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Investing in Cryptocurrency

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Since President Trump's election, headlines about cryptocurrency have seemed nearly ubiquitous, with enthusiasm frequently soaring. Bitcoin has reached record highs, exceeding $100,000 before retreating, only to surpass the milestone again. As many investors take a closer look at bitcoin, we reiterate our long-standing call to get educated on this new asset class. We also take the opportunity to publish a primer incorporating updates from some of our prior reports. We examine what cryptocurrencies are, why people invest in them and how they work, while exploring select valuation approaches. We consider both bitcoin and ethereum, combining key topics from our April 2021 primer, "Investing in Cryptocurrency" and our January 2023 primer, "Cryptocurrency 201: What Is Ethereum?" We focus on how cryptocurrencies fit into the bigger financial picture rather than on how the technology itself functions.

For additional information about the risks of cryptocurrencies, please see the Important Information in the Disclosure section of this report.

Why Do People Invest in Cryptocurrency?

Investors' interest in bitcoin and other cryptocurrencies typically centers on one or more of three investment theses. First, the "digital gold bugs" see bitcoin as digital gold—a "safe haven" from fiat currency debasement. The monetary response to the COVID-19 pandemic, persistent deficits and ensuing inflation have made this argument more convincing to many. We suggest that investors aligned with this thinking carefully note this report's valuation section, which compares the valuation of bitcoin with that of gold.

Second, some view cryptocurrency as a disruptive technology that is slowly gaining share, like innovations in other areas of the economy. Advocates of this theory compare the rise of bitcoin with disruption in other sectors and industries. When penetration in a large addressable market is low, an investment in a disruptive innovator can generate attractive returns if market penetration continues to increase. The adoption-focused thesis is prevalent among technology stocks, which are less dependent on valuation and more reliant on adoption. Investors who hold this view see bitcoin as disrupting the $115 trillion market for money as a store of value due to bitcoin's tight monetary policy and its decentralization, which makes it difficult for governments or corporations to control. Other cryptocurrencies, namely smart contract platforms such as ethereum, are disrupting the app store market. These smart contract platforms allow anyone to upload, run or access decentralized apps. Investors might be interested in valuation based on operating metrics such as network market capitalization to fees or market capitalization per user, which assess bitcoin based on the pace of adoption.

Third, some see bitcoin and other cryptocurrencies as volatile, uncorrelated assets appropriate for diversification under Modern Portfolio Theory. In our August 2024 report, "To Eth or Not to Eth, That Is the Question," we showed how a small, theoretical allocation to bitcoin or a combination of bitcoin and ethereum would have fared versus a conventional 60% stock/40% bond portfolio from 2019 to 2024. Several firms, such as CoinShares, Bitwise Asset Management and Galaxy Digital, have performed variations of this analysis in the past several years using different bitcoin allocations, time periods and rebalancing frequencies. In general, they found that small allocations of bitcoin tended to improve the potential performance of a traditional portfolio. A key assumption of these analyses is that correlations will remain low and volatilities will remain high. However, correlations with stocks have risen over time while volatility has declined. We believe our examination of bitcoin's halving cycle can help explain why its low correlations with other assets could endure.

The list of risks related to cryptocurrency is extensive. Some —such as those pertaining to product dynamics, volatility and uncertain valuation frameworks—are familiar, while some are unique to cryptocurrency. For example, a cryptocurrency's encryption could be breached, or there could be a catastrophic software bug. Notably, there have already been two severe bugs in bitcoin and more in other cryptocurrencies. Government action of various types could negatively impact cryptocurrency functionality or adoption as well.

Short History of Bitcoin and Ethereum

The original bitcoin white paper was published in a cryptography group on Halloween 2008. The paper outlined the key ideas of the bitcoin protocol, which later had to be programmed into a downloadable piece of open source software code. The code began running on Jan. 3, 2009, and on Jan. 12, the first transaction took place. On May 22, 2010, what is famously known as "Bitcoin Pizza Day," a software developer hoping to promote bitcoin as an everyday transactional currency offered to pay 10,000 bitcoins (currently the equivalent of $1 billion) for two pizzas. After that, bitcoin transactions caught the attention of those interested in a low-cost money transfer system that was both "permissionless" and anonymous—open to anyone with a computer and an internet connection. Bitcoin demand grew and, due to the limited supply, prices began to increase. New users started to view the currency as a kind of digital gold, regarding it more as a store of value than as a payment system.

Bitcoin first appeared in the mainstream media in 2011 and 2012 and became more prevalent in 2013 as concerns about Cyprus's banking system made the idea of a stateless currency more attractive. Later that year, the price of one bitcoin topped $1,000 for the first time and regulators began to examine it more closely. The Internal Revenue Service (IRS) provided tax guidance, and states such as New York began to add regulations. This preceded the first bursting of a bitcoin bubble—an 84% price drop. Even so, the number of transactions continued to grow. Other cryptocurrencies, such as ethereum, emerged, drawing on bitcoin's design to run code that could do more than send and receive currency.

Ethereum, the second-largest cryptocurrency protocol, was conceived in 2013, funded in a crowd sale in 2014 and launched in 2015. Vitalik Buterin, a young bitcoin enthusiast, was foremost among ethereum's founders. Ethereum is also the leading smart contract platform—a sort of decentralized app store. Among its first apps were smart contracts that helped startups raise money and decentralized exchanges that allowed investors to trade newly formed cryptocurrencies.

After the bitcoin quadrennial halving of 2016 slashed the supply of new bitcoins created each year in half, a second bubble formed. By this time, cryptocurrencies were disrupting traditional venture capital by making it possible for tech startups to raise money through initial coin offerings (ICOs).

If the 2013 bubble was about a store of value and payment system that did not rely on any centralized authority like a government or company, the 2017 bubble was about bitcoin as an investment. Early in 2017, the Securities and Exchange Commission (SEC) issued the first of many rejections of a bitcoin exchange-traded product (ETP). At the end of 2017, the Chicago Mercantile Exchange (CME) launched bitcoin futures, providing a way for Wall Street firms to participate in the market. Again, parabolic price gains captured headlines, as retail investors hoped to beat the Wall Street firms to a new asset class. Regulators began to clarify which ICOs were securities, and enforcement officials pursued some of the worst actors of the second cryptocurrency bubble. In the end, despite the arrival of futures, most of Wall Street never arrived, and adoption declined in 2018.

By 2019, bitcoin had survived its second global bubble. Institutions such as the Intercontinental Exchange (ICE) and Fidelity Investments, which had announced products during the bubble year, slowly built out new cryptocurrency offerings and a financial infrastructure, addressing tricky issues such as custody. Leading up to the third halving in May 2020, many debated whether bitcoin's supply restriction was already priced in (there had been a big spike in mid-2019) or whether there would be a third bubble.

Just before the 2020 halving, COVID changed the narrative again, as central banks began to print money to support the economy and governments began to run record deficits. Concerns about currency debasement and inflation spiked, and investors began to look for hedges. A few institutional investors gravitated toward bitcoin. In May, the bitcoin halving cut supply growth by 50% just as demand was increasing for macroeconomic reasons, fostering what some regarded as a perfect storm. In December of that year, bitcoin surpassed its 2017 high, leading many who had written it off to take another look.

By the time institutions turned their attention back toward the cryptocurrency, much had changed. To start with, bitcoin liquidity had sharply increased since 2017. Stepped-up regulatory guidance had enabled more products, risk-mitigation strategies and arbitrage opportunities. Futures and options allowed for more hedging, retail-focused platforms brought more potential buyers online, and institutional adopters have filled large orders.

Meanwhile, ethereum has been attracting more attention as well, both for decentralized finance (DeFi) and non-fungible tokens (NFTs). DeFi apps allow investors to trade, invest and borrow against cryptocurrencies. Stablecoins, cryptocurrencies that attempt to maintain a value near one dollar, had become more popular for payments, trading and borrowing. NFTs allow digital art, memes and gaming items to be created and exchanged on the ethereum network. NFTs entered pop culture as they were referenced by celebrities, joked about on TV and displayed proudly on social media networks.

The mania that began in 2020 peaked in the fourth quarter of 2021, almost two months before major stock indexes did. As with the introduction of the first bitcoin futures contract in December 2017, which marked the top of that bubble, the introduction of the long-awaited bitcoin futures-backed ETP came near the top of the 2021 market. At its peak in fall 2021, bitcoin had appreciated from $3,000 to $70,000, for a market capitalization above $1 trillion. Roughly seven years after its launch, its peer, ethereum, reached a market capitalization over $500 billion. While it is hard to point to any bitcoin-specific news that marked the top, on Nov. 3, 2021, the Federal Reserve announced that it would begin tapering bond purchases related to its quantitative easing (QE) program that December. By January 2022, year-over-year growth in the US dollar, per M2 money supply, began decelerating, declining from a 12%–13% in 2021 to outright contraction by the end of 2022. Like the introduction of bitcoin futures before it, the bitcoin ETP launch turned out to be a "sell the news" opportunity, and over the next year, excessive leverage was wrung out of the cryptocurrency ecosystem.

As the Fed tightened in 2022, with the fastest increase in fed funds in history, the digital asset industry faced its own issues. High-profile stablecoin failures led to the failure of some leveraged cryptocurrency funds. Multiple organizations that lent customers cryptocurrencies failed due to incompetence, fraud or both. As losses mounted, regulators vowed to investigate the industry, slow adoption and prosecute fraud. The collapse of centralized cryptocurrency exchange FTX and eventual bankruptcy filing in November 2022 occurred near the low.

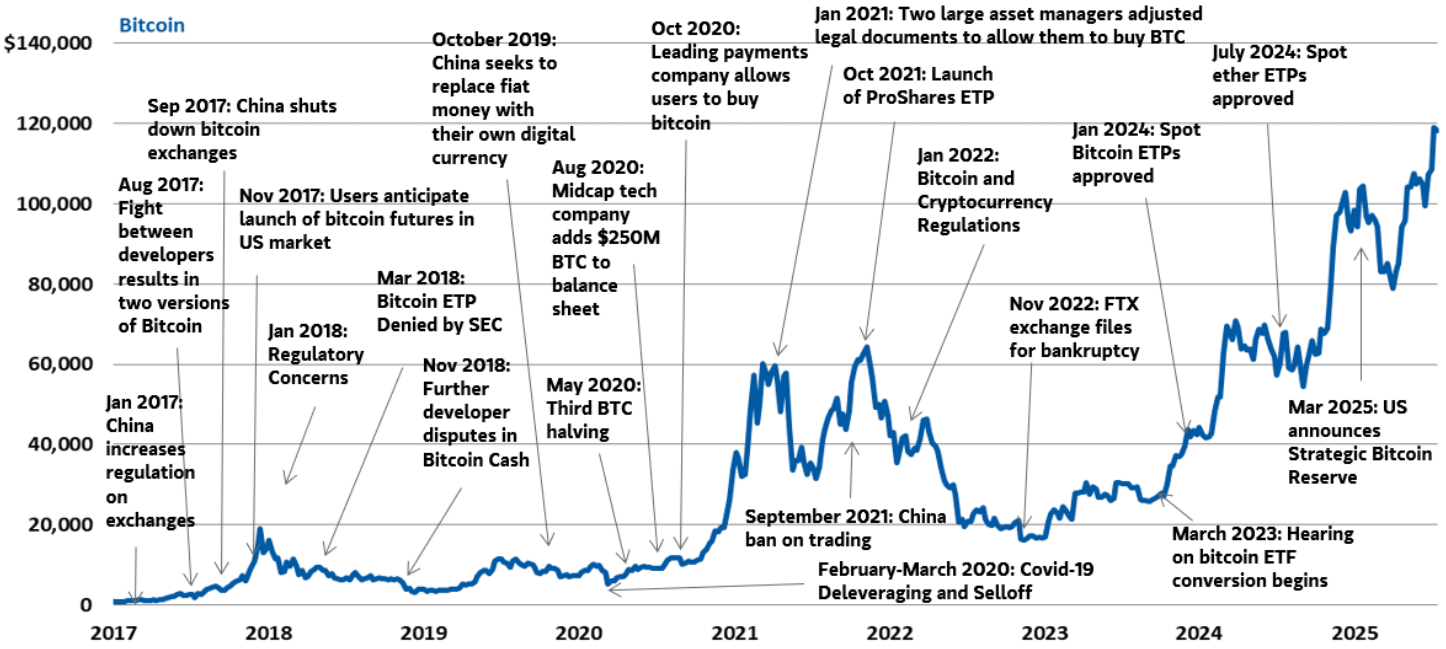
At the start of 2023, cryptocurrency prices began rising again. Important legal cases worked their way through courtrooms, helping to define how securities laws apply to cryptocurrencies and examining the SEC's past rejections of spot bitcoin ETPs. By June, prospects for the eventual launch of bitcoin and ether spot exchange-traded products (ETPs) became more apparent. In January 2024, the SEC approved the listing and trading of 11 spot bitcoin ETPs, citing a change in circumstances as the catalyst for approval, while asserting that it signaled nothing about its stance toward listing standards for other crypto assets. The launch of the bitcoin ETPs became the most successful in terms of first year asset flows in ETP history.

Despite the SEC's earlier assertion, in May 2024, it issued its second decision of the year regarding ETPs by approving eight ether spot ETPs. The approval of ether spot ETPs was especially significant because bitcoin has had a more deeply entrenched regulatory framework than ether. In October 2024, the SEC approved options trading for three spot bitcoin ETPs.

Later, the cryptocurrency industry started to make headlines as presidential candidates discussed crypto policies on the campaign trail. After President Trump won the election, bitcoin's price surged more than 50%, surpassing the $100,000 mark in December 2024. Some investors hopes for crypto's continued ascent have largely been fueled by the prospect that the Trump administration will act favorably toward the industry. During the campaign, Trump promised to ease regulatory scrutiny and to build a US bitcoin reserve. Moreover, SEC Chair Gary Gensler, who led aggressive crypto industry regulatory enforcement, stepped down on Inauguration Day. Trump selected Paul Atkins as his pick to replace Gensler as SEC Chair and he was confirmed on April 9. Atkins has critiqued Gensler's approach toward regulating the industry. In March 2025, President Trump issued an executive order calling for the establishment of a Strategic Bitcoin Reserve and US Digital Asset Stockpile (see Exhibit 1). These developments further underscore the ever-evolving nature of the crypto landscape.

Currently, it seems unlikely that bitcoin and other cryptocurrencies will disappear unless the code fails irreparably. Placing a valuation on cryptocurrency is difficult now and may always be challenging, given the extreme volatility of the asset. Another 85% drop would take the price back below $20,000. Yet, after surviving three bubbles, recovering from them and subsequently achieving new highs, we believe it is likely that bitcoin will remain a fixture on the investment scene.

Exhibit 1: Bitcoin's Volatile Journey to $1 Trillion Market Cap



Source: Bloomberg, Morgan Stanley Wealth Management Global Investment Office as of July 21, 2025

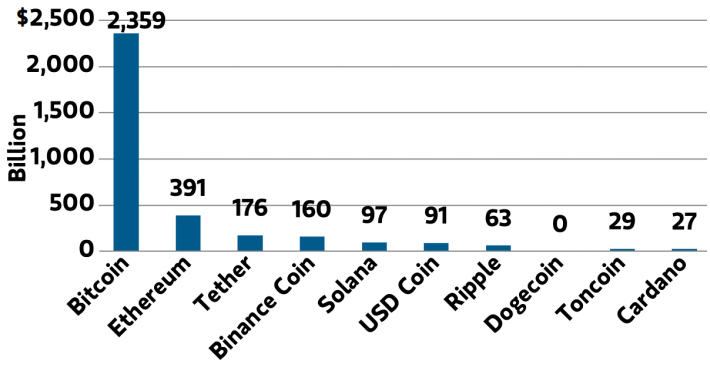
What Is Cryptocurrency?

Cryptocurrencies are virtual currencies that operate on a peer-to-peer basis without a central authority. They are digital and, unlike the US dollar, have no physical form and no central repository. The decentralized nature of cryptocurrencies requires computers to perform cryptography —computerized encoding and decoding of information to verify transactions and prevent counterfeiting. Unlike traditional-currency transactions, which rely on a trusted third party such as a credit card company or bank to verify that the funds are available to complete a transaction, cryptocurrencies depend on a network of computers to confirm transactions. When a transaction is initiated, it is broadcast to the network, where it awaits verification from computers that solve an algorithm to determine if the transaction is legitimate. Bitcoin trading volumes have continued to grow (see Exhibit 2). Bitcoin accounts for most of the market cap in the cryptocurrency industry (see Exhibit 3).

Exhibit 2: Crypto Trading Volumes Have Continued to Grow

Source: Wealth Management Global Investment Office as of Jan. 15, 2025

Exhibit 3: Bitcoin Is by Far the Largest Cryptocurrency



Source: Coinmarketcap.com, Wealth Management Global Investment Office as of July 16, 2025

Three Important Factors Have Helped Bitcoin Flourish

Bitcoin is "trustless." Apart from the place where the Bitcoin open-source software is accessed, investors do not have to trust any entity at any step in the transaction. The only way to move bitcoin is for the user to input their "private key," or password. Economic incentives and mathematical checks keep actors honest, because the reward for honesty is so much greater than the potential gains from dishonesty, and the mathematical checks make it easy to find dishonest participants.

Bitcoin is "permissionless." Anyone can access the network as a miner or user with minimal computing and connectivity requirements. There are no accounts or approvals needed, allowing anyone to participate in most cryptocurrencies.

Bitcoin has limited supply. Before cryptocurrencies, text, music and movie files could all be copied. There was no easy way to know who had the original copy of anything and no easy way to create scarcity. Using a distributed blockchain, only new assets explicitly authorized by the code can be created. No entity has the power to change the code; it is instead adopted by universal consensus. Finally, it is easy to detect invalid copies of the assets by tracing each one's history on the blockchain.

The combination of these three characteristics is unique. Digital scarcity, such as the right to a trademark, song or movie, has been enforced by the courts, a centralized and permissioned system. On the other hand, while cash is a permissionless asset, it has all the limitations of a physical object. It cannot be sent instantly or stored on a phone or computer. It also requires trust in the courts or in law enforcement to remove counterfeit bills from circulation. Bitcoin and similar cryptocurrencies do not need a judicial system to work and cannot be copied, yet they retain the flexibility of a fully digital asset that can be moved within minutes and stored on any device with computing power.

Bitcoin is one of the scarcest assets—if it works. Digital scarcity enforced by code is unique. As the rate of bitcoin inflation falls, it has the potential to become the most scarce, fungible asset on the planet—that is, one bitcoin is the same as another. After the April 2024 halving, bitcoin's supply growth fell below 1.0% y/y, significantly below gold, its analog rival. Bitcoin has the potential to be something completely new, an asset for which supply can never increase faster than its predetermined schedule.

Many cryptocurrencies have almost zero supply response. Bitcoin miners can't significantly step up production because supply growth is strictly enforced by code. It's true that higher prices encourage people to spend more resources (electricity or cash) to mine or buy cryptocurrency, but these transactions do not affect supply. Put differently, spending more will change a miner's share of coins mined but won't impact the number minted. So far, 19.9 million coins have been mined, and a maximum 21 million will be reached around 2140. With the recent halving in April 2024, bitcoin's annual supply increases only about 1% per year, roughly half the rate of gold. Thus, if the code doesn't fail—and that's a big if—it could become the first truly scarce, fungible and divisible asset in history.

The Three Categories of Cryptocurrency

Among the tens of thousands of cryptocurrencies and other digital assets, we see three broad categories: cryptocurrencies, smart contract platforms and applications. Bitcoin is the largest cryptocurrency, ethereum is the largest smart contract platform, and tether is the largest application.

Not only is bitcoin the largest cryptocurrency, it is the largest by far. The network is famously permissionless: Anyone can use it, it's censorship-resistant, and no one can technologically block a transaction (though transactions can be made illegal). Its primary use is as a store of value, similar to the use of a certificate of deposit in an unusually volatile emerging market currency. A bitcoin user is more likely to buy it, hold it for a few years and then sell it to make a large purchase of something else than to use it to make everyday payments.

Digital scarcity and decentralization have been applied to many areas beyond sending, holding and receiving digital currencies. While bitcoin has undoubtedly been the winner in the cryptocurrency space, most cryptocurrencies focus on either using digital scarcity in new ways—such as for art, gaming and collectibles—or on decentralizing new activities such as those related to banks, exchanges, social media, artificial intelligence and hardware networks.

After bitcoin began to be established as a currency, enthusiasts began to envision solving other problems using a decentralized organization and blockchain. While bitcoin could only execute simple commands, such as "send," a similar system could in theory execute all kinds of complicated programs. These programs are known as smart contracts. A system that hosts smart contracts is known as a smart contract platform. Smart contract platforms are the second most valuable category of cryptocurrencies.

In the same way that bitcoin is like a decentralized bank, a smart contract platform is like a decentralized app store. Like mobile phone app store platforms, which host software apps developed by third parties, a smart contract platform can host applications (lines of code) built by third parties that are uploaded to the blockchain. Anyone can access and run these apps without asking permission. Unlike centralized app stores, developers do not need approval to upload their programs. Once deployed, the apps cannot be forcibly removed or censored. Ethereum is the leading smart contract platform, though it has many competitors, including solana and binance smart chain. Developers have also recently tried to build smart contract platforms directly connected to bitcoin.

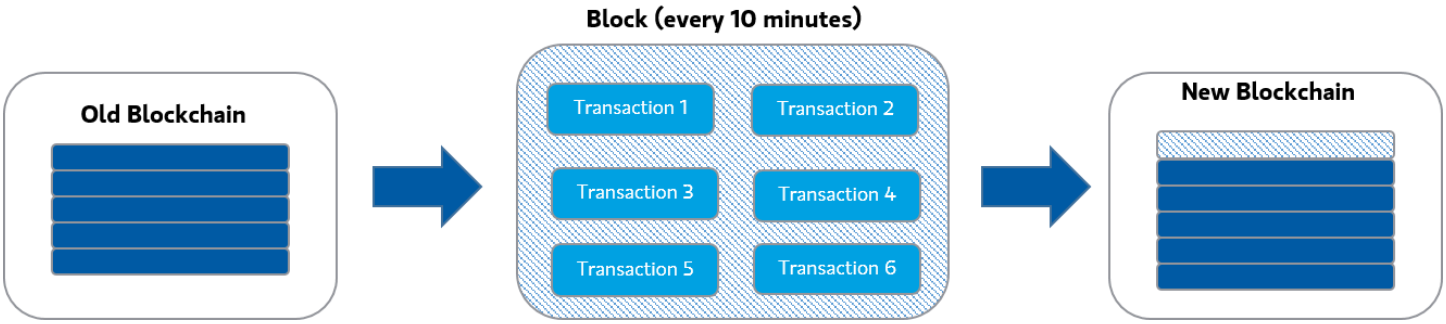
The third category of cryptocurrencies are coins associated with applications. There are tens of thousands of coins tied to apps, with new ones created every day. Most apps are very small compared to bitcoin or the smart contract cryptocurrencies, though there are a few very large payments aps. Tether and USDC are two cryptocurrencies that attempt to minimize volatility versus the US dollar. These "stablecoins" dominate the payments category and are by far the most valuable cryptocurrencies associated with apps.

How Does Bitcoin Work?

Cryptocurrencies such as bitcoin use different techniques from one another to process transactions and keep track of the balances controlled by one password, or private key. However, they have a few key elements in common. Private keys control one or more addresses on one or more blockchains.

The Bitcoin blockchain is a record of all the Bitcoin transactions that have ever occurred. Each account balance at any point in time and each transaction between two accounts is stored. There are thousands of copies of the file on computers around the world. As long as a copy of the blockchain exists, the Bitcoin system can function. Since there is no one server or computer that holds a master copy, a hacker, government or other organizations would have to alter the data in multiple locations. However, this does not entirely insulate the process from theft, as third parties such as exchanges and wallets that interface with blockchain technology have been hacked recently. Exhibit 4 illustrates the process of adding new transactions to the blockchain.

Exhibit 4: Bitcoin Uses Blockchain for Transaction Verification



Source: CoinDesk, Blockchain.info, Morgan Stanley Wealth Management Global Investment Office

For bitcoin, a block of transactions is processed roughly once every 10 minutes. These blocks comprise unspent transaction outputs; that is, they are the result of a certain number of bitcoins (or fractions of a bitcoin) having moved from one address to another. The blockchains allow the tracking of each coin as it is created, sent, divided, aggregated and sent again. When all these blocks are stacked in chronological order, it shows a chain of custody for every bitcoin ever mined.

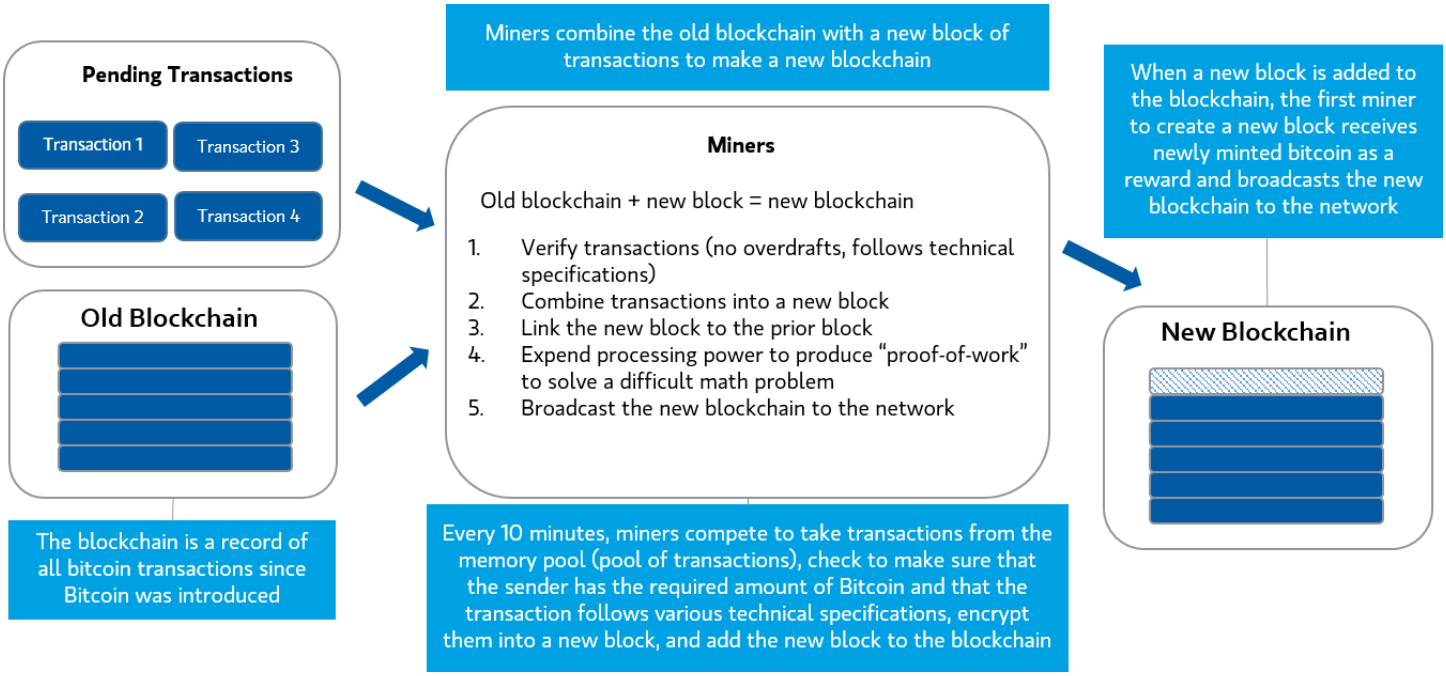
In the bitcoin system, block producers are called "miners." Miners run code that checks to make sure all the transactions in a block follow all the rules. No coins can exist in more than one place, and the total number of coins must match the coins expected. If someone sends a bitcoin, that bitcoin must have been in that user's address. If the transactions meet all the checks, a new block of transactions is added to the blockchain. An important design consideration for cryptocurrencies is how to select which producer produces each block. In bitcoin, block producers race to be the first to perform the checks and are rewarded with newly created (mined) coins (see Exhibit 5). Currently, a block producer gets a 3.125-bitcoin block reward ($330,000) plus transaction fees (about 1%–5% of the block reward) for each successful block.

Different blockchains have different rules for who can produce a block. This allows users to reach a consensus on which is the valid blockchain—and which are incorrect, or even fakes. For bitcoin, the first entity to find an encrypted number that meets all the rules and happens to start with a certain series of numbers is allowed to produce the block and earn the block reward. The only way to find a number is through trial and error, which requires a miner to spend heavily on computing power and equipment.

The high upfront costs incentivize miners to process blocks correctly so they can earn a reward. This process is called "proof of work." It refers to the concept that block producers must prove they spent real resources performing a difficult task to be paid. The official chain is the longest chain with the most work (calculations). Other blockchains reach consensus by awarding blocks randomly to block producers that have a certain amount of the underlying cryptocurrency deposited in escrow (known as "proof of stake") or that are on a list of "approved" block producers.

Producers can become approved in various ways. Some methods are centralized, and some are decentralized, such as winning a lottery, meeting various technical requirements or winning a vote of coin holders. Cryptocurrencies rely on cryptography to make changes to the blockchain, to connect blocks, to ensure blocks stay in the correct order and to encrypt users' passwords when they request transactions. Encryption ensures that if one person sends cryptocurrency from one account to another, the instructions cannot be intercepted and rerouted to a third account, unless a user has the key (password) or has cracked the encryption.

Exhibit 5: Miners Are the Computers Behind the Bitcoin Network



Source: CoinDesk, Morgan Stanley Wealth Management Global Investment Office

Who Controls Bitcoin?

Bitcoin's decentralized nature means no one party controls the entire network. There are complex economic relationships among various parties that may encourage users to follow the rules. However, some portions of the network are more centralized (software developers, miners, fiat gateways) than others, potentially increasing concentration risks. Below, we compare the various stakeholders.

Software developers. All bitcoin software is open source. Bitcoin Core software, the most popular version, verifies transactions, assuring that there are no overdrafts and that technical specifications are followed. It also includes a wallet to store coins. Anyone can contribute, test or verify the code. Historically, over 800 developers have contributed to "Core," but various studies have pegged the number of active developers between 40 and 300, depending on the time and frequency of updates.

Node Operators. Nodes (computers connected to the network) hold complete copies of the blockchain, run software that validates for issues like double spending and relay transactions to miners. In 2024, there were more than 19,000 bitcoin nodes globally.

Miners. Anyone can theoretically download free software and mine bitcoin, though many miners join a mining pool to combine resources and smooth out their revenue. Miners take transactions from nodes, verify transactions, compile them into blocks and broadcast new blockchains to the network. In 2024, more than 75% of bitcoin blocks were mined by one of four mining pools.

Fiat Gateways. Fiat gateways allow currency to be electronically exchanged for bitcoins. Fiat gateways include domestic and international exchanges, bartering sites that allow people to meet and exchange cash for bitcoin, and bitcoin ATMs.

Bitcoin Owners. Bitcoin owners own a password that allows them to send instructions to the network. They store these passwords, known as private keys, in a "digital wallet." Owners can store bitcoin private keys with third parties such as exchanges or wallet providers, on hardware wallets similar to USB drives or on their computers or mobile devices. Sometimes, many users appear as sharing a single address of a custodian or asset manager, similar to the manner in which many stocks appear as being held by the broker that purchased them. In 2024, unique active addresses ranged from 470,000 to 800,000 a month.

What Is Ethereum?

Ethereum was conceived in 2013, funded in a crowd sale in 2014 and launched in 2015. It is the second-largest cryptocurrency by market cap and the most valuable smart contract platform. The largest smart contract platforms are shown in Exhibit 6.

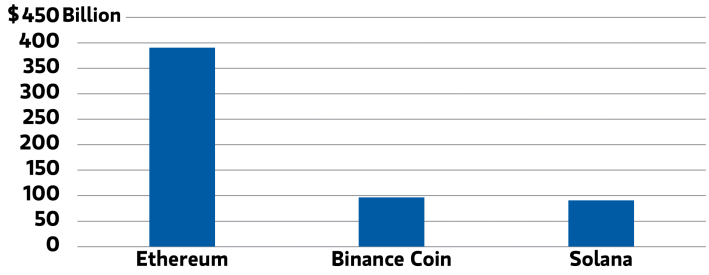
Among other things, ethereum is a programmable blockchain, built using the concepts introduced by bitcoin, but designed differently. Rather than seeking to create a decentralized savings account, like bitcoin, ethereum developers aspire to create a decentralized open-source app store. Like bitcoin, ethereum utilizes a blockchain, which is a chain of blocks of data connected using cryptographic techniques. Like instructions listed in an assembly manual, the blocks must remain in a specific order relative to one another.

Changing the order of the blocks will cause a failure. Bitcoin's blockchain contains a record of all historical transactions. Transactions are bitcoins moving from one address to another. Ethereum's blockchain contains transactions, lines of code and data. The lines of code and data can be combined to write programs called smart contracts. One of the first analogies ethereum developers used to describe the network likened it to a "world computer." Anyone can log on to the computer, upload programs or run somebody else's programs. Another useful analogy likens ethereum to a decentralized app store. To use the apps, customers pay a fee for each transaction in ether. These fees pay for the computer-processing power and memory required to run the software program.

Differences Between Ethereum and Bitcoin

Ethereum uses different hardware, employs a different programming language and has a different fundamental design than bitcoin. Its programming language, Solidity, is more flexible than bitcoin's language, Script. Because app stores need to handle more transactions than savings accounts, ethereum's blocks are produced every 12 seconds—much faster than bitcoin's, which are produced every 10 minutes. If bitcoin's demand is driven by users' desire to hold bitcoin, a large portion of ether's demand is driven by users who want to spend it on transactions. Given these dynamics, if bitcoin can be viewed as digital gold for holding, ether can be viewed as digital oil for burning.

Exhibit 6: Market Capitalization of the Top Three Smart Contract Providers



Source: Coinmarketcap.com, Morgan Stanley Wealth Management Global Investment Office as of June 11, 2025

How Does Ethereum Work?

Ethereum's goal—to become a decentralized app store—makes it different from most of the earlier cryptocurrencies that merely attempted to improve bitcoin. Ethereum was designed as a platform to upload and run smart contracts. While many of the details of how ethereum works are beyond the scope of this paper, a simplified explanation, visualizing its four most important "layers," can be helpful.

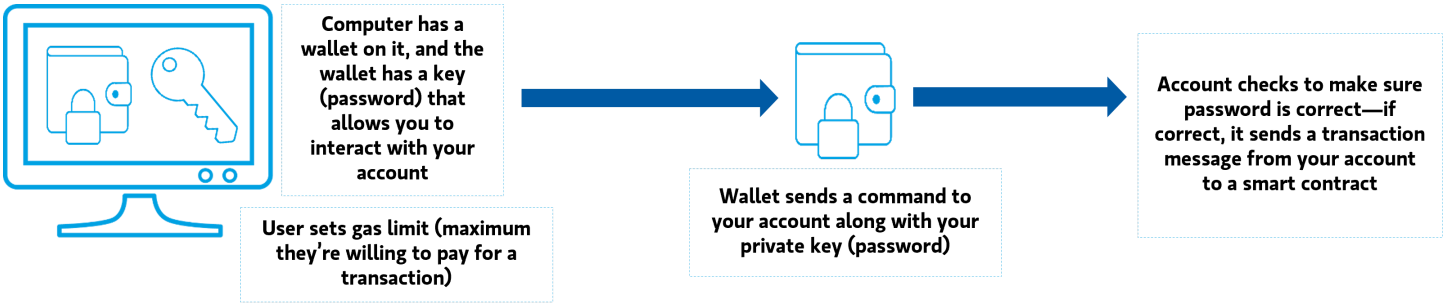
First layer—the physical network. This is a distributed collection of computers, called nodes, running ethereum software. Some of the nodes mine the cryptocurrency and some broadcast the blockchain and transactions around the world.

Second layer—the Ethereum Virtual Machine. This code allows developers to upload smart contracts to the blockchain and external accounts (users) to interact with the smart contracts. External accounts are controlled by a private key (password). Smart contracts are simply computer programs. By design, all the programs are stored on every node in the ethereum network—a very redundant but resilient design.

Third layer—the smart contract. Smart contracts are programs that receive instructions and can send messages or instructions to other accounts or other smart contracts. A smart contract might do something like change a variable or send a cryptocurrency to another address.

Fourth layer—the decentralized application (dapp). Dapps are collections of smart contracts that perform complicated tasks, such as exchanging one token for another or lending a token using another one as collateral. They are accessed through websites that allow users to connect their "web 3" wallets to the ethereum network. Web 3 wallets hold passwords associated with cryptocurrency addresses. A wallet can broadcast instructions (lines of code) to the ethereum blockchain. These wallets approve transactions by electronically signing them with passwords and sending the approval to the ethereum network.

Exhibit 7: An Ethereum Transaction Entails Three Key Steps



Source: Morgan Stanley Wealth Management Global Investment Office

What is an ethereum transaction? An ethereum transaction is a message sent across the network. Using wallet software, a user can send a message from their address to another user or to a smart contract. A message might be as simple as "Send ether from address 1 to address 2," or it could be more complicated, such as a command to run a specific piece of code or to save data to the blockchain.

Most users typically rely on websites to write and send the code to the ethereum network. The ability to send more complicated codes makes ethereum more advanced than bitcoin, which can only process simple transactions. Ethereum can run complicated smart contracts.

As illustrated in Exhibit 7, once an instruction is written, it is "signed" using a user's private key, then broadcast to the network. When a message is sent, users include a transaction fee denominated in ether with their message. Nodes on the network running ethereum software listen for messages and rebroadcast them to the broader network. Randomly selected validators from a list of stakers then organize all the messages into blocks, process them and add them to the blockchain. Other validators then vote to approve that the proposed block correctly follows the rules. In return, validators receive a staking reward. Staking rewards fluctuate depending on how many people are staking, how much time a staking node is up and running and how many penalties a staking node incurs for making mistakes.

Currently, 32 staked ethers generate about 2%-4% more ether per year for every 32 ethers staked. Most of this reward is funded by newly minted ether, with the balance funded by transaction fees. The newly minted ether inflates the total supply of ether, but most of the transaction fees merely move from one owner to another and some of it is retired or "burned" in a process similar to a stock buyback. Transaction fees are called "gas." Much like with cars, gas is the fuel on which the ethereum network runs. Some messages require more gas than others. When the network is congested, gas prices go up, and when relatively few are using the network, gas prices go down. Transaction fees keep the network secure by preventing spam (low-value transactions) and infinite loops, which would cause a smart contract to run out of gas.

Who controls the ethereum network? As with bitcoin, no single person controls the ethereum network. Rather, it is controlled by thousands of computers called nodes. Validators, developers, exchanges and crypto businesses might all run nodes. If changes to the network are needed, these nodes must coordinate in a decentralized way. Unlike a tech company that might require users to upgrade software, node operators do not have to upgrade to the newer versions of software.

Each node owner decides which version of ethereum software to run. Node owners generally prefer to run versions compatible with most other nodes so that their software will work with everyone else's. Thus, node operators try to come to a consensus on the most optimal software updates.

Consensus sounds attractive, but what if the stakeholders don't agree on software upgrades? If there were two incompatible versions of code, with both attracting many node operators, the code would "fork" into two networks, each with its own version of the code. This happened to ethereum in the summer of 2016 when one ethereum chain became ethereum classic, and one kept the name ethereum. Most forks do not lead to two networks. Typically, the smaller fork dies off—as no one maintains that blockchain, and no one wants to use the cryptocurrency stored on it.

Through this adversarial process, consensus is formed on topics such as which is the optimal version of the code.

Code changes. Ethereum's more expansive vision has led to many more forks than experienced by bitcoin. Most of these forks have not been contentious, with almost every node operator agreeing on the upgrade and the old code abandoned, leaving only one chain. However, every code change increases the potential for a software bug—one of the five major risks of cryptocurrency. Bitcoin's more conservative node operators tend to avoid hard forks to ensure that older, battle-tested versions of the code still work.

Ethereum node operators, on the other hand, embrace forks, and the ethereum protocol even has a feature that encourages them. By December 2022, ethereum had undergone 18 hard forks since its launch in 2015. In September 2022, the ethereum community successfully "forked" the code from proof of work to proof of stake, a very significant adjustment. Since 2022, ethereum has had roughly one hard fork per year.

Bitcoin versus ethereum. Although ethereum relies on many of the same concepts as bitcoin, there are some key differences, as illustrated in Exhibit 8.

Exhibit 8: Key Differences Between Bitcoin and Ethereum

Key Difference	Bitcoin	Ethereum
Goal	Decentralized saving accounts	Decentralized app store
Structure	Unspent transaction outputs	Account based system
Consensus	Proof-of-work	Proof-of-stake
Scalability	Seven transactions per second	30 transactions per second
Size of the Blockchain	643 gigabytes	1,254 gigabytes

Source: Bitcoin.org, Bitnodes.io, Ethereum.org, Etherscan.io, Morgan Stanley Wealth Management Global Investment Office as of March 24, 2025

What Is Ethereum Used For?

Technologists and various ethereum advocates have proposed using ethereum in several different ways. Recommended applications include social media, gaming, supply chain management, network coordination, art and collectibles, and voting and governance. Thus far, DeFi and NFTs have gained the most traction. But before exploring those two trends, it's important to understand the new capabilities that ethereum offers.

Among other attributes, ethereum shares two important capabilities with bitcoin that have enabled bitcoin to compete with national currencies: digital scarcity and decentralized organization. In ethereum's case, these capabilities allow it to reimagine the concept of an app store.

Smart contract use cases that do not require one or both of these innovations have been slower to gain traction because blockchains are so much more expensive than traditional designs. Instead of just a few computers processing transactions, many more computers compete to process them.

This redundant design drives up the cost to run the network and requires high transaction fees. Thus far, only applications that need digital scarcity or decentralized organization have attracted users willing to pay those high fees.

Ways to Value Bitcoin and Ether

Relative Value Approach

Relative value approaches used to value equities lend themselves to valuing bitcoin. In a relative value approach for equities, an analyst identifies similar companies and uses them as a valuation benchmark. Subcategories of relative value include market-capitalization relative value and operating-metric relative value. For example, when comparing market caps of different automobile industry companies, one might find that an auto company is worth about $10 billion, on average; therefore, an "above-average" auto company should be valued at more than $10 billion. Alternatively, another analyst might use an operating metric, such as earnings. An analyst might value auto companies at a multiple of earnings or sales, or by using a metric such as annual production versus peers. Using this approach, bitcoin is sometimes valued relative to gold or to the money supply of a country.

Gold is the most popular relative benchmark on a market-cap basis. It's also a popular benchmark for investors who are attracted to bitcoin as a hedge against the debasement of fiat currencies. Bitcoin has often been described as "digital gold" or "gold 2.0." In keeping with this approach, employing a gold valuation framework reflects an appreciation on the part of investors for its relative simplicity.

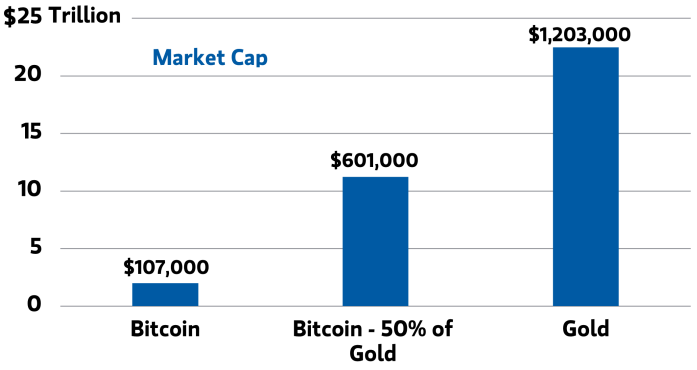
Thinking of bitcoin as a commodity, gold has many of the same properties (see Exhibit 9). Both are scarce, have supply growth of around 1% to 2% a year and are divisible and fungible, i.e., one bitcoin or one ounce of gold is the same as any other. While both make it easy to store large amounts of value in small places, bitcoin itself is easier to store, move globally and break into smaller pieces, and some advocates say that makes it superior to gold. Gold, on the other hand, has been around longer, works without electricity, has a more stable regulatory framework and is not subject to hacks, code bugs or the failure of encryption technology. According to gold's advocates, these factors make it superior to bitcoin.

Exhibit 9: Comparing Cryptocurrencies With Precious Metals

	Cryptocurrencies	Precious Metals
History	The largest cryptocurrency was invented in 2008	Precious metals have been used as a store of value for centuries
Mining	The largest cryptocurrency creates new coins through mining, a software process	Thousands of tons of precious metals are mined each year
Scarcity	Cryptocurrencies typically have a fixed supply. For example, 21 million bitcoins can be created	Precious metals are finite resources; amount depends on the natural environment
Usability	Transfer or pay electronically using software	Store of value, medium of exchange, industrial applications
Volatility and Liquidity	Cryptocurrencies are more volatile and have less liquidity	Precious metals are less volatile and have more liquidity
Risks and Drawbacks	Limited acceptance and potential for further declining acceptance; potential technology flaws; regulatory oversight uncertainty; concerns around account security; relies on internet connectivity; market manipulation potential; highly speculative and risk of substantial loss in short amount of time	Storage/transportation costs; physical property is stolen; changing regulations

Source: Bitcoin.org, CoinDesk, Morgan Stanley Wealth Management Global Investment Office

Exhibit 10: Bitcoin Potential Prices Based on Precious Metals



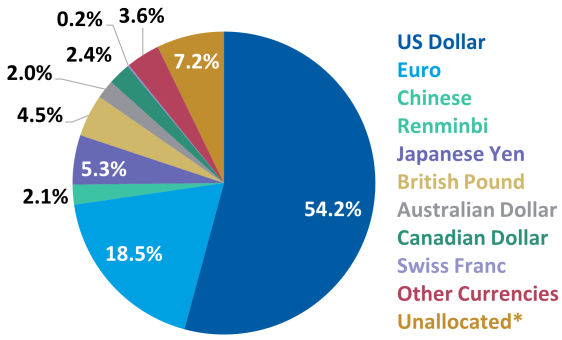
Source: World Gold Council, Bloomberg, Morgan Stanley Wealth Management Global Investment Office as of June 25, 2025

What is gold's market cap? Gold held by governments as currency reserves amounts to about $3.8 trillion—almost double bitcoin's total valuation. The most optimistic take would compare bitcoin to all the gold ever mined. According to the World Gold Council, total above-ground gold—including reserves, private holdings, jewelry and other fabrications—comes to 201 kilotonnes. At today's prices, that suggests a $21 trillion total market cap for gold, or roughly 10 times that of bitcoin (see Exhibit 10).

Another relative value framework compares bitcoin or ether with the money supply of countries. Since both Bitcoin and most money is electronic in nature, M2 money supply seems a better proxy than M1. M2 includes M1 (currency and coins held by the nonbank public, checkable deposits, and travelers' checks) plus savings deposits (including money market deposit accounts), small time deposits under $100,000 and shares in retail money market mutual funds. Morgan Stanley & Co. Research calculated that cryptocurrency total market cap is about 2% of global M2 (see Exhibit 11). Given its volatility and short history, we often compare bitcoin with the money supply of emerging market currencies. Since our first report on crypto in 2021, bitcoin's market cap has moved past the value of most emerging market countries' money supply and into the ranks of developed market countries. Frequently, with larger market cap comes greater liquidity, and it is already likely easier to buy or sell bitcoin globally than to buy or sell many emerging market currencies. On the other hand, bitcoin's volatility is much higher and its history much shorter than that of developed market currencies like the Canadian dollar and British pound. Perhaps it should trade below the capitalization of countries like Canada and Australia. On other measures, in our view, it looks more attractive than some developed countries' currencies. Bitcoin's supply growth is slower and more predictable than that of the Canadian dollar, British pound and even the US dollar. Whether its status is closer to that of an emerging market currency or a developed market currency is debatable.

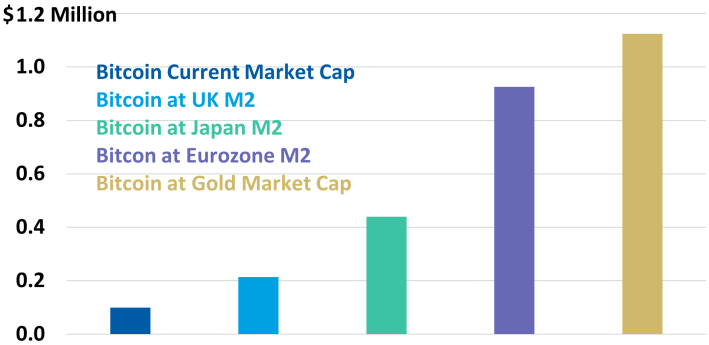
One mark of a developed market currency is its presence in global currency reserves. While the US dollar is the most prevalent currency among reserves, currencies of smaller countries like Canada, Australia and the United Kingdom each account for 2% to 5% of global currency reserves. Today, a small amount of bitcoin is held by sovereign nations, but given its market cap, if volatility continues to fall, it might be reasonable to expect it to eventually account for 2% to 5% of reserves. Exhibit 12 displays the market cap of leading currencies in global currency reserves, divided by the bitcoin supply. If bitcoin achieved the same market cap as that of the British pound, it would imply a bitcoin price of $200,000. A valuation consistent with the Japanese yen's market cap would imply over $400,000. And, while it's hard to imagine in the near term, longer-term parity with the euro would imply a price of more than $800,000 per bitcoin.

Exhibit 11: Major Global Currencies Held in Foreign Exchange Reserves



*Unallocated reserves represent the difference between a country's total foreign exchange reserves and the portion of those reserves for which the currency composition is specifically reported.
Source: The International Monetary Fund (IMF), Morgan Stanley Wealth Management Global Investment Office as of Dec. 31, 2024

Exhibit 12: Price of Bitcoin If It Achieved the Market Cap of Major Currencies or Gold



Source: Bloomberg, Morgan Stanley Wealth Management Global Investment Office as of Dec. 31, 2024

Using Operating Metrics for Valuation

A more fundamental approach is to consider a valuation multiple. In equities, investors rely on price-to-earnings, price-to-sales and price-to-book valuations. In cryptocurrencies, the blockchain provides a whole new set of variables that can be used as valuation metrics. Some approaches look at the money that has been invested in a given cryptocurrency, other approaches aim to capture how much a blockchain is used for transactions or how often its used to store assets. To measure blockchain usage, some investors look at price-to-transactions-fees, or price-to-total-value-locked, or TVL. TVL is a measure of the value in US dollars of all the tokens issued by a smart contract platform. It represents all the value that can be traded on a particular smart contract platform. While debate about the best operating metrics continues in this nascent asset class, for bitcoin we think the most valuable operating metric is bitcoin's price-to-book, explained below. For smart contract platforms like ethereum, we see price-to fees or price-to-total-value locked as the top operating metrics for valuation.

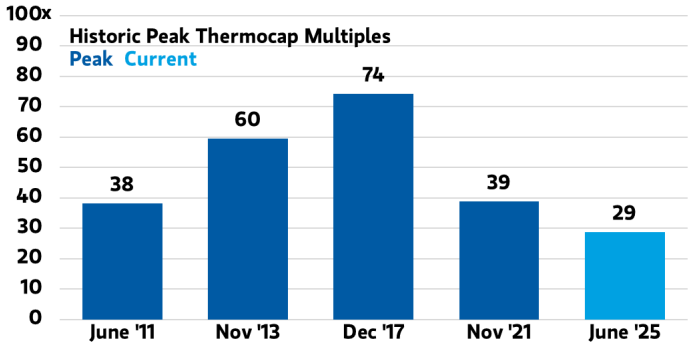
Bitcoin's Price to Book. Sales and earnings do not make sense for bitcoin, but there is a potentially relevant metric similar to book value. For a bank, book value measures how much money has been invested into a bank through share sales and retained profits. When a bank stock trades near or below book value, investors fear that the bank might fail. When it trades at a low price-to-book multiple, investors fear that the bank will accumulate less money in the future (through retained profits). When the bank trades at a high price-to-book multiple, it suggests investors believe it will keep adding earnings to its book value at a rapid pace.

Bitcoin "thermocap" is a similar concept to book value. Thermocap captures how much money has been invested in bitcoin since its inception. Thermocap is calculated by summing the number of bitcoins that have been mined each day and multiplying that by each day's market price. Traditionally, it has been interpreted as either an approximation of the amount of money spent on energy and equipment to run the bitcoin network or the amount spent securing the network. Theoretically bitcoin's network is considered secured because it would cost an attacker a huge amount of energy to disrupt the network.

Comparing bitcoin's market cap with its thermocap is like calculating the price-to-book ratio of a bank. Bitcoin's current thermocap is roughly $74 billion, according to Glassnode. As displayed in Exhibit 13, it trades at roughly 29 times thermocap value today, up from seven times in November 2022. Peaks occurred between 38x and 74x in the past.

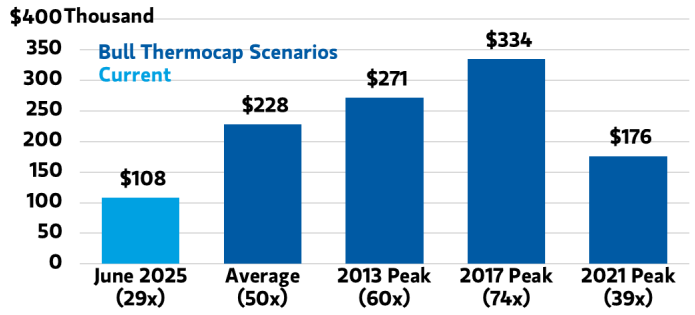
Applying these historical peak multiples to bitcoin's current thermocap results in a range of estimates of $173,000 to $327,000 (see Exhibit 14). Of course, bitcoin may have already reached its peak multiple this cycle. The assumption that bitcoin peaks at the same multiple each cycle may be optimistic. In the case of corporations, sometimes stock valuation peaks reached early in their existence are never repeated. However, these estimates may also be somewhat conservative. Every day, people are putting more money into bitcoin. In the past month, bitcoin's thermocap has been growing at about 22% per year. If this bull market lasts into fall 2025, thermocap might then be 20% higher than today.

Exhibit 13: Potential Peak Prices Based on Prior Thermocap Multiples



Source: Glassnode, Morgan Stanley Wealth Management Global Investment Office as of June 30, 2025

Exhibit 14: Potential Bull Cases Based on Prior Peak Thermocap Multiples

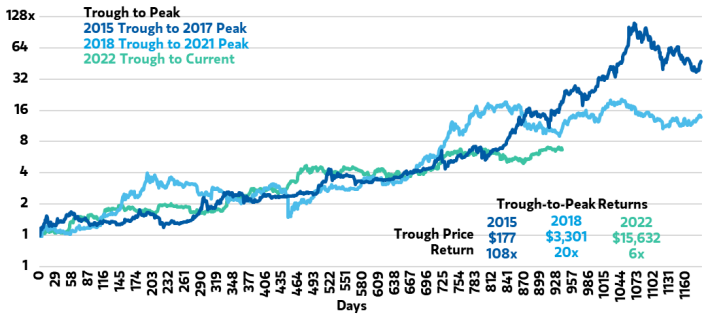


Source: Glassnode, Morgan Stanley Wealth Management Global Investment Office as of June 30, 2025

A cyclical or technical approach to valuation

In currency markets, various technical or cyclical indicators are sometimes used for shorter-term projections. Cyclical techniques are particularly good for bitcoin because its four-year cycle is known in advance. A comparison of bitcoin's progress in this cycle with progress in its previous ones can be a helpful indicator (see Exhibit 15).

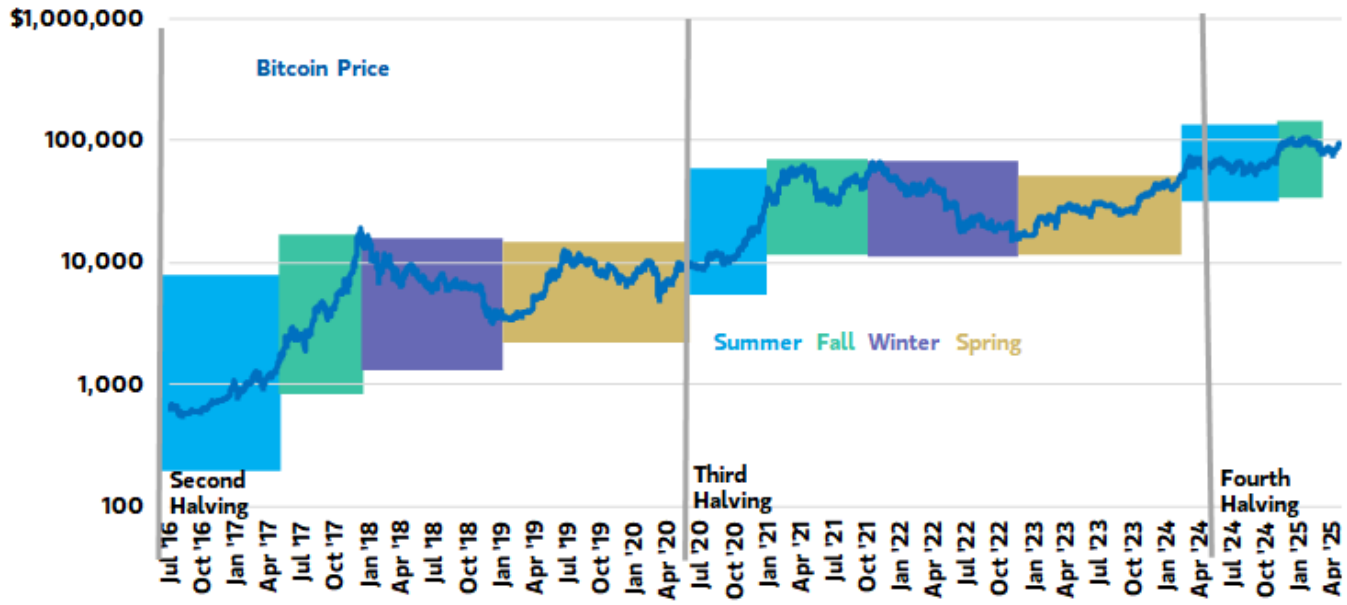
Exhibit 15: Bitcoin Performance From Trough to Peak



Source: Bloomberg, Wealth Management Global Investment Office as of June 25, 2025

In the current cycle, the price seems to be rising slower than in 2013, 2017, and 2021. However, there is no reason that should continue. Prior to this cycle, some bitcoin advocates expected each cycle to appreciate at a slower pace than the previous one, as the rate of appreciation in 2016 was slower than in 2012. Nevertheless, a comparison with previous cycles illustrates that this cycle has already lasted longer than the 2013 cycle, though only two-thirds as long as the 2017 cycle.

Exhibit 16: Bitcoin Has Historically Followed a Seasonal Pattern



Source: Bloomberg, Morgan Stanley Wealth Management as of June 25, 2025

The Bitcoin Halving Cycle

If one assumes that the four-year cycle, which bitcoin and several other cryptocurrencies have loosely followed, is not purely happenstance, there is a top-down macro explanation and a bottom-up micro explanation. The top-down explanation for the cycle is that bitcoin and other cryptocurrencies respond to accelerating and decelerating global money supply. Interestingly, the cycle for money supply is also approximately four years. The bottom-up explanation for the cycle relates to bitcoin's halving. Every four years, the number of bitcoins created every ten minutes, as a block of transactions is approved, is cut in half. This creates a planned supply shortage. Historically, the four times that halvings have occurred, they have kicked off 12-to-18-month bull runs (see Exhibit 16, where the vertical gray bars indicate halvings). These bull runs were followed by 12-to-14-month declines similar in magnitude to that of US equities during the Great Depression.

For the fourth halving in April 2024, the related cycle is incomplete; still, results so far look similar to those of the prior three halvings. While most analysts describe the bitcoin cycle as one featuring just two periods—a "bull market" and "winter"—our "Four Seasons of Cryptocurrency" framework incorporates all four seasons. In our two reports on the topic, we described a cycle specific to bitcoin and another pertaining to the broader cryptocurrency asset class (see the May 1, 2024 report, "How Should Cryptocurrency Investors Evaluate Performance?"). The two methods differ only regarding when "crypto summer" turns into "crypto fall," with one method marking a transition to fall when bitcoin makes a new all-time high, and the second when both bitcoin and ether make new all-time highs. Per the framework, we define these seasons as follows:

- "Crypto spring" is the period between the point when bitcoin reaches a post-peak low and the next halving.
- Crypto summer is the period between the halving and when a new all-time high is reached.
- Crypto fall is the period after the new highs have been established in both bitcoin and ether and before the ultimate cycle peak in bitcoin.
- "Crypto winter" is the ensuing downturn.

Could Ethereum Fit in a Portfolio?

We take no position as to whether investors should buy, sell or hold ether. That said, it's likely they will hear a variety of cases for and against it. To help investors understand the pros and cons, we detail several below.

Bull Case

Bigger market. Ethereum may have a bigger addressable market than bitcoin. Bitcoin's addressable market is the market for store of value products like savings accounts and gold. Ethereum's market is the global smart contract market which could one day encompass the global software market and global financial services market. This market might be bigger than bitcoin's addressable market and therefore ethereum may be worth more than bitcoin.

Supply dropping. The switch from paying miners transaction fees to burning ether for transactions reduces supply, and if demand for transactions is high enough it could lead to less supply growth for ethereum than bitcoin.

Lower float. The move from proof of work to proof of stake replaced miners with stakers. The stakers deposit ether to create a node that can validate ethereum transactions. If they make a mistake, some of their deposited ether is burned. Staking reduces the float (ether available to be sold) in two ways. First, when someone becomes a validator, they must collect 32 ethers and deposit them in a contract, reducing the amount available to be purchased in the open market. Second, if a staker reinvests ether rewards to start a new ethereum node to increase their staking reward, there may be less ether outstanding for others to buy. Compared to proof-of-work miners, ethereum stakers in the new system have more upfront costs (ether) and fewer variable costs like electricity. Unlike miners, ethereum stakers will have little reason to sell any of the ether they receive for validating the network because their operating costs are very low. By contrast, bitcoin miners must sell enough of their rewards to pay for new chips and electricity.

Bear Case

Competition. Ethereum faces more competition in the smart contract market than bitcoin does in the store-of-value market. Ethereum may lose smart-contract-platform market share to faster or cheaper alternatives.

Not Scalable. Fewer transactions per user are needed to "use" bitcoin, which is akin to a decentralized savings account. Ethereum demand is tied more closely to transactions. As such, similar scaling constraints hamper ethereum demand more than they suppress bitcoin demand, as bitcoin users do not need many transactions. It may be that no blockchain is scalable enough for smart contract applications.

Regulatory demand pressure. Ethereum's regulatory landscape is still evolving, and many applications on the ethereum platform could face regulatory risk. DeFi apps or NFTs used to raise money to attempt to buy original copies of the US Constitution, for instance, could be scrutinized. Some DeFi activities may conflict with securities laws. If regulation or legislation reduces demand for these transactions, demand for ether could drop.

Cryptocurrency Risks

Cryptocurrency risks can generally be categorized as 1) traditional risks; 2) cryptocurrency asset class risks; and 3) cryptocurrency-specific risks. For additional information about the risks of cryptocurrencies, see important information in the Disclosure section at the end of this report.

Traditional risks include concentration of holders and volatility. Most cryptocurrencies have concentrated ownership due to holdings of early developers or early financiers. Even for bitcoin, the most decentralized cryptocurrency, the top 100 holders hold approximately 18% of the total supply as of March 2025. Concentration risk is significant for ethereum given that almost 50% of ether is deposited in the staking contract and the next 60 addresses own around 18% of the total supply as of March 2025. Thus, it is less decentralized than bitcoin. Volatility risk is critical given that both cryptocurrencies are among the world's most volatile assets.

Asset class risks pertain to cryptocurrencies in multiple ways. We see encryption risk, software bug risk and risk of coordinated government action as the top three asset class-specific risks. Encryption risk is the risk that encryption techniques will break and that an attacker will subsequently divert a transaction and related assets to the attacker's own account. If this were to occur, it would likely affect many or all cryptocurrencies and engender lost funds and excessive volatility until the identification and implementation of a solution.

Software risks may manifest themselves in several ways, including via bugs, as all cryptocurrencies are based on software. Severe software bugs have caused inflation (more coins being "printed" than expected) and other issues in the past. These risks depend on the individual cryptocurrency, and most of the time a bug in one cryptocurrency does not mean the same bug is exploitable in another. Ethereum's software risk is higher than bitcoin's because 1) its code changes more frequently, given its annual hard forks versus rare hard forks for bitcoin; 2) and it is more complicated, consistent with its ability to solve more problems and its greater propensity for glitches.

Government action risks pertain to potential for government actions to reduce demand or force nodes in relevant jurisdictions to run malicious codes. This could make a blockchain splinter into less valuable regional blockchains and cause demand to drop for certain versions of the code. Due to the decentralized nature of cryptocurrencies, the most negative government actions might depend on coordinated action among many of the world's governments.

Cryptocurrency-specific risks. Each cryptocurrency has its own unique risks. Ethereum's cryptocurrency-specific risk stem from its strategic goals, design and position in a new market.

Ethereum currently has dominant market share leads in the smart contract platform market in terms of value, liquidity and number of developers and users, but its market shares in these areas could decrease over time. Network effects—the tendency for networks to become more valuable as more participants join them—constitute a wide moat for ethereum, but even wide moats are sometimes overcome. Prominent ethereum competitors, among others, include binance smart chain and solana. Chinese smart contract platform binance smart chain is affiliated with the largest cryptocurrency exchange. Solana, the sixth largest cryptocurrency, is designed to facilitate faster, cheaper smart contract transactions.

Blockchain bloat and scalability Are the second major ethereum-specific risk. Blockchains are fundamentally expensive technologies because they have built-in redundancy. To be a global smart contract platform, ethereum needs to store a very large amount of data (primarily related to variables for each smart contract), and it needs to be faster, more desirable and/or cheaper per transaction than potential alternatives. Ethereum's blockchain, measured in gigabytes, is growing faster than bitcoin's, and its memory requirements have surpassed bitcoin's in half the time. Over time, ethereum's storage demand, unless changed, could outstrip its resources. As of March 2025, one version of ethereum full-node software required 1,300 gigabytes of memory. If memory requirements for each node were to expand faster than memory capacity, it wouldn't be plausible for all nodes to store the entire blockchain. It would also increase the cost of deploying new data.

High transaction fees create scalability problems and threaten user demand. High costs make ethereum too expensive for small-value transactions. Layer 2 platforms—separate blockchains that synchronize with ethereum—ease congestion on the main ethereum chain but also divert activity from ethereum to their own platforms.

The changing regulatory landscape poses another major risk. Much of the activity on ethereum is in DeFi and NFTs—two areas with rapidly evolving regulations. Regulations that restrict or eliminate certain market segments, such as finance, from using ethereum could reduce demand for ethereum transactions.

Glossary

Block Reward: Cryptocurrency given to crypto miners or stakers for creating a new block.

Burning: Sending a cryptocurrency to an address with no password. Burning reduces the outstanding supply of cryptocurrency.

Client: Software run by nodes on a network. There can be many clients compatible with the protocol.

Contract Account: An account on the ethereum blockchain associated with a smart contract. The smart contract code executes when it receives a message from another account.

Decentralized Autonomous Organization (DAO): An organization without a hierarchical management, meant to function in a decentralized manner.

Dapp: A decentralized application built on a peer-to-peer network like ethereum.

Decentralized Exchange (DEX): A decentralized application that lets users swap tokens.

Decentralized Finance (DeFi): Decentralized financial products and services provided through decentralized applications that are composed of smart contracts on the blockchain

Ethereum Improvement Proposal (EIP): A design change in ethereum features or processes.

Externally Owned Account (EOA): A cryptocurrency address for users on ethereum. EOAs contain balances of different tokens associated with the address.

Ethash: The proof-of-work algorithm for ethereum that governs the process by which ether is mined.

Ether (ETH): Native cryptocurrency on the ethereum network.

Ethereum Virtual Machine (EVM): A runtime environment for code and smart contracts.

Fork: A point at which one blockchain splits into two. This can happen if two groups of miners are unable to communicate or if a software change on some computers is not compatible with software running on other computers.

Gas: Fees in ether for miners to process transactions.

Gwei: A denomination of ether used to price gas. One ether equals 1,000,000,000 gwei.

Hash: A coded identifier produced by a hash function.

Internal Transaction: A transaction from a contract account to another contract account or externally owned account while a smart contract is running.

Message: An internal transaction on ethereum that's only sent within the ethereum virtual machine.

Non-Fungible Token (NFT): A token type that enables each token to be unique and not directly interchangeable. NFTs can represent ownership of digital or physical assets like art and collectibles.

Node: A computer running a software client that joins it to the ethereum network.

Private Key: A secret string of numbers and letters that enables access to and proves ownership of an account.

Proof of Stake (PoS): A consensus mechanism that requires nodes to prove ownership of a certain amount of ether to participate in transaction validation on the network.

Proof of Work (PoW): A consensus mechanism that requires miners to spend energy (work) by finding a solution to an algorithmic puzzle before they can update the blockchain. On ethereum, the Ethash algorithm is used.

Public Key: A string of numbers and letters connected to a private key that can be used to verify a user's digital signature. Cryptocurrency addresses are derived from public keys.

Smart Contract: A self-executing program that operates in a predictable way based on inputs.

Solidity: The main programming language on ethereum.

Stablecoin: A cryptocurrency coin linked to another asset's value, such as the US dollar or gold.

Staking: The process of depositing ether to become a validator on the network.

Validator: A node that checks transactions and creates new blocks under the proof-of-stake consensus mechanism and is the alternative to a miner on the proof-of-work consensus mechanism.

Volatility: A statistical measure of the dispersion of returns for a given security or market index. Volatility can either be measured by using the standard deviation or the variance between returns from the same security or market index. Typically, the higher the volatility, the riskier the security.

Wallet: Computer software that holds private keys and is used to access and control ethereum accounts.

Disclosure Section

Index Definitions

For index definitions referenced in this report please visit the following: https://www.morganstanley.com/wealth-investmentsolutions/wmir-definitions

Glossary

Correlation This is a statistical measure of how two securities move in relation to each other. This measure is often converted into what is known as correlation coefficient, which ranges between -1 and +1. Perfect positive correlation (a correlation coefficient of +1) implies that as one security moves, either up or down, the other security will move in lockstep, in the same direction. Alternatively, perfect negative correlation means that if one security moves in either direction the security that is perfectly negatively correlated will move in the opposite direction. If the correlation is 0, the movements of the securities are said to have no correlation; they are completely random. A correlation greater than 0.8 is generally described as strong, whereas a correlation less than 0.5 is generally described as weak.

M2 is a measure of the money supply that includes all elements of M1 as well as "near money." M1 includes cash and checking deposits, while near money refers to savings deposits, money market securities, mutual funds and other time deposits.

M3 is a collection of the money supply that includes M2 money as well as large time deposits, institutional money market funds, short-term repurchase agreements, and larger liquid funds. M3 is closely associated with larger financial institutions and corporations than with small businesses and individuals.

Volatility This is a statistical measure of the dispersion of returns for a given security or market index. Volatility can either be measured by using the standard deviation or variance between returns from that same security or market index. Commonly, the higher the volatility, the riskier the security.

Risk Considerations

Virtual Currency Products (Cryptocurrencies)

Buying, selling, and transacting in Bitcoin, Ethereum or other digital assets ("Digital Assets"), and related funds and products, is highly speculative and may result in a loss of the entire investment. Risks and considerations include but are not limited to:

- Digital Assets have only been in existence for a short period of time and historical trading prices for Digital Assets have been highly volatile. The price of Digital Assets could decline rapidly, and *investors could lose their entire investment*.
- Certain Digital Asset funds and products, allow investors to invest on a more frequent basis than investors may withdraw from the fund or product, and interests in such funds or products are generally not freely transferrable. This means that, particularly given the volatility of Digital Assets, an investor will have to bear any losses with respect to its investment for an extended period of time and will not be able to react to changes in the price of the Digital Asset once invested (for example, by seeking to withdraw) as quickly as when making the decision to invest. Such Digital Asset funds and products, are intended only for persons who are able to bear the economic risk of investment and who do not need liquidity with respect to their investments.
- Given the volatility in the price of Digital Assets, the net asset value of a fund or product that invests in such assets at the time an investor's subscription for interests in the fund or product is accepted may be significantly below or above the net asset value of the product or fund at the time the investor submitted subscription materials.
- Certain Digital Assets are not intended to function as currencies but are intended to have other use cases. These other Digital Assets may be subject to some or all of the risks and considerations set forth herein, as well as additional risks applicable to such Digital Assets. Buyers, sellers and users of such Digital Assets should thoroughly familiarize themselves with such risks and considerations before transacting in such Digital Assets.
- The value of Digital Assets may be negatively impacted by future legal and regulatory developments, including but not limited to increased regulation of such Digital Assets. Any such developments may make such Digital Assets less valuable, impose additional burdens and expenses on a fund or product investing in such assets or impact the ability of such a fund or product to continue to operate, which may materially decrease the value of an investment therein.
- Due to the new and evolving nature of digital currencies and the absence of comprehensive guidance, many significant aspects of the tax treatment of Digital Assets are uncertain. Prospective investors should consult their own tax advisors concerning the tax consequences to them of the purchase, ownership and disposition of Digital Assets, directly or indirectly through a fund or product, under U.S. federal income tax law, as well as the tax law of any relevant state, local or other jurisdiction.
- Over the past several years, certain Digital Asset exchanges have experienced failures or interruptions in service due to fraud, security breaches, operational problems or business failure. Such events in the future could impact any fund's or product's ability to transact in Digital Assets if the fund or product relies on an impacted exchange and may also materially decrease the price of Digital Assets, thereby impacting the value of your investment, regardless of whether the fund or product relies on such an impacted exchange.
- Although any Digital Asset product and its service providers have in place significant safeguards against loss, theft, destruction and inaccessibility, there is nonetheless a risk that some or all of a product's Digital Asset could be permanently lost, stolen, destroyed or inaccessible by virtue of, among other things, the loss or theft of the "private keys" necessary to access a product's Digital Asset.
- Investors in funds or products investing or transacting in Digital Assets may not benefit to the same extent (or at all) from "airdrops" with respect to, or "forks" in, a Digital Asset's blockchain, compared to investors who hold Digital Assets directly instead of through a fund or product. Additionally, a "fork" in the Digital Asset blockchain could materially decrease the price of such Digital Asset.
- Digital Assets are not legal tender, and are not backed by any government, corporation or other identified body, other than with respect to certain digital currencies that certain governments are or may be developing now or in the future. No law requires companies or individuals to accept digital currency as a form of payment (except, potentially, with respect to digital currencies developed by certain governments where such acceptance may be mandated). Instead, other than as described in the preceding sentences, Digital Asset products' use is limited to businesses and individuals that are willing to accept them. If no one were to accept digital currencies, virtual currency products would very likely become worthless.

- Platforms that buy and sell Digital Assets can be hacked, and some have failed. In addition, like the platforms themselves, digital wallets can be hacked, and are subject to theft and fraud. As a result, like other investors have, you can lose some or all of your holdings of Digital Assets.
- Unlike US banks and credit unions that provide certain guarantees of safety to depositors, there are no such safeguards provided to Digital Assets held in digital wallets by their providers or by regulators.
- Due to the anonymity Digital Assets offer, they have known use in illegal activity, including drug dealing, money laundering, human trafficking, sanction evasion and other forms of illegal commerce. Abuses could impact legitimate consumers and speculators; for instance, law enforcement agencies could shut down or restrict the use of platforms and exchanges, limiting or shutting off entirely the ability to use or trade Digital Asset products.
- Digital Assets may not have an established track record of credibility and trust. Further, any performance data relating to Digital Asset products may not be verifiable as pricing models are not uniform.
- Investors should be aware of the potentially increased risks of transacting in Digital Assets relating to the risks and considerations, including fraud, theft, and lack of legitimacy, and other aspects and qualities of Digital Assets, before transacting in such assets.
- The exchange rate of virtual currency products versus the USD historically has been very volatile and the exchange rate could drastically decline. For example, the exchange rate of certain Digital Assets versus the USD has in the past dropped more than 50% in a single day. Other Digital Assets may be affected by such volatility as well.
- Digital Asset exchanges have limited operating and performance histories and are not regulated with the same controls or customer protections available to more traditional exchanges transacting equity, debt, and other assets and securities. There is no assurance that a person/exchange who currently accepts a Digital Asset as payment will continue to do so in the future.
- The regulatory framework of Digital Assets is evolving, and in some cases is uncertain, and Digital Assets themselves may not be governed and protected by applicable securities regulators and securities laws, including, but not limited to, Securities Investor Protection Corporation coverage, or other regulatory regimes.
- Morgan Stanley Smith Barney LLC or its affiliates (collectively, "Morgan Stanley") may currently, or in the future, offer or invest in Digital Asset products, services or platforms. The proprietary interests of Morgan Stanley may conflict with your interests.
- The foregoing list of considerations and risks are not and do not purport to be a complete enumeration or explanation of the risks involved in an investment in any product or fund investing or trading in Digital Assets.

Investing in foreign markets entails greater risks than those normally associated with domestic markets, such as political, currency, economic and market risks. Investing in currency involves additional special risks such as credit, interest rate fluctuations, derivative investment risk, and domestic and foreign inflation rates, which can be volatile and may be less liquid than other securities and more sensitive to the effect of varied economic conditions. In addition, international investing entails greater risk, as well as greater potential rewards compared to U.S. investing. These risks include political and economic uncertainties of foreign countries as well as the risk of currency fluctuations. These risks are magnified in countries with emerging markets and frontier markets, since these countries may have relatively unstable governments and less established markets and economies.

Investing in commodities entails significant risks. Commodity prices may be affected by a variety of factors at any time, including but not limited to, (i) changes in supply and demand relationships, (ii) governmental programs and policies, (iii) national and international political and economic events, war and terrorist events, (iv) changes in interest and exchange rates, (v) trading activities in commodities and related contracts, (vi) pestilence, technological change and weather, and (vii) the price volatility of a commodity. In addition, the commodities markets are subject to temporary distortions or other disruptions due to various factors, including lack of liquidity, participation of speculators and government intervention.

Physical precious metals are non-regulated products. Precious metals are speculative investments, which may experience short-term and long term price volatility. The value of precious metals investments may fluctuate and may appreciate or decline, depending on market conditions. If sold in a declining market, the price you receive may be less than your original investment. Unlike bonds and stocks, precious metals do not make interest or dividend payments. Therefore, precious metals may not be appropriate for investors who require current income. Precious metals are commodities that should be safely stored, which may impose additional costs on the investor. The Securities Investor Protection Corporation ("SIPC") provides certain protection for customers' cash and securities in the event of a brokerage firm's bankruptcy, other financial difficulties, or if customers' assets are missing. SIPC insurance does not apply to precious metals or other commodities.

Equity securities may fluctuate in response to news on companies, industries, market conditions and general economic environment.

Companies paying dividends can reduce or cut payouts at any time.

An investment in an exchange-traded fund involves risks similar to those of investing in a broadly based portfolio of equity securities traded on an exchange in the relevant securities market, such as market fluctuations caused by such factors as economic and political developments, changes in interest rates and perceived trends in stock and bond prices. Investing in an international ETF also involves certain risks and considerations not typically associated with investing in an ETF that invests in the securities of U.S. issues, such as political, currency, economic and market risks. These risks are magnified in countries with emerging markets, since these countries may have relatively unstable governments and less established markets and economics. ETFs investing in physical commodities and commodity or currency futures have special tax considerations. Physical commodities may be treated as collectibles subject to a maximum 28% long-term capital gains rates, while futures are marked-to-market and may be subject to a blended 60% long- and 40% short-term capital gains tax rate. Rolling futures positions may create taxable events. For specifics and a greater explanation of possible risks with ETFs, along with the ETF's investment objectives, charges and expenses, please consult a copy of the ETF's prospectus. Investing in sectors may be more volatile than diversifying across many industries. The investment return and principal value of ETF investments will fluctuate, so an investor's ETF shares (Creation Units), if or when sold, may be worth more or less than the original cost. ETFs are redeemable only in Creation Unit size through an Authorized Participant and are not individually redeemable from an ETF.

Please consider the investment objectives, risks, charges and expenses of the fund(s) carefully before investing. The prospectus contains this and other information about the fund(s). To obtain a prospectus, contact your financial advisor. Please read the prospectus carefully before investing.

The spot cryptocurrency ETPs are not registered investment companies under the Investment Company Act of 1940, and therefore are not

subject to the same regulatory requirements as mutual funds or traditional exchange traded funds. Shareholders do not have the same regulatory protections associated with registered investment companies

Derivatives and Leverage. Derivatives are financial contracts whose value depends on the value of underlying assets, reference rates or indices. The use of derivatives involves risks that are in addition to, and potentially greater than, the risks associated with investing directly in securities and other more traditional assets. These include imperfect correlation between the value of the derivative and the underlying asset, risks of default by the counterparty to certain transactions, magnification of losses incurred due to changes in the market value of the underlying asset, and risks that the transactions may not be liquid. Certain derivative transactions may give rise to a form of leverage, which can magnify the potential for gain and/or the risk of loss and could thus have a disproportionate impact on the performance of the fund. Leverage associated with derivative transactions may cause a fund to liquidate portfolio positions to satisfy its obligations when it may not be advantageous to do so, or may cause a fund to be more volatile than if it had not been leveraged. Commonly used derivative instruments and techniques include:

Futures. A futures contract is a standardized, exchange-traded agreement to buy or sell a specific quantity of an underlying instrument or commodity at a specific price at a specific future time. Futures contracts may be offered on agricultural commodities, energy commodities such as crude oil and natural gas, as well as on a vast array of financial instruments, including currencies, government securities, and stock indices. In addition to the derivatives risks discussed above, the prices of futures can be highly volatile. They are affected by many factors, including changes in overall market movements, speculation, real or perceived inflationary trends, index volatility, changes in interest rates or currency exchange rates and political events. Using futures can lower total return, and the potential loss from futures can exceed a fund's initial investment in such contracts.

Options. Options are contracts giving the holder the right to buy or sell a specific amount of the underlying instrument or futures contract on the underlying instrument at an agreed-upon price. Like futures, the prices of options can be highly volatile and they are impacted by many of the same factors. The use of options can also lower total returns.

Investing in smaller companies involves greater risks not associated with investing in more established companies, such as business risk, significant stock price fluctuations and illiquidity.

Stocks of medium-sized companies entail special risks, such as limited product lines, markets, and financial resources, and greater market volatility than securities of larger, more-established companies.

Value investing does not guarantee a profit or eliminate risk. Not all companies whose stocks are considered to be value stocks are able to turn their business around or successfully employ corrective strategies which would result in stock prices that do not rise as initially expected.

Growth investing does not guarantee a profit or eliminate risk. The stocks of these companies can have relatively high valuations. Because of these high valuations, an investment in a growth stock can be more risky than an investment in a company with more modest growth expectations.

Asset allocation and diversification do not assure a profit or protect against loss in declining financial markets.

Environmental, Social and Governance ("ESG") investments in a portfolio may experience performance that is lower or higher than a portfolio not employing such practices. Portfolios with ESG restrictions and strategies as well as ESG investments may not be able to take advantage of the same opportunities or market trends as portfolios where ESG criteria is not applied. There are inconsistent ESG definitions and criteria within the industry, as well as multiple ESG ratings providers that provide ESG ratings of the same subject companies and/or securities that vary among the providers. Certain issuers of investments may have differing and inconsistent views concerning ESG criteria where the ESG claims made in offering documents or other literature may overstate ESG impact. ESG designations are as of the date of this material, and no assurance is provided that the underlying assets have maintained or will maintain and such designation or any stated ESG compliance. As a result, it is difficult to compare ESG investment products or to evaluate an ESG investment product in comparison to one that does not focus on ESG. Investors should also independently consider whether the ESG investment product meets their own ESG objectives or criteria. There is no assurance that an ESG investing strategy or techniques employed will be successful. Past performance is not a guarantee or a dependable measure of future results.

Because of their narrow focus, sector investments tend to be more volatile than investments that diversify across many sectors and companies. Technology stocks may be especially volatile. Risks applicable to companies in the energy and natural resources sectors include commodity pricing risk, supply and demand risk, depletion risk and exploration risk.

Alternative investments often are speculative and include a high degree of risk. Investors could lose all or a substantial amount of their investment. Alternative investments are appropriate only for eligible, long-term investors who are willing to forgo liquidity and put capital at risk for an indefinite period of time. They may be highly illiquid and can engage in leverage and other speculative practices that may increase the volatility and risk of loss. Alternative Investments typically have higher fees than traditional investments. Investors should carefully review and consider potential risks before investing. Certain of these risks may include but are not limited to: Loss of all or a substantial portion of the investment due to leveraging, short-selling, or other speculative practices; Lack of liquidity in that there may be no secondary market for a fund; Volatility of returns; Restrictions on transferring interests in a fund; Potential lack of diversification and resulting higher risk due to concentration of trading authority when a single advisor is utilized; Absence of information regarding valuations and pricing; Complex tax structures and delays in tax reporting; Less regulation and higher fees than mutual funds; and Risks associated with the operations, personnel, and processes of the manager. Further, opinions regarding Alternative Investments expressed herein may differ from the opinions expressed by Morgan Stanley Wealth Management and/or other businesses/affiliates of Morgan Stanley Wealth Management.

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Rebalancing does not protect against a loss in declining financial markets. There may be a potential tax implication with a rebalancing strategy. Investors should consult with their tax advisor before implementing such a strategy.

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