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Cryptocurrencies and Digital Assets: Market Structure, Risks, and Opportunities

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The digital-asset market seeks an innovative solution to build a global, decentralized, and secure network that facilitates payments and other transactions. This article explores how proof-of-work protocols, such as bitcoin mining, and proof-of-stake protocols, such as Binance, are used to secure networks and complete transactions. Behind many of these currencies are real businesses, such as ethereum smart contracts that facilitate borrowing and lending as well as options and futures trading. Stablecoins pegged to the U.S. dollar (USD), euro (EUR), or gold can earn yields of up to 7.4 percent with minimal volatility. Returns and volatility data will be presented, as well as evidence about how digital assets can add return to a diversified portfolio with little additional risk and how the extreme volatility in this space can work to investors' favor. The risks of digital assets are discussed, including valuation, custody, smart contracts, and central bank digital currencies (CBDC) risks.

BLOCKCHAIN AND DISTRIBUTED LEDGER TECHNOLOGIES

Historically, the financial system has been enabled through a network of centralized counterparties, such as banks and brokerage firms. These counterparties facilitate borrowing and deposits as well as enable trading and custody of securities. These counterparties typically have a physical domicile where they are required to comply with local or national banking laws and securities regulations. Each nation has its own currency, which brings currency conversion costs to

global trading. Each currency has its own government, central bank, and monetary and fiscal policies, which sometimes leads to hyperinflation and currency debasement, with the most recent extreme cases seen in Zimbabwe and Venezuela. There also are concerns about the risks that these counterparties bring to the global financial system, which was demonstrated during the Global Financial Crisis. These centralized counterparties also earn significant fees that can be reduced through a decentralized system.

Each of these counterparties keeps a private, centralized ledger of all the assets and liabilities in each customer's account. Should that ledger be compromised due to fire, flood, cyberattack, or insolvency of the counterparty, clients may struggle to recover or identify their personal assets. The goal of a distributed ledger system is to have multiple copies of these asset and liability accounts available on a publicly accessible network maintained by redundant ledger keepers. In the digital-asset world, the distributed ledger systems are termed blockchains. If the distributed ledger on each blockchain is maintained by 1,000 globally distributed counterparties, the risk of failure of a single counterparty is reduced substantially.

Each public blockchain is designed to be global, distributed, and immutable. Once a transaction is recorded on a blockchain, it can't be changed. Each miner or validator—local operators who maintain a copy of the distributed

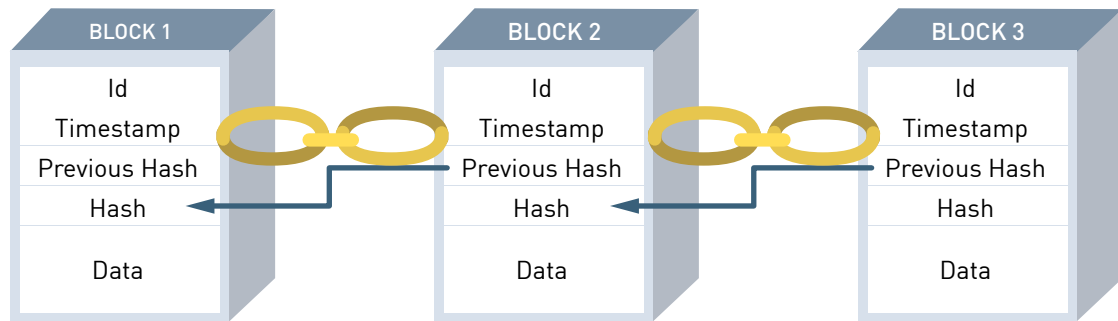
ledger—records transactions to the blockchain. The term cryptocurrency is derived from the idea that these networks are secured by cryptography, which encrypts data to ensure that it cannot be changed. A focus of these cryptographic mathematical puzzles are hashes. An example of a hash is the 64-character output from bitcoin's SHA-256 hash algorithm: f7225388c1d69d57e6251c9fda50cbb-f9e05131e5adb81e5aa0422402f048162.

On the bitcoin blockchain, transactions are gathered for 10 minutes and then published as a block (see figure 1). The transaction records in each block will include the sender's bitcoin address, the receiver's bitcoin address, and the size of the transaction. When either of these addresses transacts again in the future, the ledger keeper will look back to this transaction to view the available balance of each market participant. The key innovation is that this structure prevents the double-spending of each currency or token.

Immutability of these records is enforced when each block is identified with a hash that is a unique identifier of the information contained in that block. The hash of the previous block is included in the next block, which chains the blocks together with a common identifier. If a single character in a block is modified, the hash will completely change and the mismatch between the two blocks will be recognized by the ledger keepers. Once this error is noted, the ledger keepers will go back into their records and

Figure
1

ILLUSTRATION OF A BLOCKCHAIN



Source: Paiementor (2020)

replace the mismatched or recently changed information with the correct, original version of the transaction log.

CRYPTOCURRENCIES AND DIGITAL ASSETS

Given that a blockchain is simply a way to secure and store information, each blockchain can be designed to track the ownership of a specific asset. A wide variety of assets or information can be tracked using blockchains. Off-chain assets may include real-world assets, such as the contents and payments of shipping containers or the ownership of specific real estate properties. On-chain assets may include cryptocurrencies such as bitcoin or tokens such as ether.

CUSTODY ISSUES

Custody is one of the key risks in digital assets. Cryptography is used to encrypt secure transactions using public keys and private keys. Each user of a blockchain will disclose a public key whenever receiving value. It is safe to share a public key, because it is similar to an email address; it is a unique destination that others use to send information or value. In order to send value from an address, the sender's private key is used to verify that the asset may be removed from the sender's account. This is similar to an email password, but it is designed to be much more secure. There is no evidence that methodical guessing or hacking has been able to compromise private keys, which are protected by the long and complex cryptographic hashes. There is evidence, however, that

cyberattacks have successfully stolen private keys and digital-asset values after breaking into personal computers or cryptocurrency exchanges (such as Mt. Gox)¹ that were not well defended by secure passwords. That is, the bitcoin blockchain itself has not been hacked, but users have lost value from their bitcoin wallets through insecure storage at the user or exchange level.

The safest way to secure digital assets from theft is through the use of a hardware wallet. In this truly decentralized process, the user downloads the digital assets into a piece of computer hardware, such as a universal serial bus (USB) drive, and keeps the hardware in a secure location that is not accessible through the internet. If the user's private keys are nowhere in a phone, computer, or any other internet-accessible location, a hacker cannot find those private keys and take value from the user's account. Some users will keep the USB drive in a safe deposit box, with perhaps a paper copy of the private key separate from the public key or the USB drive in another safe location. Although this is the safest way to secure digital assets from theft, users with hardware wallets are trusting themselves with the physical custody of those digital assets. There is no way to recover the value if the USB drive is lost due to fire or flood, if the user dies or becomes incapacitated without disclosing the private key to a family member or other trusted individual, or if the private key is simply lost or forgotten. When the goal is to remove

centralized counterparties from the financial system, there is no password recovery help desk or reset process.

Many users trust the custody of their digital assets to an exchange such as Gemini, Coinbase, or Binance. In these centralized exchanges, users can exchange fiat currency for cryptocurrencies and digital assets or exchange one digital asset for another. These exchanges are termed "on-ramps," because they allow fiat currency to be added to the account through the use of credit cards or bank transfers and then be converted into digital assets. Exchanges may perform many services that are familiar to users of traditional banks or brokerage firms, such as custody of assets, ability to process trades, deposits and withdrawals, know your customer/anti-money laundering controls, name beneficiaries, and password resets. This may be convenient, but it introduces custody risk, because the exchange stores your private keys. The adage "not your keys, not your crypto" sums up the risk: You are not guaranteed full control of your account if anyone else, including a centralized exchange, has access to your private keys.

VALUATION MODELS FOR DIGITAL ASSETS

The prices of digital assets change on a daily basis, but at the time of this writing, the digital universe had a market capitalization of \$1.2 trillion. That includes approximately \$570 billion in bitcoin (BTC) at \$30,600, \$215 billion in

ether (ETH) at \$1,800, and \$66 billion in top decentralized finance (DeFi) tokens such as Chainlink, Uniswap, Aave, and Synthetix. Coinmarketcap.com tracks the market capitalization of more than 10,000 cryptos in real time, indicating a market cap of about \$400 billion for all cryptos beyond the six named here. Bitcoin dominates with 46 percent of the market cap of all crypto assets, and 17 percent is in ether, leaving 37 percent of the value in the other 10,000 assets. Seventy-five digital assets have market capitalizations exceeding \$1 billion and over 200 have valuations of more than \$100 million each. Thousands of these digital assets are likely to have zero value in the long run, so due diligence on each investment is important.

The valuation of digital assets is highly uncertain. Although some people may think the entire space is worth nothing and others may think it is worth trillions more than the current market cap, the annualized price volatility exceeding 100 percent on many digital assets shows the continued uncertainty of valuation. Some liken bitcoin to digital gold and compare its role as a store of value to the \$9.3-trillion market capitalization of gold (at \$1,800 per ounce). The DeFi tokens are building new protocols for borrowing and lending as well as options and futures trading on digital assets. Centralized and decentralized exchanges are building large businesses facilitating the trading of digital assets. If the DeFi sector can build a substantial financial business, perhaps it may reach or exceed the market capitalization of a large bank, such as J.P. Morgan's \$430 billion at \$140 per share.

Some financial market participants may think that the magical internet money has no value, but others are starting to use traditional market metrics to value the space. The trailing 12-month revenue to miners, stakers, and liquidity providers, indicates that many of these crypto assets have annual revenues exceeding \$200 million (see table 1). In the 12 months ending May 2021, bitcoin

Table 1
TRAILING 12-MONTH REVENUE TO MINERS, STAKERS, AND LIQUIDITY PROVIDERS

May 2021

Project	12-Month Revenue
Bitcoin (BTC)	\$1.1 billion
Ethereum (ETH)	\$4.1 billion
Uniswap (UNI)	\$790 million
Sushiswap (SUSHI)	\$250 million
Compound (COMP)	\$200 million

Source: TokenTerminal.com

miners earned revenues of more than \$1.1 billion, the fees paid on the ethereum blockchain exceeded \$4 billion, and the decentralized exchanges of Sushiswap and Uniswap had combined revenues of more than \$1 billion. Based on a price-to-sales multiple, some believe that these projects are indeed worth billions of market capitalization. Revenues on some of these projects have been growing more than 100 percent per quarter; Compound, Aave, Uniswap, and Sushiswap recently traded at three to 13 times trailing four-quarter revenues.

Before trading, investors are encouraged to seek out the white papers, verify the progress made toward goals, and decide if the right team is in place for the project.

In addition to managing the digital assets specifically focused on building an alternative financial ecosystem, some digital assets track the performance and value of real-world businesses. These may be viewed as publicly traded venture-capital investments. Basic Attention Token (\$1-billion market cap) is awarded to users of the Brave web browser, which competes with Google Chrome by enhancing privacy and paying internet users to view advertisements. Filecoin tokens (\$5.3 billion) are

paid by users of globally distributed cloud storage, competing with Amazon Web Services and Microsoft Azure. Binance (\$53 billion) is the world's most valuable crypto exchange. The valuation of Binance increased sharply at the time of Coinbase's direct listing (now \$48 billion) on Nasdaq.

Of course, not all coins and tokens will have value, because they are not backed by a strong user network or an operating business. Metrics to gauge projects include the number of users or active addresses or the number of software developers currently adding value to the project. Many digital asset projects publish white papers describing how they plan to deploy money invested in specific projects. Before trading, investors are encouraged to seek out the white papers, verify the progress made toward goals, and decide if the right team is in place for the project. Any digital asset without a white paper, development team, and network of users is less likely to grow and maintain significant valuation.

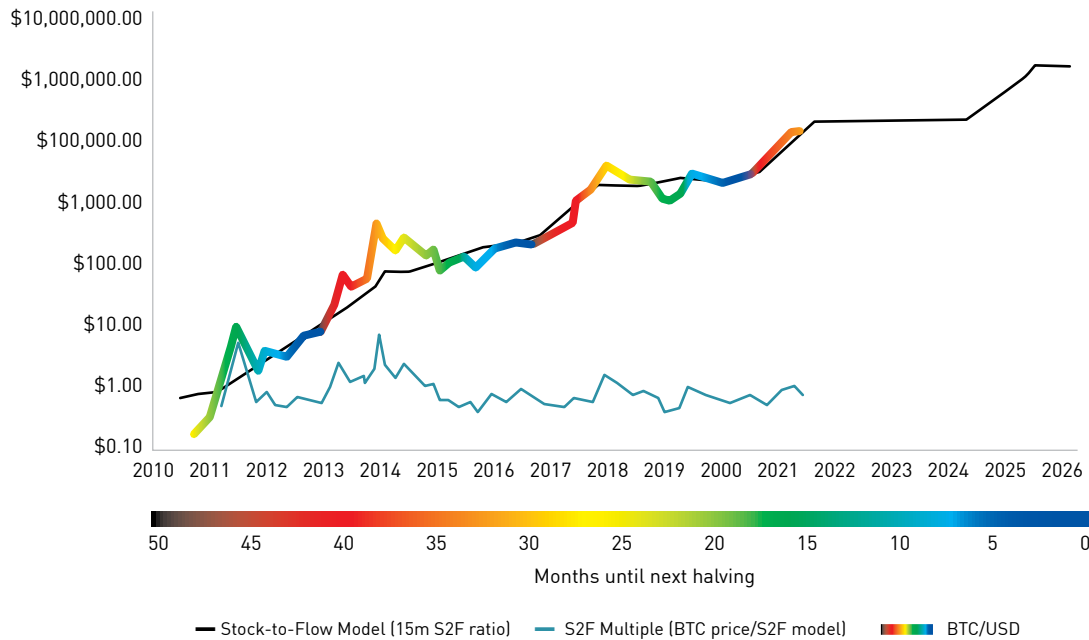
BITCOIN MINING AND STOCK-TO-FLOW VALUATION

The two key value propositions for bitcoin are the strict monetary policy that allows the distribution of only 21 million coins and the strong network of users. An increasing number of corporate treasuries are moving a significant portion of their cash balances into bitcoin, including Square, Tesla, and MicroStrategy. In June 2021, El Salvador became the first country in the world to approve bitcoin as legal tender.

Bitcoin miners are a globally distributed group that employs computing power to secure the bitcoin network through cryptography. Every 10 minutes, a new block of transactions is published. The current reward is 6.25 bitcoin, winner take all; that is, the first mining group to solve the cryptographic puzzle in each 10-minute period gets a reward currently valued at nearly \$200,000 (6.25 × \$30,600). Over time, that reward

Figure
2**BITCOIN STOCK-TO-STOCK FLOW MODEL (S2F)**

Plan B @ \$100 trillion USD—PlanBTC.com



Source: Ehrlich (2021)

has been declining. From its 2009 inception to November 2012, the reward was 50 bitcoin. From November 2012 to July 2016, the reward was 25 bitcoin. The second halving in July 2016 reduced the reward to 12.5 bitcoin, and the most recent in May 2020 halved the reward to 6.25 bitcoin. The next halving will take place around October 2024. These halvings will continue until the supply of 21 million bitcoin is exhausted sometime in 2140.

As shown in figure 2, bitcoin historically has had a strong rise in prices in the year after halving (red and yellow), with the value of bitcoin falling after the rise, perhaps two years after halving (green). Like other scarce commodities, bitcoin may be valued based on supply and demand. Because the supply is limited, some believe that growing demand will continue to increase the price of bitcoin. As each halving reduces the speed at which the new supply of coins is minted, believers in the stock-to-flow model predict that growing demand will increase the price of bitcoin to \$100,000 and beyond. The attraction of bitcoin is

its limited supply, which is in stark contrast to the massive fiscal and monetary stimulus of global central banks that is continuing to sharply increase the money supply of fiat currencies. Those who strongly believe in cryptocurrency state that this inexorable increase in the supply of fiat currencies will lead to inflation and debasement in value, leaving only digital assets with strong monetary policy as a store of value.

BITCOIN

Bitcoin is a digital currency used primarily as a trading vehicle and a store of value. The significant volatility and taxable nature of bitcoin makes it impractical for everyday spending. In the United States, digital assets are taxable: Short-term gains taxes are applied to positions held less than 12 months and long-term gains taxes are applied to positions held more than 12 months. Transactions are taxable when digital assets are sold or converted into another digital asset. A consumer using bitcoin to buy groceries and gas on a regular basis might have hundreds of taxable transactions each year. Transaction fees

can also be an obstacle, because the fees charged on each transaction are likely larger than the value of small everyday purchases, perhaps doubling or more the original purchase price.

In the long run, the value is based on its scarcity and the number of investors who believe that it has value. In the short run, the value is determined by technical analysis and sentiment largely derived from social media posts. A significant portion of the discussion on digital currencies takes place on YouTube and Twitter, where individual influencers can move the price of a crypto in either a positive or negative direction based on the sentiment of their comments.

Many speculators and technology entrepreneurs may have most or all of their financial assets in cryptocurrencies, but most investors are advised to invest only a small portion of their asset allocations into digital assets. A 2020 study by Bitwise notes that, assuming quarterly rebalancing, adding between 1 percent and 2.5 percent of bitcoin to a portfolio of 60-percent stocks and 40-percent

Table
2

PORTFOLIO PERFORMANCE METRICS

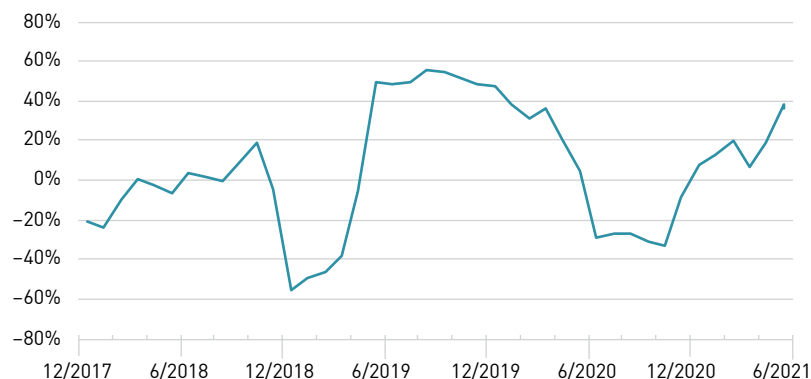
Adding BTC to a stock and bond portfolio; period between January 1, 2014, and March 31, 2020 (assuming quarterly rebalancing)

Portfolio	Cumulative Return	Annualized Return	Volatility (annualized standard deviation)	Sharpe Ratio	Maximum Drawdown
Traditional Portfolio	26.22%	3.80%	9.86%	0.31	21.07%
Traditional Portfolio + 1.0% bitcoin	33.52%	4.74%	9.87%	0.41	21.32%
Traditional Portfolio + 2.5% bitcoin	44.91%	6.13%	10.07%	0.54	21.80%

Source: Lawant and Hougan (2020)

Figure
3

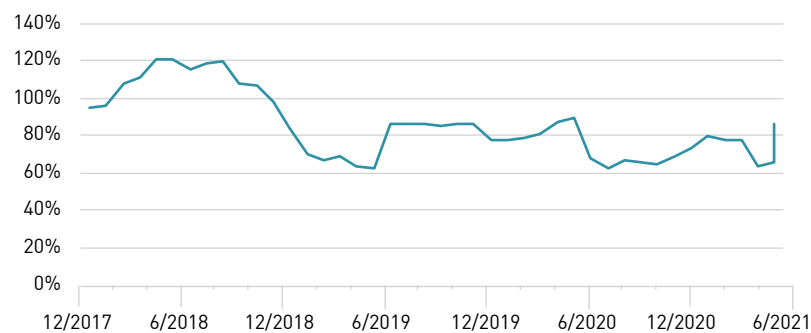
AUTOCORRELATION OF BITCOIN ROLLING 12 MONTHS



Source: CAIA Association

Figure
4

ANNUALIZED VOLATILITY OF BITCOIN ROLLING 12 MONTHS



Source: CAIA Association

bonds from 2014 to 2020 added 1 percent to 2.3 percent to annual returns without a significant increase in portfolio volatility or drawdown (see table 2). Over that time period, the price of bitcoin rose from \$755 to \$6,479, with a high price during that period of \$19,397. An allocation of more than 5 percent allows the high volatility of bitcoin to overwhelm the rest of the portfolio and substantially increase volatility and drawdown statistics.

VOLATILE ASSETS AND DIVERSIFICATION RETURN

Diversification return is the excess return earned when investors regularly rebalance holdings in highly volatile assets, especially when the volatile asset has a low correlation of returns to other assets in the portfolio. Regularly rebalancing a volatile portfolio may outperform a buy-and-hold portfolio, especially when asset prices are mean reverting rather than trending. When assets rise steadily

in value without significant price drawdowns, it is better for investors to buy and hold. When asset prices revert to the mean, they may have a high price volatility but often return to an average price level. When autocorrelation² is negative, asset prices are mean-reverting; when autocorrelation is positive, prices are trending. Figures 3–6 show that bitcoin has experienced high price volatility, with at least five drawdowns exceeding 30 percent since 2017, as well as periods of strong reversion to the mean. Annualized volatility of monthly BTC prices is often 60 percent to more than 100 percent, and daily volatility is significantly higher. To the extent that digital-asset prices have a low correlation to stock and bond holdings in a portfolio, the ability to diversify portfolio risk may be substantial.

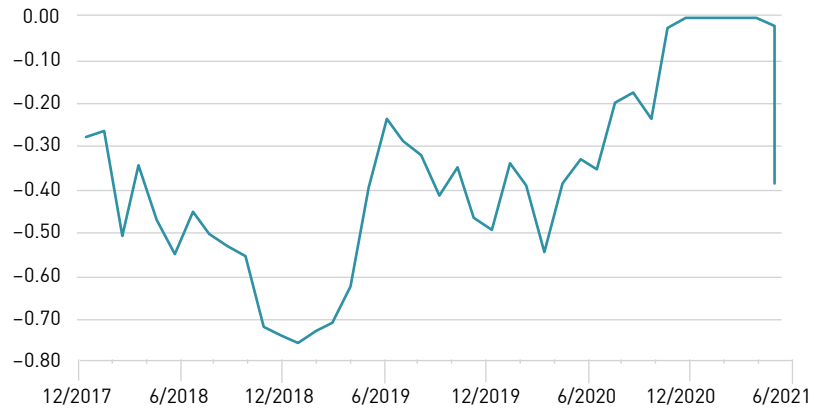
Rebalancing is accomplished by selling a portion of the assets in the portfolio that have outperformed and buying a portion of the assets in the portfolio that have underperformed. Regularly returning a specific asset to a specific allocation, such as 1 percent to bitcoin, can add value to the portfolio and reduce the risk that any specific allocation achieves an undesirably large weight in the portfolio. More-frequent rebalancing adds value when assets are volatile and mean reverting; less-frequent rebalancing or buy-and-hold investing will add value when assets have low volatility or continue to make new highs without significant price drawdowns.

Lawant and Hougan (2020) note that, due to the high volatility of bitcoin and its low correlation to traditional assets, frequent rebalancing has added substantial value

to a stock and bond portfolio. Investors who added 2.5 percent in bitcoin to a 60/40 portfolio at bitcoin's December 2017 high price of \$19,397 and aggressively rebalanced that position until bitcoin reached \$6,479 in March 2020 saw an increase in portfolio return and Sharpe ratio, even in a time when the price of bitcoin fell by two-thirds. For a more recent example of volatility and rebalancing opportunity, note that bitcoin traded at \$52,000, \$63,000, \$48,000, \$58,000, \$33,000, and \$40,000, in that order, between March 25 and June 14, 2021.

Figure 5

BITCOIN DRAWDOWN



Source: CAIA Association

ETHEREUM AND SMART CONTRACTS

Bitcoin is designed as a trading vehicle and store of value, but assets on the ethereum blockchain are powered by smart contracts. Fees for execution of the smart contracts can be paid in ether. These smart contracts may access digital applications (dApps) that provide services such as borrowing and lending, futures and options, or insurance. Uniswap is a decentralized exchange (DEX) that is built on top of the ethereum blockchain. There is no limit to the ingenuity of applications that can be enabled through the use of smart contracts. Some liken bitcoin to digital gold as a store of value, but ether is likened to digital oil—a raw material that facilitates commerce.

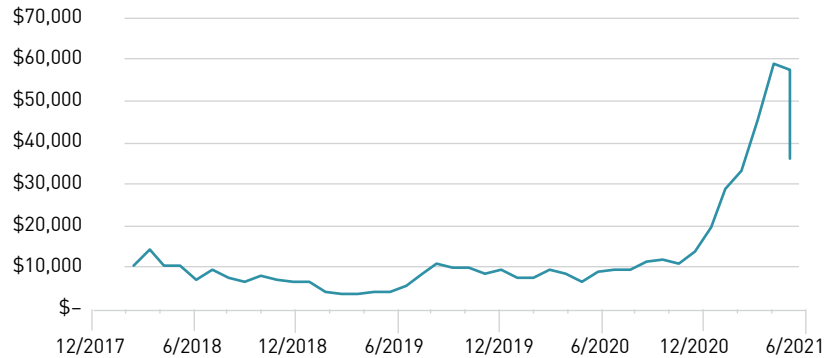
The terms of a financial agreement can be written directly into the lines of code. Users are encouraged to review the code before interacting with a dApp or ensure that the smart contract has been audited by a team experienced in blockchain and smart-contract software design. Some smart contracts have been published with software bugs that allowed the contract to be exploited and value to be lost.

PROOF OF WORK VERSUS PROOF OF STAKE

The bitcoin network is secured through a proof-of-work process, where miners compete to solve cryptographic puzzles. This community of hundreds of

Figure 6

MONTH-END BITCOIN PRICE



Source: Bloomberg

thousands of bitcoin miners running redundant ledgers makes the blockchain extremely secure, but it consumes vast amounts of energy. Bitcoin miners may use as much as 0.5 percent of the world's electricity and emit more than 0.1 percent of greenhouse gas emissions. This energy usage may be larger than that of entire countries, such as the United Arab Emirates, the Netherlands, or Argentina. Recently, attention has been focused on this energy usage, with a drive by some market participants to increase the use of renewable energy and reduce the use of electricity generated by fossil fuels. Bitcoin miners frequently are located in geographic areas with very low electricity prices, and they often seek out innovative solutions such as moving mining machines to areas with abundant

hydroelectric power during wet seasons and moving to another location when that cheap power is not available. The growth of bitcoin mining in Texas has been spurred by electricity generated with flare gas, which would otherwise emit methane into the atmosphere. Of course, bitcoin enthusiasts like to point out that the environmental impact of bitcoin mining is less than that of gold mining or investment bankers traveling the world in jet airplanes. China at one time was home to more than 65 percent of the global population of bitcoin miners, but negative publicity about the environmental impacts has led regional Chinese governments to evict miners.³

Proof of stake is the alternative way to secure a blockchain; it calls for the

owners of large holdings in a specific digital asset to secure the network by depositing assets into coins and locking the value into an operating network. Proof-of-stake projects include Cardano, Polkadot, Binance, Stellar, and Cosmos. Although the ethereum blockchain is currently managed through proof-of-work, an environmentally friendlier proof-of-stake process may arrive with ethereum 2.0.

DECENTRALIZED FINANCE (DEFI)

Although many digital assets have substantial price volatility, stablecoins are cryptocurrencies with value pegged to 1 USD or 1 EUR. Because they lack the volatility endemic with other cryptocurrencies, stablecoins are ideal for use as collateral in borrowing and lending transactions.

With junk bonds yielding less than 4 percent and sovereign debt ranging in yield from below zero to nearly 2 percent, investors have been settling for meager yields in bank deposits and the bond market. The revolution in DeFi offers some tempting yields and a completely new way to invest.⁴ DeFi Pulse, which monitors underlying smart contracts on ethereum, noted in June 2021 that the total value locked in decentralized finance protocols was more than \$50 billion. More than \$20 billion is invested in lending platforms such as Maker, Aave, and Compound, and more than \$15 billion is invested in DEXs such as Curve, Uniswap, and Sushiswap.

Gemini exchange has announced Gemini Earn, which yields 2.05 percent for assets held in BTC and ETH, and Gemini Dollar, a stablecoin that yields 7.4 percent. Investors are encouraged to investigate how the stablecoins are backed. It is safer to invest in a stablecoin where each coin is backed by one USD held in trust, although some worry that the \$62-billion stablecoin Tether (USDT) offers less transparency than other stablecoins and is backed largely by commercial paper and loans to external counterparties.

Borrowers may seek loans collateralized by their digital-asset holdings for a number of reasons. First, many investors have large gains in their digital-asset portfolios given the market rise from less than \$500 billion to more than \$1.2 trillion from the middle of 2020 to the middle of 2021. In most countries, gains on digital assets are taxable. Rather than selling digital assets, some investors will take loans against their value. This can defer taxes and allow investors to participate in further upside gains. Second, some investors may be borrowing against their crypto holdings to reinvest in other digital assets, thereby building leveraged positions. Of course, there are complications. Many digital assets have annual price volatility exceeding 100 percent and leveraged trading multiplies the degree of both upside opportunity and downside risk.

Some of the volatility in the digital assets is linked to trading by highly leveraged investors. Although the loans are overcollateralized by the value of their crypto holdings, smart-contract enforced liquidations sell off the collateral quickly and can drive down the value of a specific digital asset or the crypto market as a whole. On May 19, 2021, more than \$8 billion in liquidations in less than 24 hours drove the value of bitcoin from \$40,000 to \$30,000. Of course, other market participants may see these liquidations and add to the selling pressure.

These stated yields are paid in kind; that is, yields are in the form of extra units of the token or currency and not USD or EUR directly. There also may be some additional risk due to software errors and custody, but large exchanges and top projects such as BTC and ETH have been well vetted by this point.

DeFi is seeking to build a decentralized financial system that includes borrowing, lending, derivatives, and exchanges. The traditional world of banks and exchanges should be carefully watching the success

of this new digital world. At the yields described above, the rate of asset growth is likely to continue as investors search for yield. As user interfaces improve and security protocols are proven, the DeFi industry could take substantial market share from the traditional financial world.

Schär (2021) discusses the DeFi stack, where up to five layers of applications are combined to build and distribute financial products. Nearly 86 percent of DeFi market cap is built using ETH as the first, or settlement, layer. The second asset layer uses fungible tokens built according to ethereum's ERC-20 standard. Protocols are built as a third layer, and applications and aggregators form the fourth and fifth layers, respectively.

Dai is built on top of the ETH blockchain using on-chain collateral backing the value of the stablecoin at 1 USD through a minimum overcollateralization rate of 150 percent. USDT and USD Coin (USDC) are stablecoins built off-chain, relying on a real-world counterparty to back the value at 1 USD. Off-chain assets may be subject to counterparty risk and should be transparent and auditable.

The rise of DeFi also has been marked by the creation of DEXs. On DEXs, investors can exchange one asset for another while keeping custody of their assets. That is, no counterparty risk is created because funds are not deposited. DEXs built on smart contracts include UniSwap, Curve, Bancor, and Balancer. Investors can stake their assets into liquidity pools on these smart-contract exchanges to earn fees as liquidity providers.

Lending protocols include platforms such as Aave, Compound, and dYdX. These platforms facilitate loans collateralized by cryptocurrencies locked into smart contracts. Interest rates on these loans vary by the amount of crypto offered for loans and the demand for borrowing. Schär (2021) notes that almost 75 percent of these loans are backed by the Dai stablecoin.

As the value locked (or dollars committed to long-term investments in specific protocols) rises, user interfaces improve, and the risks are addressed, the world of digital assets, and DeFi in particular, may continue to take share and value away from the traditional finance sector. We can draw an analogy between dot-com stocks in 1997 and DeFi in 2021. Most dot-com projects had no lasting economic significance, but the companies that survived, such as Google, Amazon, and Priceline, changed the way the world does businesses. Today, those three companies have a combined equity market capitalization of \$3.2 trillion; today's value of the entire digital-asset market is \$1.5 trillion.

CENTRAL BANK DIGITAL CURRENCIES (CBDCs) AND OTHER RISKS OF DIGITAL ASSETS

There are numerous risks in the cryptocurrency space. Given the venture capital model, many of today's cryptocurrencies will be as worthless as most dot-com stocks were in 2001 following the inevitable shakeout of undercapitalized and ill-fated projects. Technology risk looms large for cryptocurrency because of the potential for hacking, theft, and errors in smart-contract code, and because innovations may make newly launched coins superior to today's offerings. Complexity risk also may be a factor, because today's crypto-backed collateralized debt obligations may be eerily similar to collateralized debt obligation squared⁵ and other structured products that posted significant losses during the Great Financial Crisis.

Some additional key risks regarding digital assets are related to taxes, government regulation, and the rise of CBDCs. The Bahamas already has launched the sand dollar, and China is testing its own digital currency dubbed DC/EP. Some of the demand for digital currencies might decline if the United States announces a Fed coin as a store of value for U.S.-based investors.

There are concerns that some nations, such as Nigeria and India, may move to restrict their citizens' use of digital assets or their ability to interface between fiat currency, local banks, and the world of digital assets. If those regulations spread, the demand for digital assets likely would decline.

Investors also may be concerned about regulatory risk, but there has been good news on this front. In July 2020, the Office of the Comptroller of the Currency (OCC), a key regulator of U.S. banks, announced that national banks and federal savings institutions are allowed to provide custody for customer holdings of cryptocurrencies. In January 2021, the OCC noted that those same banks are now able to use stablecoins to store and transfer value through blockchains. These bullish developments from the OCC are at odds with the recent comments by U.S. Treasury Secretary Janet Yellen, who has expressed concerns about bitcoin's environmental impact as well as its inefficient use in real-world transactions.

CONCLUSION

The universe of digital assets has grown from less than \$500 billion to more than \$1.2 trillion from the middle of 2020 to the middle of 2021. The strong returns to many assets as well as the potential to earn yields higher than in the traditional bond market and banking system are likely to continue to attract new investors and increased investment into the space. However, these investments have significant risks, including valuation and volatility risks, technology and cybersecurity risks, regulatory risk, and the risk that a new and innovative digital asset will make an existing project less valuable by switching the preferences of a large portion of the user network. ●

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ENDNOTES

1. "Twice Burned – How Mt. Gox's bitcoin customers could lose again," Reuters (November 16, 2017), <https://www.reuters.com/investigates/special-report/bitcoin-gox/>.
2. Autocorrelation is the correlation of the current asset return with the return of the same asset in a prior period, perhaps a day, week, or month earlier. The autocorrelation of a random walk is zero, while observations closer to one indicate either illiquidity, trending price behavior, or both.
3. MacKenzie Sigalos, "China is Kicking Out More than Half of the World's Bitcoin Miners," CNBC.com (June 15, 2021), <https://www.cnbc.com/2021/06/15/chinas-bitcoin-miner-exodus-.html>.
4. A complete analysis of the decentralized finance system is beyond the scope of this article. Readers are referred to Black (2021) and Schär (2021) for a more complete discussion.
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