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## 2022 Cryptocurrency Landscape

Morningstar's first analysis of crypto uncovers the home truths of this novel, heavily concentrated, and highly volatile asset class.

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### Morningstar Equity Research

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#### Contents

- 3 What Is a Digital Asset?
- 5 History of Cryptocurrencies
- 9 Cryptocurrencies: Too Big to Ignore
- 20 How Are Investors Getting Access?
- 25 Where Are Digital Assets Headed?
- 28 Glossary of Terms

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Madeline Hume, CFA  
Senior Research Analyst  
+1 312 244-7291  
[madeline.hume@morningstar.com](mailto:madeline.hume@morningstar.com)

Jeremy Pagan  
Research Analyst  
+ 1 312 244-7331  
[jeremy.pagan@morningstar.com](mailto:jeremy.pagan@morningstar.com)

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### Executive Summary

In the early hours of the morning of Feb. 8, 2022, the FBI raided a Manhattan apartment linked to an alleged cryptocurrency money laundering scheme. Authorities arrested two people in connection with the raid, Ilya Lichtenstein and Heather Morgan, and charged them with funding their extravagant lifestyle through a string of illicit transactions stemming from a hack of a cryptocurrency exchange in 2016. At the time of the hack, the stolen cryptocurrency was valued at about \$71 million, but amid a stunning rally in cryptocurrency prices, the pair was finding it more and more difficult to stay incognito as their stash swelled to \$4.5 billion. When the FBI seized the pair's assets, nearly 80% of the sum stolen remained stashed away in cryptocurrency wallets, away from prying eyes — or so the couple thought.

At \$1.7 trillion in total market capitalization, cryptocurrencies can no longer hide in the shadows. The asset class' stunning growth augurs as much promise as it does peril for those who are interested in its astonishing rise. Digital currencies have lured followers intrigued by their potential to displace legacy financial stakeholders, establish digital scarcity, and their jaw-dropping performance. Previously trivial sums of money have started to alter the trajectory of people's lives. But by the same token, centralized governments across the globe have raised fair questions like how to protect and guide investors while cracking down on illicit activities and regulatory arbitrage within the crypto ecosystem.

Cryptocurrencies warrant extreme caution. Today, cryptocurrencies lack academically substantiated valuation methodologies. Until more methods for valuing these securities become available, the absence of intrinsic valuations disqualifies cryptocurrency as a fundamental investment, in our view. As high-octane securities with a spotty past, investors should treat any purchase of cryptocurrencies as a sunk cost.

Our aim is not to advise investors on whether or not to dive into cryptocurrencies but to share what we've learned by surveying the landscape. Namely, the asset class is still brand new, heavily concentrated, and highly volatile. Cryptocurrency returns have no parallels to traditional risk factors across the stock and bond universes, and the contours of the market's returns in aggregate fly in the face of normal market dynamics. While cryptocurrencies have spawned entire parallel economies from scratch in just 14 short years — no mean feat — today, cryptocurrencies' decentralized infrastructure still sets up meaningful barriers against real-world use cases. Rather than a swift takeover, we expect that integration with existing systems across financial services and other sectors will likely determine future adoption rates in the space.

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### Key Takeaways

- ▶ Cryptocurrencies have exploded in popularity over the past seven years. The market capitalization of the asset class experienced more than 320 times growth, from about \$5.2 billion for the top 100 coins in January 2015 to nearly \$1.7 trillion as of January 2022.
- ▶ The cryptocurrency market remains highly concentrated, with bitcoin and ether capturing more than 60% of the total market capitalization.
- ▶ The volatility of the cryptocurrency market lands in a class all its own. From January 2015 through January 2022, the MVIS CryptoCompare Digital Assets 100 Index posted a standard deviation of 96.2, well over double that of the second-most volatile market index and more than 5 times as volatile as the MSCI All Country World Index (ACWI).
- ▶ While they still have a short history, thus far, cryptocurrencies demonstrate virtually zero sensitivity to established risk factors like size, valuation, or term and credit premiums. However, bitcoin still behaves too much like a risk asset to warrant comparisons with gold.
- ▶ Based on the return distributions of cryptocurrencies relative to other asset classes, we believe that speculative narratives have more influence on cryptocurrency prices in aggregate than the adoption of blockchain technology, making it difficult to identify future outperformers.
- ▶ Aside from market appreciation of nearly 11,500%, direct investment and derivatives have driven much of the growth in currencies, rather than pooled investment vehicles. Digital asset funds are far less popular: the total assets under management of digital asset strategies stand at \$47 billion, or 0.2% of mutual fund and exchange-traded fund assets.
- ▶ While the market value of fraudulent cryptocurrency activity has increased by 79% year over year, the proportion of transactions linked to fraud has actually declined by 1.3 percentage points in recent years and now accounts for just 0.15% of all cryptocurrency transactions.<sup>1</sup>
- ▶ Although fraud represents a small portion of all cryptocurrency transactions, we believe the absence of smart, measured regulation in cryptocurrencies hems in future growth.
- ▶ We also expect that the level of integration with real-world systems will determine rates of adoption in the space.

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<sup>1</sup> Chainalysis, February 2022. "The 2022 Crypto Crime Report." <https://go.chainalysis.com/2022-Crypto-Crime-Report.html>




## What Is a Digital Asset?

While they carry significant financial risks for participants, the versatility of cryptocurrencies has spawned a dizzying array of promising new ventures that have excited longtime crypto enthusiasts and relative novices alike. These projects allow investors to exchange a wide variety of goods and services on a cryptocurrency’s blockchain, and this constellation of projects has now gotten so big that it warrants a new moniker entirely: *digital assets*.

In contrast to traditional asset classes like stocks or bonds, digital assets only exist electronically, dutifully recorded in data files instead of clearinghouses. Third-party arbiters do not verify transactions or transfers of ownership. Instead, a decentralized ledger called a blockchain logs the entire history of ownership of a digital asset for anyone to review.

Cryptocurrencies, which are digital currencies that lack a centralized authority and instead are secured by cryptography, are one notable example of a digital asset, but it's not a category of one. Derivative projects that take place on a blockchain (a state of being that’s referred to as *on-chain*) have hatched novel digital assets, from intangible content like nonfungible tokens to decentralized financial instruments enabled by smart contracts. These financial commitments aren’t denominated in fiat currency but instead are bought, sold, or fulfilled with cryptocurrencies.

Exhibit 1 Digital Asset Ecosystem

		Crypto Tokens		
				
		Stablecoins	Non-Fungible Tokens	ICOs
Proprietary blockchain?	Yes	Depends	No	No
Method of payment?	Yes	Yes	No	No
Speculative* asset?	Depends	No	Yes	Yes

\* In this context, a *speculative asset* refers to an unpegged financial instrument that is not managed to an external reference point. This stands in contrast to assets like stablecoins, which are designed to track a specified value over time.  
Source: Morningstar. Data as of Jan. 31, 2022.

Digital assets are a heterogeneous group. Unlike shares of common stocks, which grant owners a slice of a company’s future cash flows, or bonds, which bestow a claim to a loan’s interest and principal, it's not possible to identify a common source of intrinsic value for digital assets. Some might be priced

relative to an established benchmark or currency, like the U.S. dollar, but the valuation of others, like bitcoin, seems to have no agreed-upon reference point. Some on-chain projects generate cash flows like an early-stage company, but NFTs have more in common with a Basquiat or a [toddler's art project](#) than with a share of Microsoft.

With so much diversity, it's probably simpler to think about digital assets as a technological landscape, rather than a basket of tightly correlated investments. Blockchains serve as the foundation on which a specific digital economy runs, and cryptocurrencies unlock the ability to transact within that digital economy. The price of each cryptocurrency resembles a supply and demand equation, a byproduct of the demand for its tokens and the supply of that cryptocurrency's individual coins issued to trade. (Crypto enthusiasts call this equation *tokenomics*, a nod to the parallels the space shares with traditional economics.) The balance of this report will narrow in focus to cryptocurrencies specifically, as the most common entry point for investors.

## History of Cryptocurrencies

The pursuit of an electronic cash system free of intermediation preceded the invention of cryptocurrency by several decades. Well before the global financial crisis or the tech bubble, a string of financial crises, hyperinflation, and the collapse of a major international monetary system (Bretton Woods) during the 1970s eroded trust in financial services, leading a loose collective to envision a disintermediated economy on the internet using privacy-enhancing technologies like cryptography.

Rather than entrusting banks to oversee transactions, these self-titled cypherpunks envisioned an economy that would allow individuals to transact peer to peer in a trustless system. However, the absence of central validation left digital currencies vulnerable to something known as the double-spending problem, where a bad actor could use one cryptocurrency coin in two simultaneous transactions. This opens the door to fraudulent transactions and inflation.

With this problem in mind, Satoshi Nakamoto (a pseudonym) advanced the concept of a decentralized ledger, called a *blockchain*, with bitcoin as its currency. Nakamoto distributed the white paper "Bitcoin: A Peer-to-Peer Electronic Cash System" to a cryptography mailing list in late 2008, and bitcoin became publicly available a few months after.

The genius of Nakamoto's paper was twofold. First, an algorithm was embedded in bitcoin's source code that created digital scarcity. Second, the blockchain eliminated the need for trusted intermediaries by creating a mutually agreed-upon, decentralized ledger using cryptographic proof. In practice, the platform for recording transactions takes more computational power to hack than it does to validate.

However, bitcoin's security features were perceived as enablers of other criminal activity. Illicit markets were some of the earliest bitcoin adopters. Intrigued by the anonymity of cryptocurrencies, Ross Ulbricht founded a site called Silk Road in 2011 that enabled the sale of illegal items priced in bitcoin. The site operated for two years, propelled by advertising on bitcoin forums, before the FBI ultimately shut it down.

Although the rabid enthusiasm, widespread adoption, and minimal oversight of cryptocurrencies have enticed cybercriminals, fraudulent transactions occur infrequently. Perhaps surprisingly, the proportion of transactions involving illicit activities has fallen throughout time by 1.3 percentage points and now accounts for just 0.15% of all cryptocurrency transactions.<sup>2</sup>

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<sup>2</sup> Chainalysis, February 2022. "The 2022 Crypto Crime Report." <https://go.chainalysis.com/2022-Crypto-Crime-Report.html>

Still, a single scam can have devastating consequences. Notably, the furious pace of innovation in decentralized finance has opened major security weaknesses exploited in hacks like the Poly Network breach of August 2021 and the Wormhole hack of February 2022. Cumulatively, these two attacks wiped out more than \$1 billion, a cost fronted by the developers of both networks to make investors whole.

A group of programmers led by Vitalik Buterin facilitated the rise of decentralized finance and other applications of blockchain technology by pioneering *smart contracts* — embedded if/then statements on a blockchain that allow for automatic transfers of digital assets based on specified conditions. Today, smart contract protocols like ethereum fuel decentralized applications across sectors like financial services, media, and gaming. Ethereum’s blockchain also enabled the rise of layer-two cryptocurrencies, which are networks lacking a blockchain of their own, running atop a pre-existing blockchain. These layer-two networks seek to enhance the scalability of layer-one protocols, which can get bogged down with high transaction fees when heavy traffic on the blockchain smothers its ability to authenticate blocks affordably.

**Exhibit 2** Cryptocurrency Timeline

Era	Date	Activity
Pre-Cryptocurrency	1980-1995	<ul style="list-style-type: none"><li>► Foundation of the cypherpunks movement.</li><li>► Introduction of private electronic cash systems like DigiCash, b-money, and e-gold.</li></ul>
	1996-2008	<ul style="list-style-type: none"><li>► Financial crisis begins.</li><li>► Satoshi Nakamoto publishes the bitcoin whitepaper.</li></ul>
The Arrival of Cryptocurrencies	2009-2010	<ul style="list-style-type: none"><li>► Miner mints the first bitcoin.</li><li>► The first cryptocurrency exchange gets established.</li><li>► The first transaction denominated in bitcoin takes place.</li></ul>
	2011-2014	<ul style="list-style-type: none"><li>► Mt. Gox exchange gets hacked for 850,000 bitcoin.</li><li>► Vitalik Buterin publishes the ethereum whitepaper.</li><li>► Peercoin pioneers the first proof-of-stake blockchain.</li></ul>
Crypto Enters the Mainstream	2015-2018	<ul style="list-style-type: none"><li>► The first ether token gets minted.</li><li>► Price of bitcoin rallies from \$900 to \$20,000.</li><li>► Goldman Sachs opens, then closes, a cryptocurrency trading desk.</li></ul>
	2019-Present	<ul style="list-style-type: none"><li>► Cryptocurrencies pass \$1 trillion in market capitalization.</li><li>► El Salvador adopts bitcoin as a legal tender, Tesla accepts cryptocurrency-denominated transactions.</li><li>► DeFi services begin to allow smart-contract-enabled crypto lending.</li><li>► NFTs gain meaningful adoption in art and entertainment.</li></ul>

Source: Morningstar. Data as of Jan. 31, 2022.

**What Are Blockchains, and How Do They Work?**

How exactly does traffic on a blockchain influence the cost to transact? It helps to first understand exactly what a blockchain does and how it differs from cryptocurrency. Blockchains are decentralized, digital ledgers of transactions. Blockchain technology shows promise because it allows people to package and extract information much more openly than current financial operating systems.

On the most popular networks, though, what participants gain in decentralization they lose in speed. Visa and Mastercard still trounce bitcoin and ethereum on transaction processing capabilities. That's due to the structure of blockchains themselves. On a blockchain, when two parties exchange assets, a record gets packaged into a chunk of chronological transactions. These chunks, called blocks, get sent to participants on a blockchain network at regular intervals. The time it takes to broadcast blocks to volunteers sets a ceiling on the rate at which the blockchain can add transactions to the ledger.

Once the network receives a block, mechanisms for generating consensus commonly rely on these volunteers, called *miners* or *validators*, to certify the block of transactions and add it to the blockchain. Protocols encourage participants with newly minted cryptocurrency funded by transaction fees. Proof-of-work and proof-of-stake are the most popular methods to validate transactions.

Proof-of-work makes processing transactions far more secure than other consensus mechanisms, but it is energy-intensive. As more cryptocurrency gets mined, the marginal costs of mining another coin increase, requiring more processing power to solve. The redundancy of multiple computers trying to solve more and more difficult puzzles throws off ever-increasing amounts of carbon — bitcoin mining alone consumes 0.5% of all electricity used globally.<sup>3</sup> Although it fluctuates depending on its price, bitcoin regularly surpasses the energy use of entire countries like Argentina, the Netherlands, and Thailand.<sup>4</sup>

Meanwhile, proof-of-stake mechanisms need far less computing power. Less computation translates to faster transaction processing than proof-of-work. Instead of permitting any computer on the network to mine, proof-of-stake protocols handpick validators for a particular block based on a combination of factors such as their wealth in the network, how long they've been staking, and the time since they were last elected to validate a block.

Validators must be careful — they can lose a portion of their collateralized stake for being offline when assigned to a target block. Validators may also lose their entire stake and get kicked off the network permanently if they verify a block with fraudulent transactions, even unintentionally.

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<sup>3</sup> Cambridge 2017-21. "Bitcoin Electricity Consumption Index."

<sup>4</sup> U.S. Energy Information Administration, 2017021. "International Electricity Database."

### Exhibit 3 Comparing Proof-of-Work and Proof-of-Stake Consensus Mechanisms

	Proof-of-work	Proof-of-stake
<b>Availability</b>	<p>Anyone can become a miner if they have a crypto wallet, mining software, and hardware. This leads to a system that relies on competition to approve transactions.</p> <p><b>Key limitations:</b> While mining software is free to download and use, hardware is expensive. Specialized computers that are practically necessary to mine a block, like ASICs and GPUs, can cost up to \$15,000. Wealthy miners are at an advantage, leading to a lopsided competition and the threat for centralization of a network.</p>	<p>The proof-of-stake consensus mechanism relies on an ownership model in order to certify blocks. Validators must own and collateralize a minimum number of coins in a wallet in order to participate in staking. Protocols typically favor the participants that have the most at stake.</p> <p><b>Key limitations:</b> Depending on the cryptocurrency, the protocol can require collateral of upwards of \$94,000—a massive upfront investment. The locking period before staking a coin can last over a year at times, favoring early adopters.</p>
<b>Energy Consumption</b>	<p>Today it requires a great deal of energy to “win” blocks in a PoW network. However, studies estimate that roughly 50% of the energy consumed by bitcoin, the largest PoW cryptocurrency, comes from renewable sources.<sup>1</sup></p> <p><b>Key limitations:</b> No matter the source, the energy inefficiencies of PoW systems still boggle the mind. The energy consumed by the hunt for crypto rewards can power entire countries. Miners also increasingly generate e-waste as they dispense with existing equipment in favor of newer mining chips that become available every 3-5 years.</p>	<p>Since a select group of validators work on a block at a time, PoS is much more energy-efficient than PoW. For instance, estimates indicate that ethereum’s transition from PoW to PoS (scheduled for early 2022) will reduce energy consumption by 99%.</p> <p><b>Key limitations:</b> PoS has yet to be tested with a large-scale cryptocurrency ecosystem like ethereum or bitcoin. We don’t yet know if PoS can provide a similar amount of security while reducing transaction fees at scale.</p>
<b>Confirming a block of transactions</b>	<p>Any miner can work on confirming a block of transactions. The protocol rewards the first miner to generate a matching cryptographic hash code of the target block.</p> <p><b>Key limitations:</b> Miners with the most sophisticated computing devices have a discernible edge. This setup leads to miners competing with one another in an arms race to obtain the fastest processing devices, which can be prohibitively expensive.</p>	<p>The protocol semi-randomly selects validators based on a combination of factors such as position size and staking experience.</p> <p><b>Key limitations:</b> Validators with a large amount of currency staked have higher chances of being selected. This puts wealthy validators at an advantage.</p>
<b>Rewards and Penalties</b>	<p>Blockchains reward miners with newly minted cryptocurrency. As of January 2022, a bitcoin miner would receive 6.25 BTC (\$240,787) in newly minted coins.</p> <p><b>Key limitations:</b> The protocol only rewards the fastest miner for their work on the block. All other miners’ time and electrical energy are wasted. Protocols typically do not penalize inactivity or malicious behavior.</p>	<p>Validators and attestors (those that double-check validator’s work) receive rewards that vary between 4% to 10% of the total amount of coins they stake in the protocol annually.</p> <p><b>Key limitations:</b> Reward payouts can take from minutes to weeks. Validators that miss a block because they’re offline, or unintentionally validate a malicious block, may receive penalties of up to 3x the base reward, lose their stake, or get banned from the blockchain.</p>
<b>Security</b>	<p>The great deal of energy needed to validate blocks disincentivizes malicious activity. The system is designed so that it is more time-consuming and expensive to attack than it is to redirect those resources towards certifying transactions.</p> <p><b>Key limitations:</b> If a corporation or mining pool obtains 51% of the blockchain’s cumulative hashing power they could block new transactions from being confirmed or change the order of transactions, therefore triggering the double-spending problem.</p>	<p>Malicious actors find it difficult to launch cyberattacks on PoS consensus mechanisms because they must gamble their entire stake in order to alter the blockchain. In the event that they lose control of the protocol an attacker would not only lose their cryptocurrency, but would be banned from the protocol.</p> <p><b>Key limitations:</b> If a corporation or delegation of validators obtains 51% of the cryptocurrency staked, they can alter the blockchain and reverse transactions that were already validated. Theoretically, a group could purchase control over the protocol.</p>

<sup>1</sup> Bitcoin Mining Council, 2022. “The Bitcoin Mining Council Survey.”

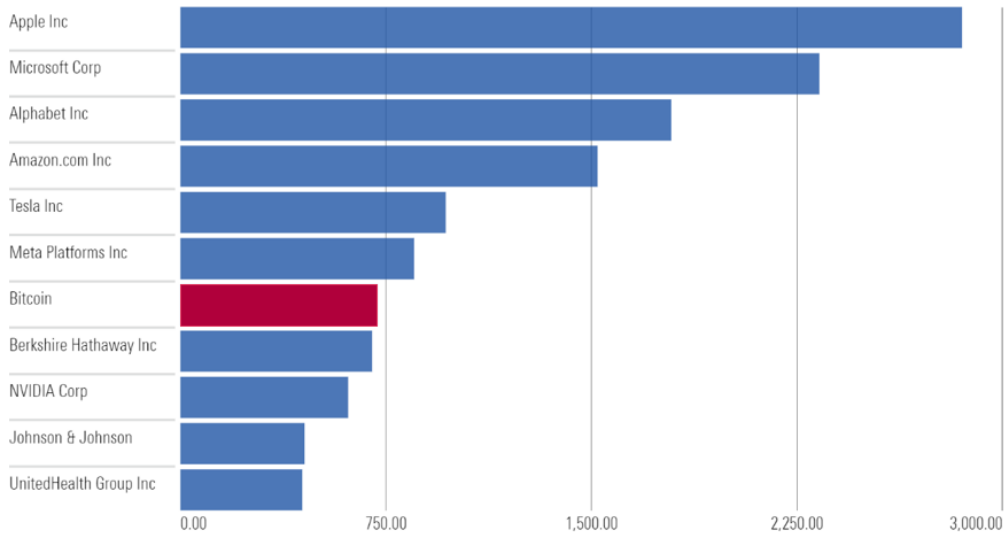
Source: Morningstar, Inc., Bitcoin Mining Council. Data as of Jan. 31, 2022.



## Cryptocurrencies: Too Big to Ignore

The growth in cryptocurrencies over the past seven years is staggering. The market capitalization of the asset class exploded from about \$5.2 billion for the top 100 coins in January 2015 to nearly \$1.7 trillion as of January 2022. Cryptocurrencies now represent the fourth-most popular type of investment among investors, behind only stocks, mutual funds, and bonds.<sup>5</sup> Bitcoin alone has a market capitalization that would rank in the top 10 largest companies in the S&P 500.

**Exhibit 4** Market Capitalization of Bitcoin Relative to 10 Largest Stocks in the S&P 500 Index (USD Billions)

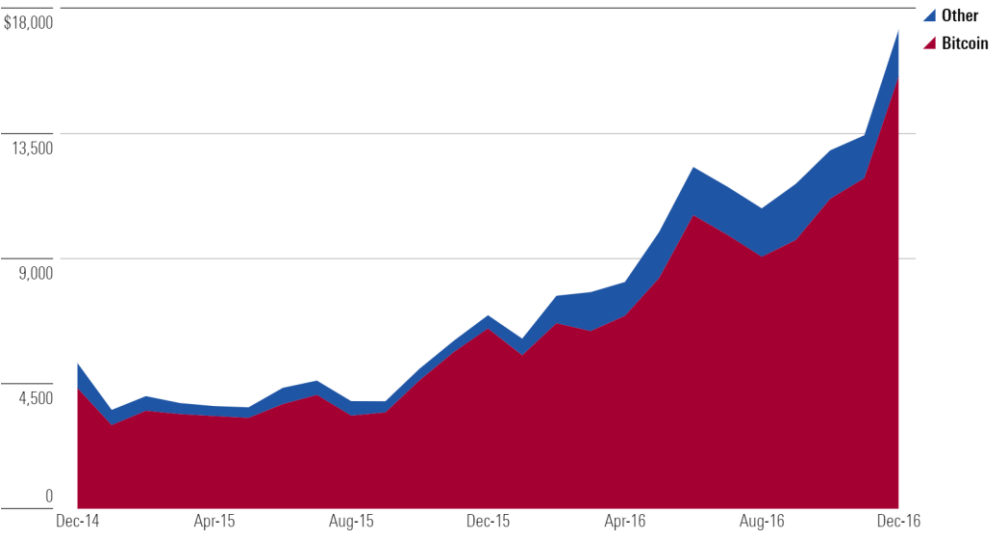


Source: Morningstar Direct, CoinGecko. Data as of Jan. 31, 2022.

Unsurprisingly, bitcoin accounts for most of that growth. From January 2015 (when regular pricing data begins) through December 2016, bitcoin consistently took up 80% or more of the market share among the top 100 cryptocurrencies.

<sup>5</sup> CNBC, August 2021. “CNBC | Mometive Poll: ‘Invest in You.’”

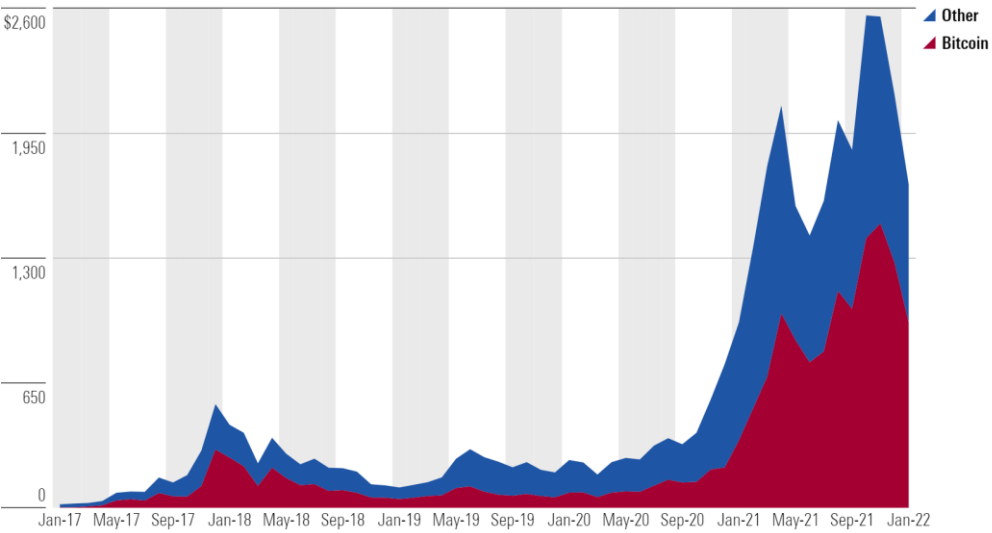
**Exhibit 5** Market Capitalization of Cryptocurrencies, 2015-16 (USD Millions)



Source: CoinGecko. Data as of Jan. 31, 2022.

But bitcoin has lost market share to several upstart currencies in recent years. From January 2017 through January 2022, a market-cap-weighted index of the 100 next-largest cryptocurrencies outperformed bitcoin by more than 75 percentage points annualized.<sup>6</sup> Even as it has returned 103% on average each year, bitcoin’s share of the market has tumbled from nearly 90% in December 2016 to less than 43% as of January 2022.

**Exhibit 6** Market Capitalization of Cryptocurrencies, 2017-22 (USD Billions)



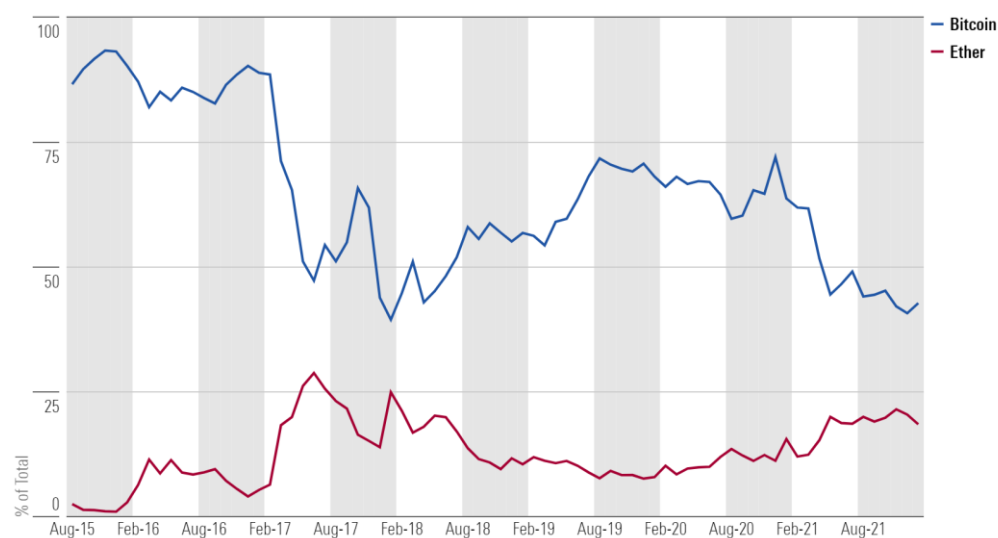
Source: CoinGecko. Data as of Jan. 31, 2022.

<sup>6</sup> Source: CoinGecko and Morningstar, Inc. Data as of Jan. 31, 2022.

The catalyst behind that lopsided growth? Ether, the cryptocurrency that goes with the ethereum blockchain. That coin has experienced sharp spikes and tumbles in its price as enthusiasts speculated on a wide variety of applications for smart contracts, from initial coin offerings and crypto kitties to decentralized finance and the metaverse.

Since January 2021, though, ether has hovered consistently between 15% and 20% of the market while bitcoin's market share has continued to steadily decline from 70% to close to 40% — even as it posted a cumulative 32% return.

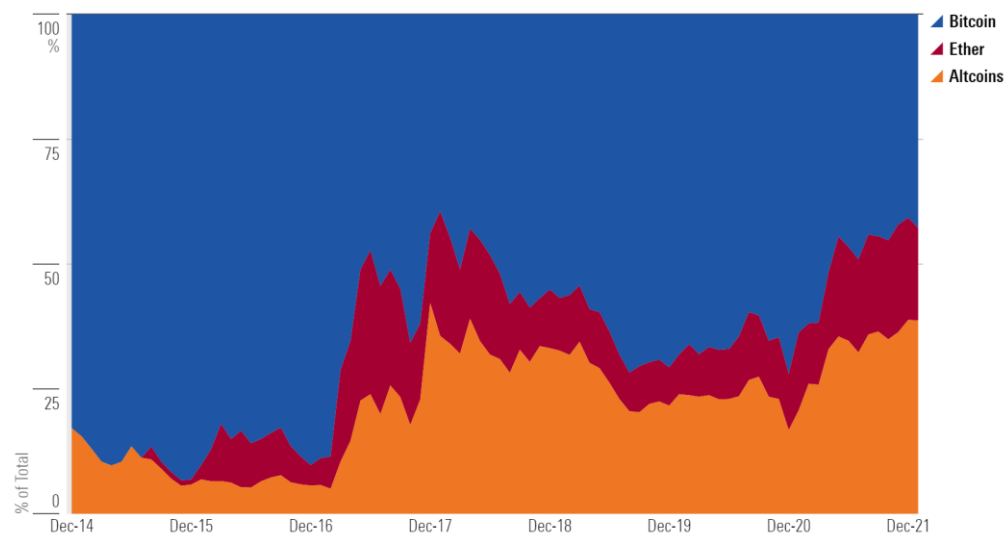
**Exhibit 7** Relative Market Share of Bitcoin and Ether, 2015-22



Source: CoinGecko. Data as of Jan. 31, 2022.

Enter the unloved cryptocurrencies, also called altcoins. Encompassing all other cryptocurrencies that aren't bitcoin or ether, altcoins have reaped the benefits of renewed interest in potential applications for blockchain technology.

So many users have flocked to ethereum that it has become cost-prohibitive to trade on that network. Other cryptocurrencies like solana have developed blockchains that undercut ethereum on transaction costs while still offering comparable applications — especially decentralized financial services — and taken market share away from ether as a result.

**Exhibit 8** Relative Market Share of Bitcoin, Ether, and Altcoins, 2015-22

Source: CoinGecko. Data as of Jan. 31, 2022.

Altcoins are a diverse and often overlooked group. They typically specialize more than either bitcoin (a cryptocurrency with hardly any derivative projects) or ether (a cryptocurrency whose blockchain offers so much flexibility that programmers can use it for practically any derivative project). For example, terra's blockchain only creates stablecoin tokens, while polkadot ferries information or assets between other blockchains. Specialization has blunted investor interest in the past, but altcoins' swelling market share has reshaped this grab bag into a force to be reckoned with.

As the cryptocurrency market matures, we expect that altcoins will behave much more in line with the narrow subsegments of the market to which they belong. In this scenario, diversity between altcoins will become a key contributor to the behavior of the asset class, breaking apart the historically tight correlations we have observed between bitcoin and other digital assets. This could facilitate a future where investors could value a cryptocurrency like luna based on the rates of adoption for stablecoins, while polkadot would perform based on how often users need bridges between blockchains. Today, though, cryptocurrencies behave too similarly, and narrative-driven rallies have too much influence to justify investing based on convergence with fundamental valuations.

### How Have Cryptocurrencies Performed?

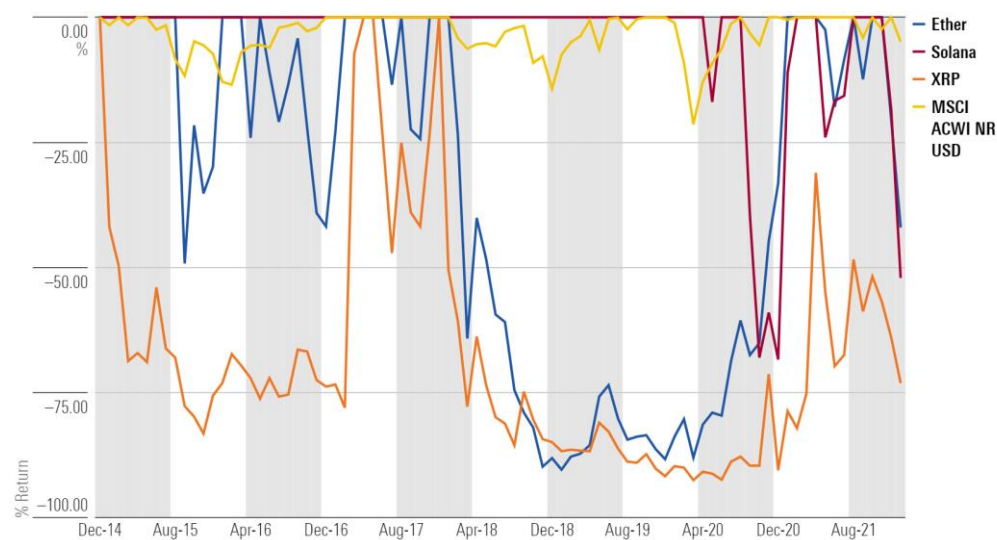
#### With Great Returns Come Great Volatility

Those narrative-driven rallies partly explain the increased demand from investors. From ether's historic 9,500% streak in 2017 to solana's 11,100% tear in 2021, much of the interest in these assets has been a self-fulfilling prophecy. Investors see astounding gains and enter the market, resulting in further upward pressure on prices.

But every breathtaking rally has ushered in an equally punishing crash on the other end, and cryptocurrencies lack a fundamental anchor like the par value of a bond or a stock's discounted cash flows. Ether lost almost 90% of its value between December 2017 and December 2018, while solana shed more than half its value between November 2021 and January 2022. XRP, still the fifth-largest cryptocurrency by market capitalization (excluding stablecoins), has yet to recoup the losses it sustained since 2018.

In late 2020, the SEC announced it was investigating XRP's parent organization, Ripple Labs, for potential violations of security registration requirements. The announcement shook investor confidence in the cryptocurrency and showed that regulation can still pose an existential threat to individual cryptocurrencies.

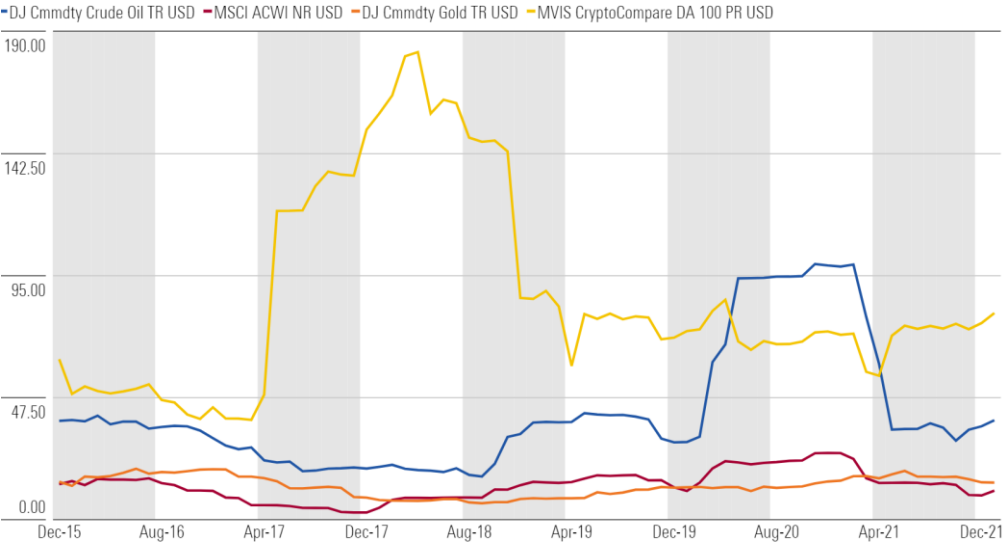
**Exhibit 9** Cryptocurrency Drawdowns, 2015-22



Source: CoinGecko, Morningstar Direct. Data as of Jan. 31, 2022.

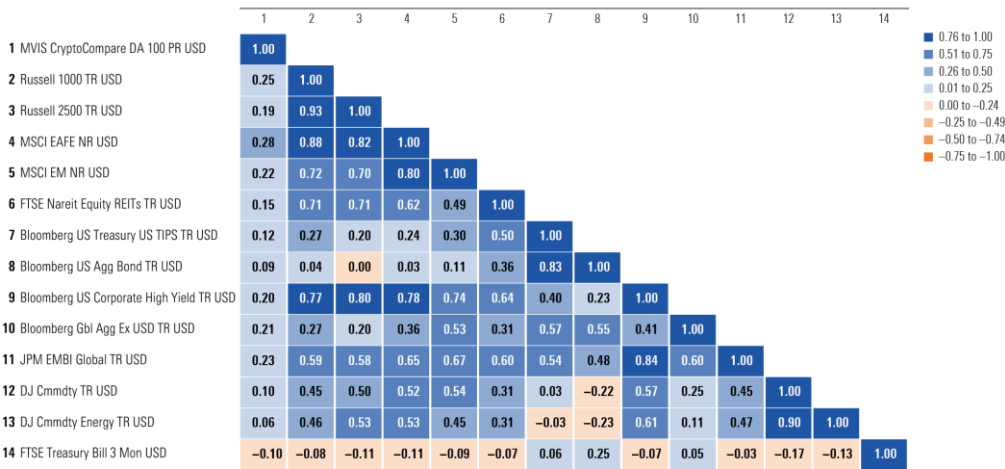
Surveyed in aggregate, the volatility of cryptocurrencies has no parallels to any other measurable asset classes. From January 2015, when regular pricing data starts, through January 2022, the MVIS CryptoCompare Digital Assets 100 Index posted a standard deviation well over double that of the second-most volatile index we identified and more than 5 times as volatile as the MSCI ACWI index. Incredibly, this measure includes stablecoins, which often link to a fixed peg. That means that unpegged cryptocurrencies in aggregate likely fluctuate even more than this figure suggests.

Exhibit 10 1 Year Rolling Standard Deviation, 2015-22



Even outside of its volatility, the cryptocurrency market doesn’t behave like any other investments, which has sparked the interest of institutional investors looking to boost their exposure to uncorrelated returns. Over its history the market’s price returns have the most in common with international developed-market stocks, but with a correlation of just 0.28 there’s still quite a lot of daylight between the pair compared with other asset classes.

Exhibit 11 Correlation of Returns, 2015-22



Regression analysis, which decomposes returns into factors that apply across like asset classes, affirms this gap. We compared a time series of the returns of the MVIS CryptoCompare Digital Assets 100 Index from January 2015 through January 2022 against the performance of five major stock market return factors:

- ▶ Market Risk Factor (MRF)
- ▶ Size (SMB)
- ▶ Valuation (HML)
- ▶ Profitability (RMW)
- ▶ Investment (CMA)

We also compared the results against two factors associated with fixed-income performance:

- ▶ Term
- ▶ Credit

Our regression analysis found that in aggregate, cryptocurrencies lack significant relationships with any of the five Fama-French factors, as well as the term premium and credit premium. As a result, the study proved that cryptocurrency returns produced statistically significant alpha against stock market returns.

Even as cryptocurrencies have proved difficult to explain using existing market frameworks, investors have noted that the correlations of cryptocurrencies to risky assets have drifted upward in recent years, especially after the stock market crashed in 2020.

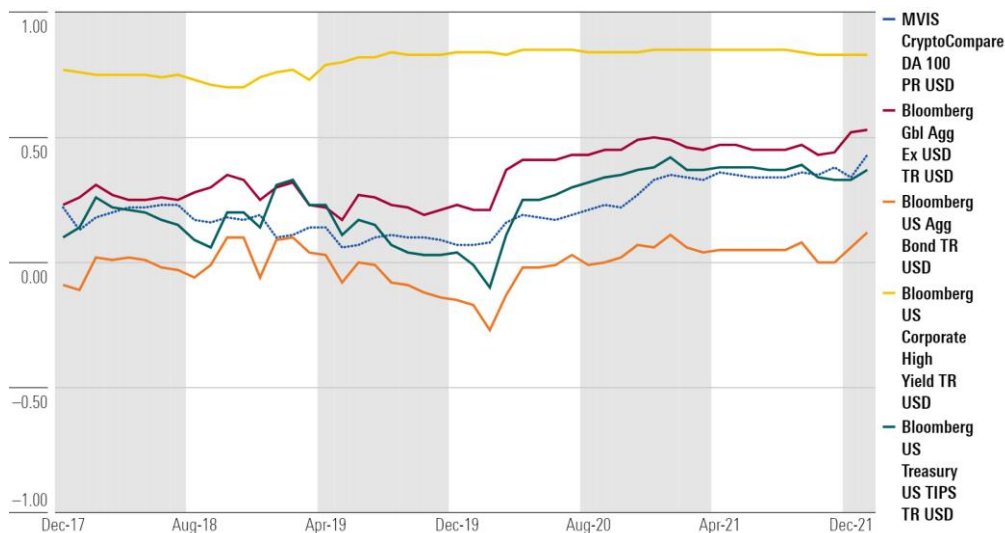
**Exhibit 12** Three-Year Rolling Correlation to the MSCI ACWI Index, 2015-22



Source: Morningstar Direct. Data as of Jan. 31, 2022.

Correlations have indeed crept up, but it's important to examine those figures in context. Cryptocurrencies are far from alone in experiencing tighter correlations to the global market cap—in fact, the sensitivities of several key subsegments of the bond market rose in lockstep with cryptocurrencies during this same period.

**Exhibit 13** Three-Year Rolling Correlations to the MSCI ACWI Index, 2015-22



Source: Morningstar Direct. Data as of Jan. 31, 2022.

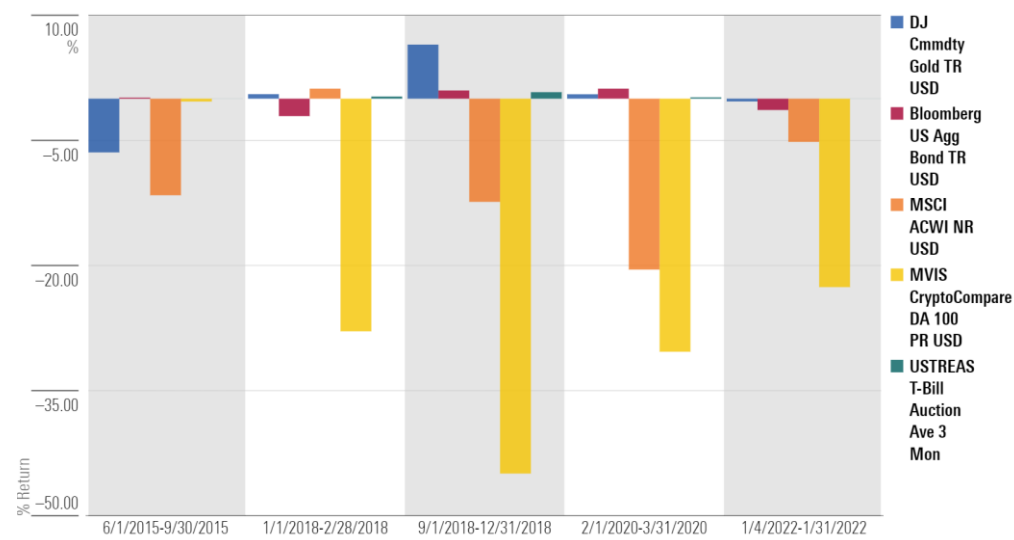
This isn't surprising. Correlations for all asset classes tend to spike during periods of market stress when liquidity compresses, and those relationships usually unwind once there are fairer winds. Higher correlations tend to persist for as long as the measurement window captures the stress event, and then roll off. In relative terms, cryptocurrencies still have virtually no correlation to stocks.

Still, while the uptick in correlations may feel like a blip for an investor accustomed to the rough-and-rowdy financial markets, it does suggest that unpegged cryptocurrencies are a poor replacement for fiat money. Unlike financial securities, safe havens like cash do not tend to act like the rest of the market when it falls.

Just the opposite—fiat currencies are designed to hold up best when the asks outweigh the bids. Currencies like the U.S. dollar stand tall during market stress because of consumer confidence, hard-won over centuries of injecting liquidity when economies become overdrawn, whether by calling on the credit of a monetary governing body or some other collateral.



Exhibit 14 Performance in Equity Down Markets, 2015-22



Source: Morningstar Direct. Data as of Jan. 31, 2022.

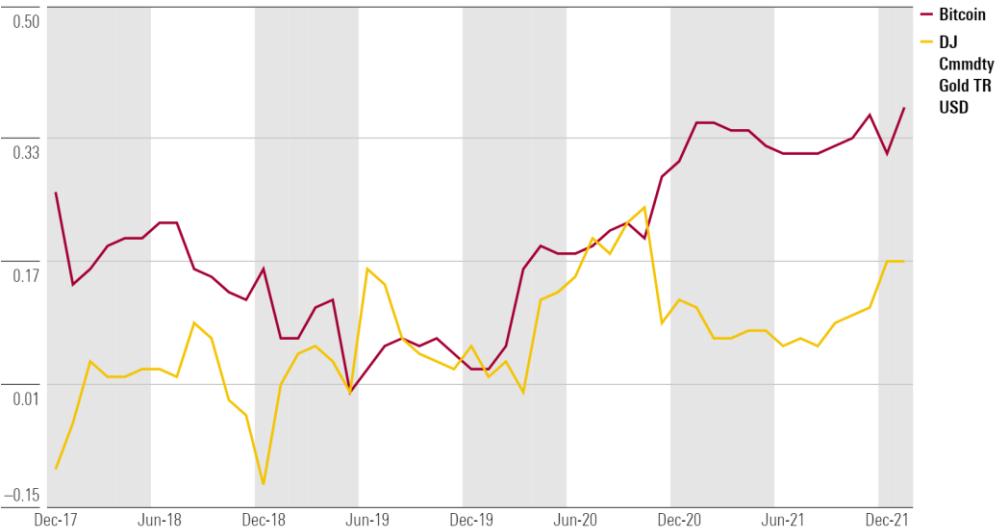
All That Glitters

This brings us to yet another asset that the market has compared cryptocurrencies, bitcoin in particular, with—gold. Hailed as *digital gold*, bitcoin's fixed supply and decentralized nature have attracted the attention of those who believe it could act as a viable competitor to the bars stored in bomb shelters by doomsday preppers.

The argument has intellectual merit, but in the near term, Morningstar analysts agree that bitcoin is unlikely to dim gold’s luster. People have used the metal to conduct business since at least 600 B.C., while bitcoin has existed for only 14 years.<sup>7</sup> Gold’s alternate use cases buffer the metal during periods of market stress so that it doesn’t depend on market sentiment to create liquidity. We believe that relative to gold, bitcoin lacks enough outside applications to outweigh the impact of market events on its price, limiting its usefulness as a store of value. Plus, the first transaction denominated in bitcoin didn’t happen until 2010, which means we have only 11 years of pricing data to study. During the one market correction in our time horizon, gold’s correlation to equities stayed low, while bitcoin’s followed the cryptocurrency market on an upward drift.

7 Goldsborough, R. 2013. "A Case for the World’s Oldest Coin." <http://rg.ancients.info/lion/article.html>

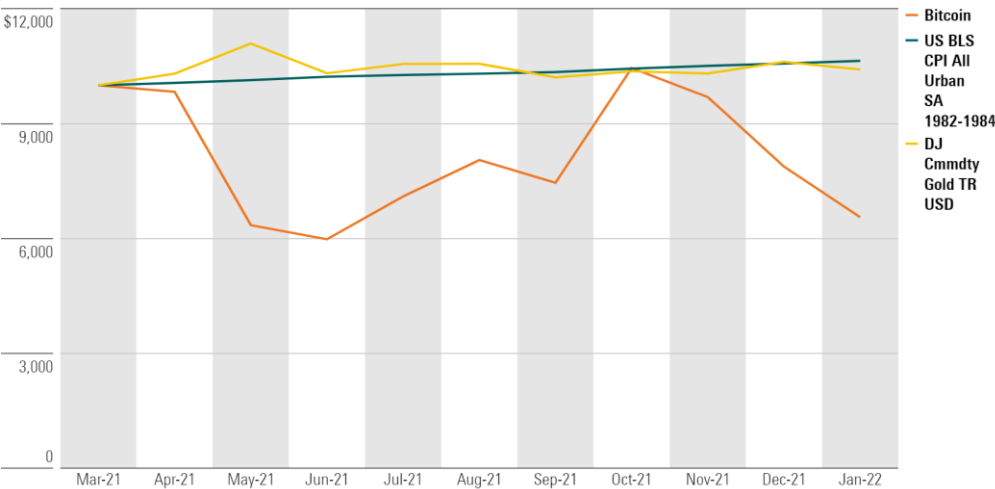
**Exhibit 15** Three-Year Rolling Correlation to the MSCI ACWI, 2015-22



Source: CoinGecko, Morningstar Direct. Data as of Jan. 31, 2022.

Some may argue that it's less important for gold and bitcoin to move in lockstep over shorter periods, so long as they both track inflation over the long run. Fair point — bitcoin has resoundingly beaten U.S. dollar inflation since 2015, but so have many other assets that don't qualify as inflation hedges. While bitcoin has outperformed inflation over its recorded history, that track record brings sustained periods of underperformance with it. In fact, bitcoin has lagged inflation in 50% of rolling three-year periods since 2015, including the period that ended January 2022, when inflation rates surged to the highest levels in 40 years.

**Exhibit 16** Growth in \$10K, March 1, 2020-Jan. 31, 2022



Source: CoinGecko, Morningstar Direct. Data as of Jan. 31, 2022.

It's worth pointing out that a 50/50 chance of beating inflation does not alone refute the argument that bitcoin can act as a hedge. A *hedge* is typically defined as an asset that has either a very high or very low correlation to the benchmark it is trying to beat. Bitcoin has neither. Over rolling six-month periods through January 2022, its correlation to the U.S. Bureau of Labor Statistics' seasonally adjusted inflation metric averaged around 0.03, meaning bitcoin essentially did not respond to changes in short-term inflation. Over longer periods, bitcoin doesn't fare much better. Its average correlation over three-year periods of around 0.06 underperforms a commodity basket's 0.42 and gold's negative 0.17.

## How Are Investors Getting Access?

The lack of performance history illustrates that cryptocurrencies are still a new phenomenon — so much so that few traditional financial intermediaries have entered the fray, citing a mix of concerns around price volatility, the lack of fundamental valuations, and regulatory uncertainty. Of these three, we believe the absence of smart, measured regulation in cryptocurrencies is the key barrier to future adoption — 55% of U.S.-based financial advisors<sup>8</sup> and 39% of institutional investors globally<sup>9</sup> cite regulation as a key roadblock.

In the absence of clear regulatory guidance, patchwork solutions have cropped up for investors and advisors looking to get broad exposure to cryptocurrencies without leaving their existing service providers. The United States, for example, hasn't yet rolled out regulatory approval for ETFs that invest directly in cryptocurrencies. That hasn't prevented asset managers from launching workaround products that track cryptocurrencies, though, so now there's an array of closed-end funds, ETFs that invest in cryptocurrency futures, and Canadian investment products (where commingled crypto funds are permitted) that seek to replicate the performance of cryptocurrency markets.

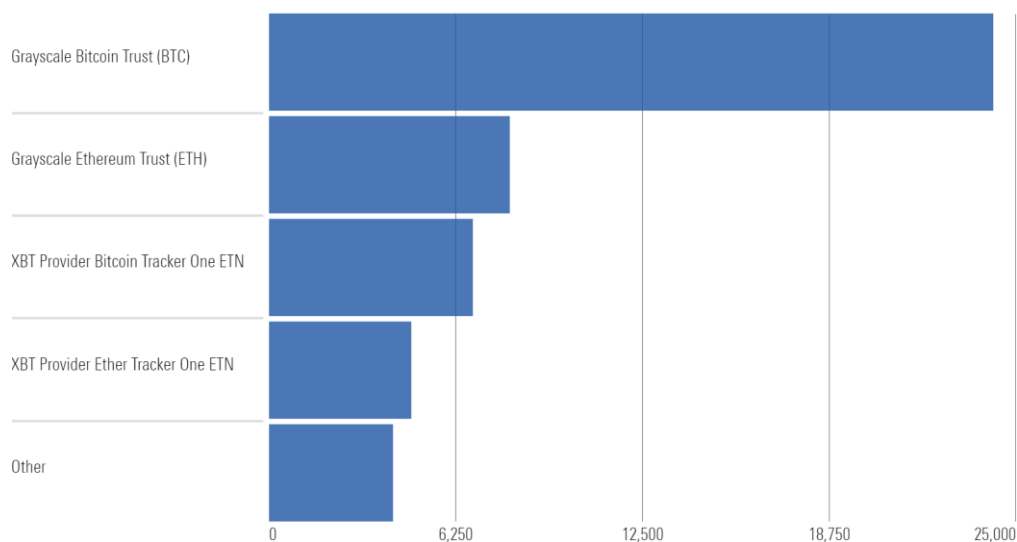
Investors haven't shown much interest. Digital asset strategies (defined as funds that invest at least 10% of their portfolio in cryptocurrencies, either outright or through derivatives) have accumulated \$1.5 billion since the launch of the Grayscale Bitcoin Trust in 2013 — no mean feat, but the group's \$47 billion in cryptocurrency investments captures under 3% of the total dollars invested in cryptocurrency worldwide as of January 2022.

Within this hodgepodge of funds, most investors have flocked toward the same underlying asset — bitcoin, specifically Grayscale's Bitcoin Trust. More than 80% of assets reside in a fund that invests exclusively in bitcoin, and Grayscale claims just over 50% of the entire market. The emphasis on bitcoin in commingled products will likely persist if regulatory approval for a cryptocurrency ETF moves forward, as the SEC has already signaled that a bitcoin ETF is most likely to gain traction right out of the gate.

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<sup>8</sup> Bitwise, 2022. "The Bitwise/ETF Trends 2022 Benchmark Survey of Financial Advisor Attitudes Toward Crypto Assets."  
<https://static.bitwiseinvestments.com/Research/Bitwise-ETF-Trends-2022-Benchmark-Survey.pdf>

<sup>9</sup> Fidelity, 2021. "The Institutional Investor Digital Assets Study."  
[https://www.fidelitydigitalassets.com/bin-public/060\\_www\\_fidelity\\_com/documents/FDAS/2021-digital-asset-study.pdf](https://www.fidelitydigitalassets.com/bin-public/060_www_fidelity_com/documents/FDAS/2021-digital-asset-study.pdf)

**Exhibit 17** Assets Under Management (USD Mil), January 2022

Source: Morningstar Direct. Data as of Jan. 31, 2022.

(Note: Responding to growth in new digital asset products, Morningstar will launch a Digital Assets Morningstar Category in April 2022. As the space grows and asset managers become more specialized, we expect that the category will evolve.)

While not available to retail investors, venture capital firms have also waded into the space, lured by the promise of continued technological development along several different key verticals. In 2021 alone, venture capitalists poured \$32 billion into cryptocurrency projects, nearly doubling the total capital invested to \$63 billion.<sup>10</sup>

Beyond pooled investments, regulatory hesitancy has also shaped the market for derivatives. CME remains the only regulated exchange that has approval to offer contracts with bitcoin as the underlying asset, and it captures just a sliver of the trading volume. Instead, offshore cryptocurrency-native exchanges like Binance, FTX, and BitMEX—which receive next to no oversight from national regulatory entities—execute the bulk of crypto futures contracts. Some exchanges, like Binance, started elsewhere and had no choice but to leave home, as China’s outright ban on cryptocurrency trading blocked it from continuing to operate in its home jurisdiction. Others, though, have relocated to dodge legal liability.

Most notably, in 2020, the U.S. Department of Justice indicted four of BitMEX’s employees—including its three co-founders—on charges of failing to implement proper know-your-customer or anti-money-laundering procedures. Law enforcement had to extradite at least one employee to the United States to face trial. In February 2022, two of the exchange’s cofounders, Arthur Hayes and Benjamin Delo, pleaded guilty to violating the Bank Secrecy Act. The third founder pleaded guilty a month later.

<sup>10</sup> Source: PitchBook and Morningstar, Inc. Data as of Jan. 31, 2022.





















Where Are Investors Getting Access?

Although derivatives exchanges have largely fled into the shadows of offshore tax havens, retail investors still have several choices for buying and selling cryptocurrencies closer to home. Lured by strong retail interest and fat commissions, several types of companies have entered the cryptocurrency exchange business, including:

- Centralized exchanges that exclusively or primarily trade in cryptocurrencies, like Coinbase and crypto.com.
- Incumbent retail brokerage platforms like Robinhood.
- Payments applications like PayPal and Block.

Unlike traditional stock exchanges, these companies often fulfill multiple roles in the cryptocurrency trading ecosystem by acting as an exchange, asset custodian, and broker.

Exhibit 18 Types of Cryptocurrency Exchanges

Centralized Exchanges	Payment Applications	Decentralized Exchanges	Retail Brokerages
 GEMINI	 PayPal		 robinhood
 FTX	 venmo		 InteractiveBrokers
 BINANCE	 Square		 Swissquote
 coinbase			 Webull
 crypto.com			 TradeStation
 kraken			

Source: Morningstar, Inc. Data as of Jan. 31, 2022.

Recently, a new breed of exchanges has entered the mix — decentralized exchanges, which, unlike traditional exchanges, have no central intermediary. Within the plumbing of a decentralized exchange, a series of executable smart contracts on a blockchain algorithmically links buyers and sellers, setting pricing for people who choose to exchange on the protocol. Unlike all other types of cryptocurrency exchanges, decentralized exchanges by design cannot denominate trades in fiat currencies — instead, all participants must buy and sell in cryptocurrency.

Despite their differences, cryptocurrency trading platforms all have one thing in common — high transaction fees. Unlike stocks or exchange-traded funds, which most brokerages will allow customers to buy and sell for free, cryptocurrencies still require a premium to trade. In part that’s a consequence of the design — any time a cryptocurrency changes hands, its blockchain must be updated to reflect the transaction, which can require a significant amount of energy to log. Due diligence for coin listings on an exchange also presents a hurdle. Robinhood, the sole provider that offers free cryptocurrency

transactions, only lists seven cryptocurrencies available for trading. Finally, while the cryptocurrency market has grown at a stunning pace over the past 15 years since its invention, its \$1.4 trillion market capitalization is still a drop in the bucket compared with the global stock market's \$116.9 trillion market capitalization as of June 2021.<sup>11</sup> Smaller markets transact less frequently and carry less liquidity, which can widen bid-ask spreads and support higher transaction costs.

All these factors exert tremendous pressure on the pricing structure of cryptocurrency trades. Per-transaction fees can range from free to upwards of 6% depending on the conditions surrounding the trade. In Exhibit 19, we've compiled a list of common exchange types, prominent members within those groups, the variety of coins available to transact, and costs of execution. For this illustration we used a sample purchase of \$500 worth of ether, executed in either U.S. dollars or USDT, a popular stablecoin that tracks the value of the dollar on decentralized exchanges where fiat currency-denominated transactions are unavailable.

**Exhibit 19** Costs to Transact on Different Cryptocurrency Exchanges

Vendor Type	Trading Platform	Domicile	Currencies Available for Trade	Fees % (\$500 ETH Maker Order, USD or USDT)	Transaction Type
Retail Brokerage	Robinhood	United States	7	0.00	N/A
	Webull	United States	27	1.00	Spread
	TradeStation	United States	5	0.30	Transaction
	Interactive Brokers	United States	4	0.18	Transaction
	Swissquote	Switzerland	26	1.00	Transaction
Payment Applications	Venmo	United States	4	1.80	Spread
	Paypal	United States	4	1.80	Spread
	CashApp	United States	1	2.30	Spread
Centralized, Crypto-Native	Coinbase Exchange	United States	156	0.50	Transaction
	Kraken	United States	123	1.50	Transaction
	FTX	Bahamas	272	0.06	Transaction
	Binance	Cayman Islands	360	0.10	Transaction
	Gemini	United States	72	1.50	Transaction
	Crypto.com Exchange	Singapore	169	0.40	Transaction
	eToroX	Israel	31	1.90	Spread
DeFi	Uniswap	N/A	980+	6.22	Gas Fee
	Sushiswap	N/A	280+	5.72	Gas Fee
	Kyber	N/A	140+	5.06	Gas Fee
	Pancake Swap	N/A	2900+	0.60	Gas Fee

Source: Morningstar, Inc., CoinGecko.com, Crypto.com, and respective websites. Data as of Jan. 31, 2022.

This illustrates that for investors accustomed to the frictionless trading of stocks and ETFs, there are no good choices. Among all these options, Binance has proved most palatable to investors, despite increasing regulatory pressure, because it charges relatively low fees to buy and sell cryptocurrencies and offers a wide variety of cryptocurrencies available to trade. Binance facilitated 41% of the total spot transactions and 52% of derivatives transactions executed in January 2022.<sup>12</sup>

<sup>11</sup> Source: Statista. Data as of June 30, 2021.

<sup>12</sup> CryptoCompare, 2022. "CryptoCompare Exchange Review, January 2022."

[https://www.cryptocompare.com/media/39501098/cryptocompare\\_exchange\\_review\\_2022\\_01-1.pdf](https://www.cryptocompare.com/media/39501098/cryptocompare_exchange_review_2022_01-1.pdf)

Choosing an exchange entails trade-offs between depth and cost. Retail brokerages may have few coins available to investors, but they charge 0.5% on average compared with the crypto-native exchanges' average fees of 0.85%. Those lower prices may come with a catch, though—Robinhood, for example, doesn't allow users to migrate their cryptocurrency purchases into a wallet at the time of publication. Payments companies, which often hire a third party to process cryptocurrency transactions, have the most unfavorable pricing structure relative to the amount of choice they provide.

Still, even those fees are dwarfed by the highly variable gas fees that ethereum network users pay to use decentralized exchanges like Uniswap. Gas fees pass the costs of mining a cryptocurrency to users of the platform by tacking a fee on to each transaction. As platforms like Uniswap proliferate, developers have increasingly focused on building scaling solutions to lower the gas fees charged to users, and ethereum plans to resolve some of the headaches by switching to a proof-of-stake blockchain in 2022. It's still unclear how much of an impact the shift will have on gas fees, but scalability concerns will continue to compound as digital assets grow in prominence.

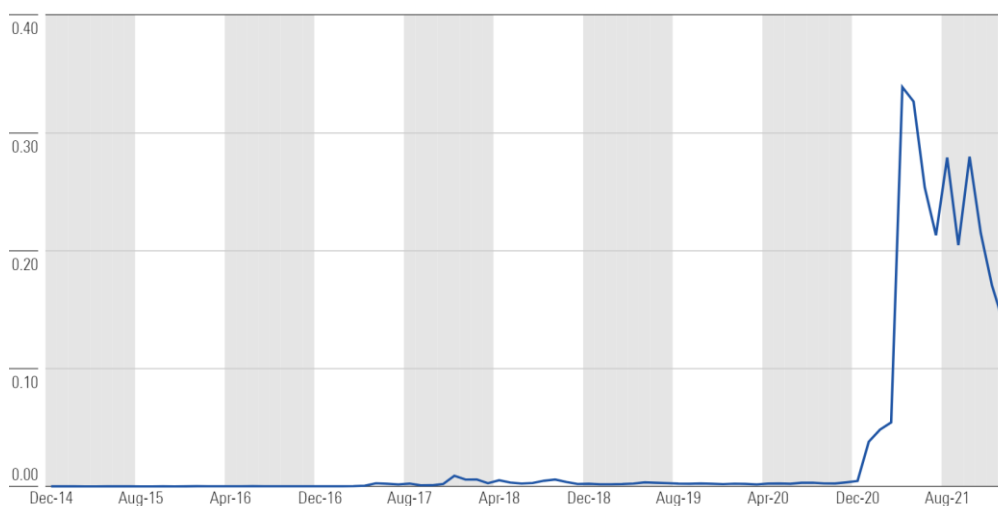


## Where Are Digital Assets Headed?

In recent months, casual awareness of cryptocurrencies has reached an all-time high, just as their valuations have cratered by 35%. With astonishing levels of uncertainty and a broadening audience, it's only natural to ask where crypto goes from here. We can't know exactly what will happen next. Still, we believe two main factors will dictate future growth of the cryptocurrency market: whether consumers adopt blockchain technology en masse and how long speculative interest in the space persists.

It's no surprise that the return charts of cryptocurrencies are littered with boom-and-bust narratives. These narratives often emerge from optimism around new applications within a particular protocol's ecosystem but sometimes may rely on nothing beyond a stray tweet from Elon Musk.

**Exhibit 20** Price of Dogecoin, 2015-22



Source: CoinGecko. Data as of Jan. 31, 2022.

What's interesting, though, is that narratives like these aren't just blips. They shape the returns of the cryptocurrency market in aggregate. Generally, market indexes' returns have negative skew, which means that above-average returns happen more often than below-average returns, but those below-average returns are more extreme and drag down the total return over the entire period. Meanwhile, cryptocurrency market returns flip that relationship. The market experiences more below-average returns

than above-average returns, but the positive outliers are more extreme and pull up the cumulative return over the period.

This means that in crypto, the periods when investors pile on and drive up the prices of a particular coin matter more than steady gains eked out by increased adoption. In our view, these runups generally overshoot the future adoption of public, tokenized blockchains in areas where compelling centralized alternatives exist. For example, centralized services like Coinbase have captured far more market share than their decentralized counterparts like Uniswap. Lower transaction fees and user-friendly interfaces matter more to these consumers right now than decentralization. In the future, centralization could allow Coinbase to amass network effects and economies of scale that lower costs and boost liquidity—assuming the crypto market does not continue to fluctuate significantly from quarter to quarter and the major coins continue to intrigue investors (bitcoin and ether trades made up 56% of Coinbase’s trading volume in 2020).<sup>13</sup>

That said, the returns from increased adoption of cryptocurrencies are not zero. Bitcoin shows that an asset can outgrow its speculative narratives and continue to thrive. So, where could durable future growth in cryptocurrencies come from? We see a couple of potential avenues.

Decentralization can be helpful in situations where it allows users to move digital assets around for the sake of interacting with the real world. Greater integration with daily life could spur increased adoption of blockchain technology, justifying future growth. This is easier said than done. For example, today's smart contracts can automate on-chain transactions, but they cannot incorporate external information like a home inspection without a third party. That means an intermediary has to upload data to the blockchain network, requiring trust. If future iterations of smart contracts could gather real-world information without drifting into centralization, that would expand the use cases for the protocols that offer them.

We don't expect that to drive adoption, however. Instead, we anticipate that over time, cryptocurrencies will converge with existing players rather than unseat them. Visa presents a strong case example. The company partnered with Coinbase to offer a debit card that allows consumers to make purchases using their Coinbase account. Here, too, service providers sacrifice the principles of decentralization for convenience—during the transaction, Visa converts cryptocurrency into the consumer's home fiat currency for the merchant. Nevertheless, the partnership reached \$2.5 billion in transactions in the fiscal first quarter of 2022. Tellingly, transaction volume has continued to grow despite the significant volatility in the cryptocurrency markets in the second half of 2021. We expect more partnerships between crypto-native, centralized companies seeking credibility and incumbents that want to preserve their market share.

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<sup>13</sup> Coinbase Global, Inc. 2020. Registration Statement.  
<https://www.sec.gov/Archives/edgar/data/0001679788/000162828021003168/coinbaseglobalinc-1.htm>

Notably, one slice of the financial-services sector has vigorously resisted cryptocurrency partnerships—banks. There's a good reason for this. The table stakes for cryptocurrency brokerage accounts and people's life savings are starkly different. But in many cases banks have expressed the desire to meet consumer demand for cryptocurrency services, if not for the absence of regulation that could clarify banks' roles in facilitating these services. Recognizing these concerns, the Federal Reserve, FDIC, and the Office of the Comptroller of the Currency issued a joint statement announcing plans to clarify rules about how banks can use cryptocurrency in 2022. Whether accommodative or combative, we anticipate a higher volume of regulatory developments in the next several years that will determine the adoption rates of cryptocurrency as a form of payment.

Clearer regulation could boost practical use cases for cryptocurrency outside of payments, too, although there's currently less demand for this type of intervention. For example, in their current state, NFTs do not grant legal ownership rights to the item they link to. That means that an artist (or thief) could theoretically mint multiple NFTs of the same artwork or collectible, so long as they're on different blockchains. Today, we don't have a way to distinguish between an NFT minted on the ethereum blockchain or one on the solana blockchain for the sake of ascertaining which item is the original. It's an improbable scenario, but if regulators vested NFTs with enforceable property rights, people might be more eager to use them for other applications besides digital gorillas.

Cryptocurrencies could also grow if people find building identities in an online world more compelling than our existing reality. In this scenario, users flock to the metaverse to occupy their time, interact, and collect goods and services. The metaverse does not need cryptocurrencies to operate, but today cryptocurrencies are the primary way most users transact things of value in the digital world, making them a likely element of future metaverse realms. We think this outcome is unlikely to drive the majority of future cryptocurrency growth, but we cannot dismiss the possibility.

Finally, the most remote scenario that we envision is that cryptocurrency eventually unseats the bulk of our financial infrastructure. The founding of cryptocurrencies was predicated on this idea, but nearly 14 years on that objective seems far-fetched. Cryptocurrency has gained wider adoption as an investment vehicle than a method of payment, and crypto's benefits have yet to materialize in ways that make doing business easier.

The fact remains that today, cryptocurrencies' decentralized infrastructure proves difficult to integrate with real-world uses. As applications on trustless blockchains proliferate, we will closely watch how the user experience, network bridging, and everyday relevance transform. We expect that integration with legacy systems across financial services and other sectors is more likely to determine future adoption rates. If that path unfolds, the opportunities will increase at a rate matched only by the risks. ■■

## Glossary of Terms

### altcoins

Refers to all cryptocurrencies other than bitcoin and ether.

### block

A block is a basket of chronological transactions that gets stored in a cryptocurrency protocol's ledger. At regular intervals, the network packages a group of all recent transactions into a single block and sends it off to a network of volunteers — called *miners* or *validators* — to certify and digitally record. Each block typically includes sender and receiver information, exchange details, and a time stamp for every transaction.

### blockchain

A transparent, quasi-permanent ledger that registers every transaction by cryptographically linking together a string of blocks that cannot be altered once they are recorded. Blockchain technology powers bitcoin and all other cryptocurrencies.

### block validation

A guess and check process that volunteers work through to find a block's hash code. Depending on the network's protocol, block validation is either a competition between participants or a process carried out by a volunteer nominated by the network.

### cryptocurrency

Often referred to as *crypto*, a cryptocurrency is a form of decentralized money that only exists digitally on a blockchain. Rewards of cryptocurrency incentivize participants to validate transactions on that blockchain.

### cryptography

A privacy-enhancing technology that scrambles ordinary text into ciphertext, similar to encryption.

### decentralization

A process for making decisions peer to peer rather than through a central authority.

### decentralized applications (dApp)

Digital applications are used for financial services, art and entertainment, and social media. So far, dApps can only exist on blockchain networks that utilize smart contracts (ethereum, for example). These programs are strictly peer to peer and are not controlled by a single authority, so they are open-source, resistant to censorship, and never go offline.

### decentralized finance (DeFi)

A type of dApp that provides financial services using cryptocurrency and does not have any intermediaries. This includes decentralized exchanges and lending platforms where individuals can buy, sell, trade, and borrow cryptocurrencies with one another.

**double-spending problem**

The problem is when digital bits (money) can be used multiple times simultaneously. Intermediaries use anti-counterfeiting technology and limit consumers' access to the code of the digital bits to avoid this problem.

**hash**

A unique digital fingerprint made up of a string of alphanumeric characters that links one block to another in a chain. The longer the hash is, the harder a blockchain is to tamper with.

**layer one**

Can refer to either a blockchain protocol or its native cryptocurrency. Bitcoin and ether are layer-one cryptocurrencies.

**layer two**

A third-party application that sits on top of an existing blockchain, typically engineered to enhance the scalability of the existing blockchain. For example, the Lightning Network is a layer-two solution built on the bitcoin network to improve transaction speeds.

**miners**

Volunteers who use computer processing power to guess and check a block's hash function. Once the hash is found, miners can process and validate a block of transactions onto a proof-of-work blockchain, and they receive cryptocurrency as their reward.

**nonfungible token (NFT)**

A certificate that establishes uniqueness for digital objects using smart contracts. Once an NFT is minted, that digital image cannot be reproduced for another NFT on the same blockchain. NFTs have gained traction primarily within art and entertainment.

**proof of stake**

Proof of stake is a consensus mechanism that uses an ownership model, requiring participants to lock up a certain amount of cryptocurrency as collateral to validate blocks on the network. A selected group of validators works on one block at a time, which makes this consensus mechanism more energy-efficient than proof of work.

**proof of work**

Proof of work is a consensus mechanism that relies on competition between volunteers called miners to validate blocks. Every volunteer on the PoW network receives a copy of a block awaiting validation, triggering a race to identify the hash code that will validate the transaction. The first miner to correctly find the hash code receives newly minted coins as their reward. Proof of work is highly secure but has massive energy redundancies.

**smart contract**

A smart contract is a program stored on a blockchain that automates the contract execution process when predetermined conditions are satisfied.

**stablecoins**

A form of cryptocurrency that is pegged against another asset like the U.S. dollar or gold.

**validators**

Participants that post collateral, called a *stake*, in the hopes of getting selected to validate transactions on a proof-of-stake blockchain. These participants are handpicked to work on a block based on a combination of factors such as their wealth in the network, how long they've been staking, and the time since they were last elected to validate a block. Validators receive a cut of the network's transaction fees in exchange for certifying a block, but logging off during a block assignment or validating erroneous blocks can result in steep penalties.

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+1 312 696-6869

equitysupport@morningstar.com



22 West Washington Street  
Chicago, IL 60602 USA

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