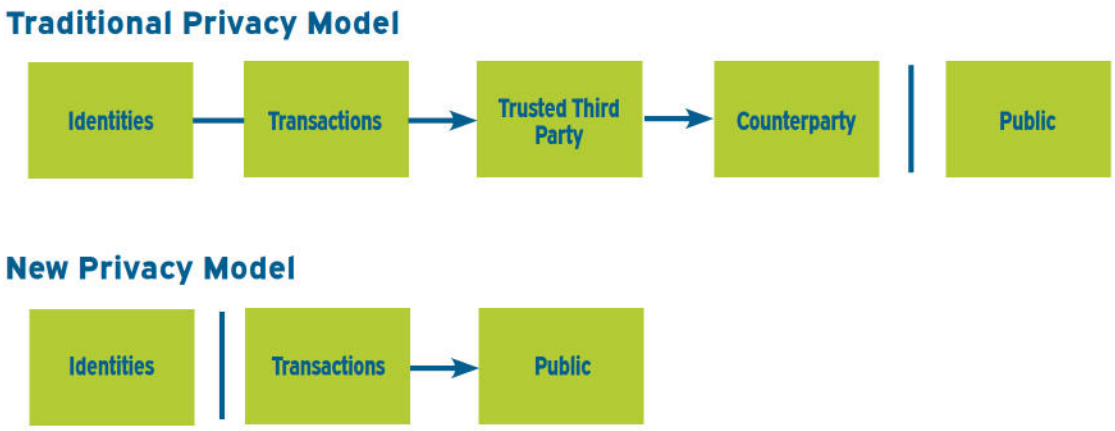

FIGURE 7
Original Satoshi Nakamoto Diagram

Source: Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," www.bitcoin.org. circa 2007.

The traditional payment system depends on the veracity and accuracy of transactions to reduce fraud and costly errors. The trade-off that is associated with ensuring this is the slow speed of transactions and increased costs. Traditional, physical payment systems rely on cumbersome and costly accounting and verification systems. Internal transfers within the same bank can take at least 24 hours to settle, and inter-bank, wire house, credit card and brokerage transactions can take days or even weeks to settle.

Technology has increased efficiencies in the payment system. However, integrating the traditional physical payment system of trusted third-party intermediaries and the rapidly evolving capacity of the internet required its own series of computational and technological innovations. Peer-to-Peer (P2P) direct transaction technologies are upgrading and disrupting the traditional payment system. For example, in China, it is estimated that nearly 80% of transactions are conducted on mobile applications. Mainline banking institutions such as BNY Mellon and JP Morgan are actively developing and integrating blockchain technologies.

While blockchain technologies may appear to offer an ability to circumvent the traditional banking payment systems, global central banks, commercial and investment banks are well aware of the advent of the P2P payment revolution and its challenges/opportunities. The Bank for International Settlements (BIS), a voluntary organization of national central banks including the US Federal Reserve, is coordinating multi-lateral central bank initiatives to evaluate and eventually incorporate blockchain technologies into the international payment system.

Bitcoin blockchain demands a complicated mathematical process of hashing which encrypts the last line of a ledger block and links it to the first line of the next ledger block. Blockchain users verify proof of work of other users/miners' ledger blocks; if the encrypted ending block code does not match previously created duplicate blocks, the block is rejected. The process of verifying prior ledger blocks as proof of work make it increasingly resistant to hacking and manipulation as the number of distributed ledger blocks increase.

Mining

For thousands of years, coins were made from precious metals that had to be extracted, or mined from the Earth. Similar to a precious metal, each individual Bitcoin must be "mined". In cryptocurrency terms, mining is the process of using computers to solve hash puzzles. Computers race to solve these puzzles, and the miner that solves it first gets the reward.

Mining incurs expenses in the form of equipment and the electricity costs needed to power and cool it. These electrical costs are believed to be on par with the costs necessary to power the national grids of some small countries. As of February 2021, the amount of computer energy needed to mine bitcoin accounted for approximately 0.56% of the world's total electricity consumption, according to the Cambridge Centre for Alternative Finance. This attribute calls into question the appropriateness of cryptocurrency in portfolios with an emphasis on environmental, social and corporate governance (ESG). The rate at which miners can hash blocks slows as the number of miners increases. Today a Bitcoin is mined every 10 minutes.[10]

[10] Source: https://www.blockchain.com/charts/total-bitcoins.

Wallets and Storage

A common feature of these blockchain/cryptocurrencies is their dependence on unique digital wallets to store and transfer coins. The encrypted digital wallets may offer a sense of anonymity for owners of cryptocurrency coins, but there are drawbacks. In by-passing trusted third parties, digital wallet transactions are irreversible and cannot be appealed, so that in the event of fraud or error, the crypto-coin transaction cannot be amended once it is recorded in the blockchain ledger. Without a deposit insurance guarantee, digital wallet assets can be stolen, especially when interfacing with cryptocurrency trading platforms that do not have the same level of encryption. Like bank deposit accounts, exchange based digital wallets lend cryptocurrencies on deposit and may offer interest on these lending accounts.

Cryptocurrency coins can be stranded if the security codes for digital wallets are lost, as most wallets have a limited number of attempts to unlock the wallet before they become locked forever. Significant crypto-assets may warrant 'cold storage' where the coins are physically secured on servers or laptops disconnected from the internet. In the US, all of the cryptocurrency trading platforms offer free digital wallet services which may be a viable secure option for crypto-coin portfolios. But some platforms have been hacked like Mt. Gox in Japan in 2015 resulting in the loss of hundreds of millions of cryptocurrencies.

TABLE 5

Popular Types of Cryptocurrency

Name	Date Created	Operating Goal	4/15/2021 Coin Price ($)	4/15/2021 Market Capitalization ($ mm)
Bitcoin (BTC)	2009	Largest cryptocurrency by market capitalization and by transaction data on its blockchain, has had many software upgrades	63,486	1,200,000
Ethereum (ETH)	2015	Smart contracts - decentralized Applications & Financial Products	2,500	289,000
Litecoin (LTC)	2011	open-source global payment network, consumer-grade CPUs to mine	286	19,200
Cardano (ADA)	2017	Research based approach with proof of stake peers for decentralized financial applications, Ouroboros proof of stake blockchain	1.5	47,000
Polkadot (DOT)	2016	Inter-operability between blockchains to connect permissionless and permissioned blockchains and oracles to create systems	43.5	929
Stellar (XLM)	2014	Positioned for Institutional Transactions, allows for cross-currency exchanges	<1	14,500
Chainlink (LINK)	2017	Oracle developer for cross-crypto development and payments settlement	42.6	17,900
Binance (BNB)	2017	Utility currency for paying fees on Binance Platform using proof of stake model, future, crypto-trading platform, crypto collateral margin trading, ERC-20	548	84,700
Tether (USDT)	2015	Stable currency pegged to USD fiat currency with blockchain	1	46,600,000,000

Sources include: CoinBase. Market capitalization and trading volumes are as of February 15, 2021.; www.coinmarketcap.com and coin proprietary websites and white papers. Coins list above represent most popularly traded cryptocurrencies as of creation of these materials. Coin prices at $1 are less than $1 but have been rounded upwards for simplicity and prices are subject to change.

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