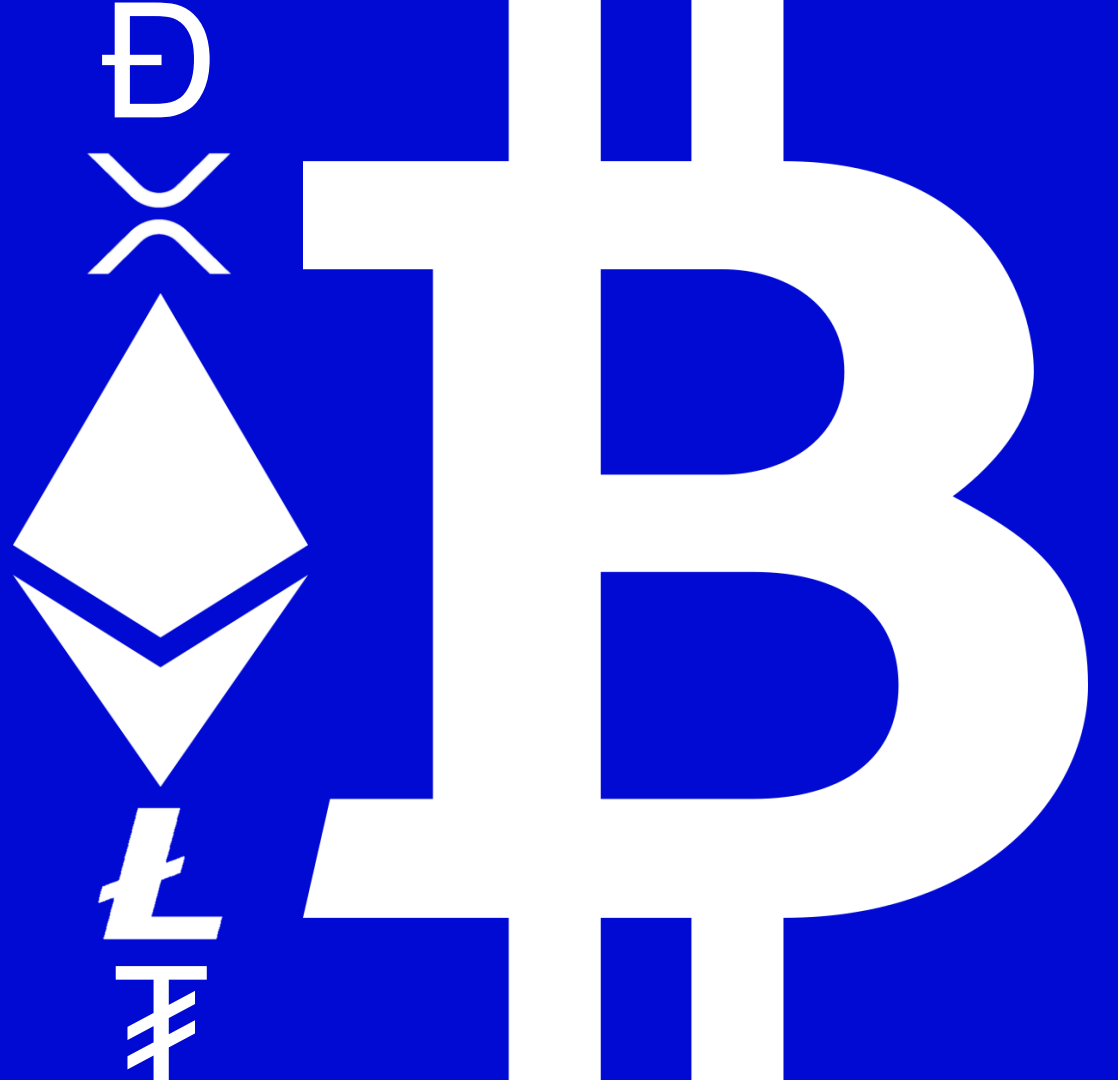
Invesco

Exploring Cryptocurrencies

Trending Conversations
January 2023

Ashley Oerth
Senior Investment Strategy Analyst

Drew Thornton, CFA
Head of Solutions Thought Leadership



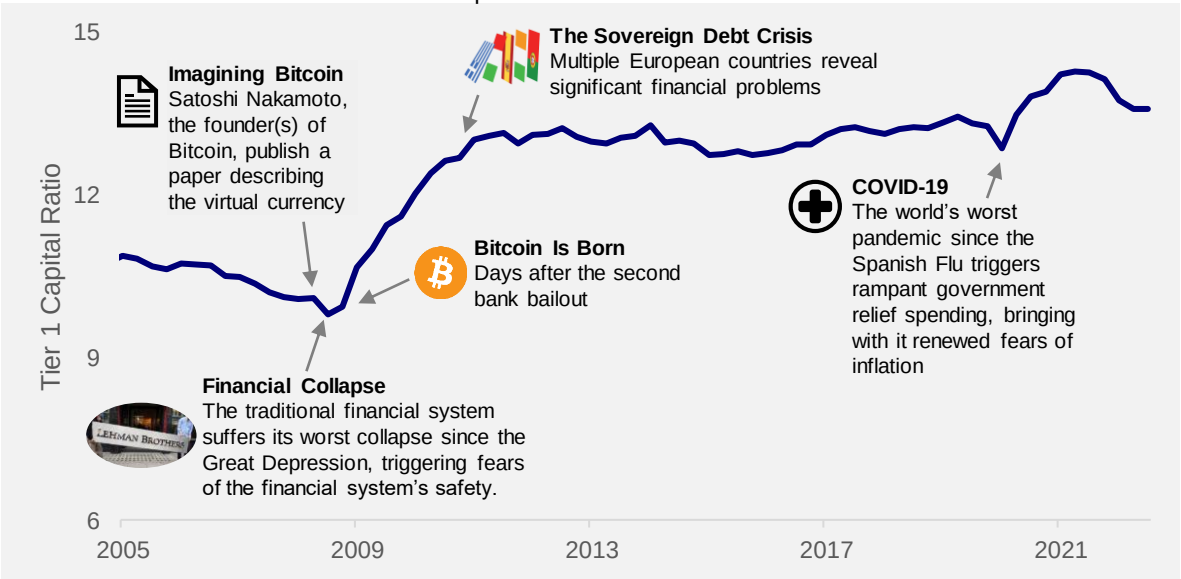
What Started It All?

A financial crisis and a distrust in institutions

Bitcoin, the first cryptocurrency, was invented in the depths of the financial crisis as an alternative to the traditional banking system. Satoshi Nakamoto, the anonymous author(s) of the research paper, *Bitcoin: A Peer-to-Peer Electronic Cash System*, approached the impending financial crisis like any other technologist: Take something fragile, inefficient, and far too large, and disrupt it. As banks were failing, Satoshi inscribed in the code of the first mined bitcoin block a message that reads, "The Times 3 January 2009 Chancellor on brink of second bailout for banks."

Since 2009, self-styled 'cryptocurrencies' have developed well beyond Bitcoin, becoming a vast and rapidly changing ecosystem. This paper offers an overview of the trend and technology behind cryptocurrencies, as well as an assessment of the risks, valuation, and potential long-term outcomes of cryptocurrencies. No matter Bitcoin's outlook, 13 years after authorship and despite a pandemic, Satoshi would be surprised to see well-capitalized banks, US equities up 300%, and a booming economy.

Distrust in the Traditional Financial Sector Spawns Decentralized Assets



Sources: Macrobond, US Federal Deposit Insurance Corporation, latest available data as of 1 January, 2023.

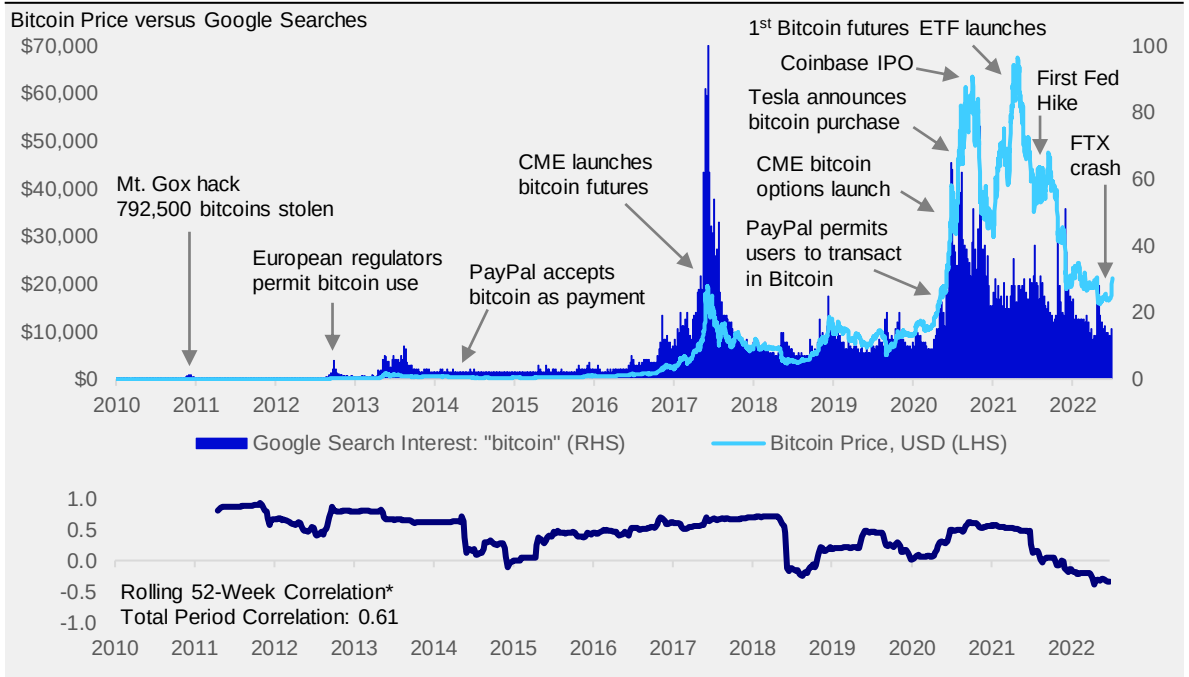
Why Is Everyone Paying Attention?

"A bubble is only a trade that someone missed." –Anonymous

Between March 2020 and November 2021, Bitcoin increased from $8,000 to an all-time high of about $68,000 (a 850% cumulative gain). Bitcoin now sits around $21,000. Although applications of Bitcoin's underlying blockchain technology are interesting and may have great potential, we argue that such applications are often an afterthought. Instead, many crypto-investors focus on Bitcoin's potential for rapid price appreciation.

Cryptocurrencies are unique and deserve review. Finding assets that grow at exponential rates and have little correlation to traditional assets like stocks, bonds, and commodities is the Holy Grail for portfolio construction (but only if future returns are expected to be positive). At first glance, Bitcoin seems to fit this description. But this is changing.

In the past, price fluctuations could mostly be explained by retail interest. Yet, as cryptos have become more mainstream, their price behavior has increasingly mirrored traditional markets. When viewed as a cyclical, risk-on asset, we can explain some of Bitcoin's recent moves.

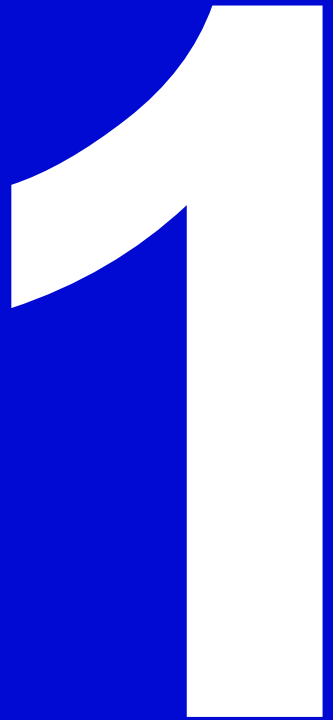


* Correlation is calculated on the change of average weekly Bitcoin prices versus the change of Google search interest over the same period.
Sources: Google, Macrobond, and Invesco. As of 17 January 2023. Past performance does not guarantee future results.

Contents

Bitcoin and Blockchain... How Does It Work?

Back



The Crypto Believer Manifesto

A dash of distrust of institutions and a pinch of cryptographic tech…

For many, the Global Financial Crisis, and institutional/government responses to it, highlighted just how fragile and outdated financial systems had become. Satoshi Nakamoto's seminal paper, *Bitcoin: A Peer-to-Peer Electronic Cash System*, envisioned a financial system that put power and accountability in the hands of decentralized systems.

In his paper, Satoshi described a system which was decentralized, democratized, international and immutable. Bitcoin captures those primary characteristics. Cryptocurrencies developed after Bitcoin are often designed to fulfil a specific use-case or better reflect a specific belief about how financial systems ought to be structured. Naturally, some cryptocurrencies appear far more cozy with traditional financial structures than others.

Still, common themes tend to re-emerge, and they are usually based on a distrust of institutions and fiat currencies and the pursuit of a decentralized financial system ("DeFi").

Decentralization

The lack of a central authority controlling the currency is an attractive trait in a world distrustful of traditional financial institutions.

Democratization

Cryptocurrencies are designed to operate with consensus. Majority decisions are required for structural changes to most coins or tokens.

Cross-Border Payment Facilitation

Existing in cyberspace, crypto-currencies trade outside the realm of government borders on often under- or unregulated exchanges.

Blockchain Immutability

Cryptocurrencies rely on cryptography to preserve anonymity while preventing on-blockchain double-spend and ensuring settlement.

Finite Supply

With certain cryptocurrencies designed to have a finite supply, there is virtually no risk within such coins for a central authority diluting the value of assets.

Peer-to-Peer (Disintermediated)

Trades occur without intermediating authorities, such as banks or bookkeepers, which allows settlement to take place in real-time.

Source: Invesco. For illustrative purposes only. Not all cryptocurrencies exhibit the principles outlined above.

How Does One Get a Bitcoin?

The circle of Bitcoin's life

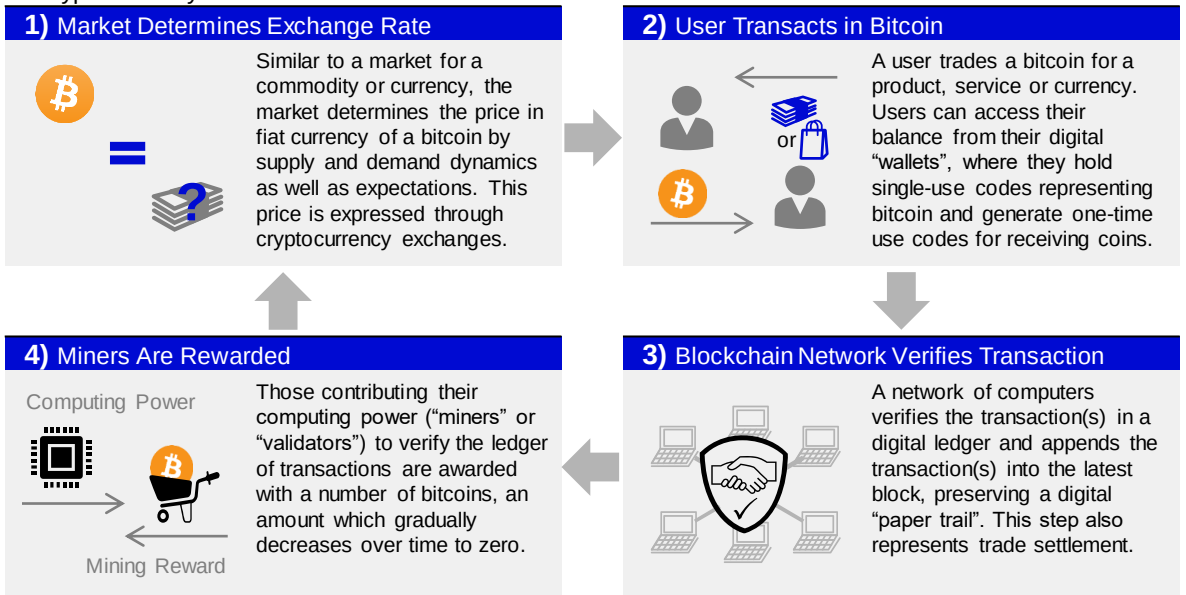
Before exploring the technical details of blockchain technology, it is useful to first understand how one may obtain a Bitcoin.

There are three options:

1. Buy Bitcoins—and other cryptocurrencies—from centralized exchanges.
2. Participate in the "mining" process whereby new coins are generated.
3. Participate in blockchain-based transactions and receive Bitcoins as part of an exchange.

Participants can trade bitcoins for other currencies or goods and services from a limited number of participating vendors. Crypto exchange rates (e.g. Bitcoin/USD) are determined by inter-exchange trading.

A Cryptocurrency in Motion



Sources: Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, 30 October 2008. Please refer to glossary for further definitions.

Understanding Blockchain Technology

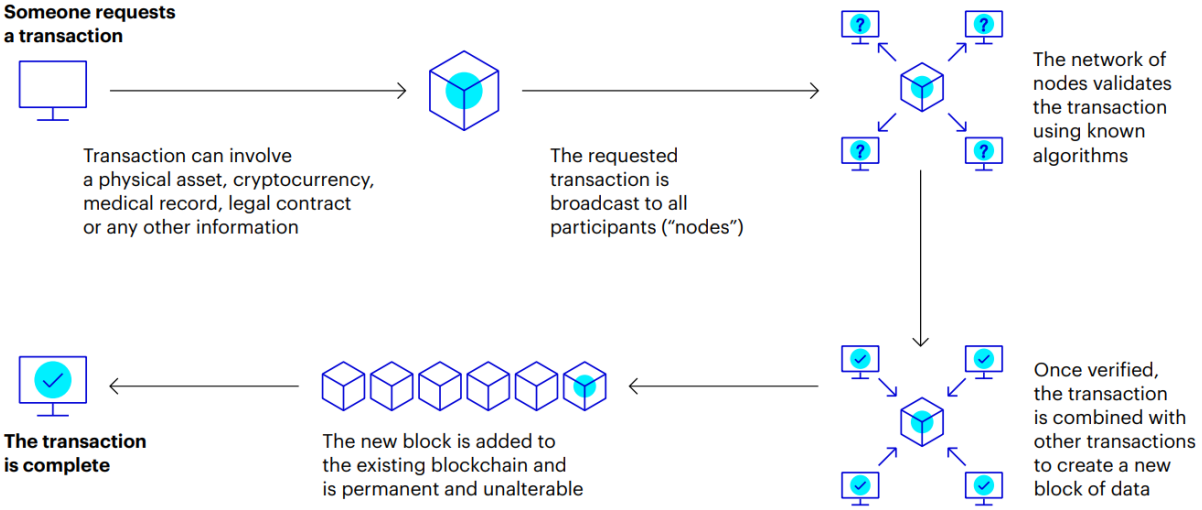
A blockchain is a decentralized database, maintained by a network of peers

Blockchain technology is the darling of the cryptocurrency phenomenon. In essence, a blockchain is a new kind of database, owned and maintained by a network of peers.

Each transaction—or change in data—is provided to the network and integrated into a packet of data called a "block". In contrast with a traditional centralized system, a decentralized database needs to have a mechanism whereby the various participants in the database agree on the current state of data (including any changes to it). To achieve this, each block undergoes an energy-intensive verification process using a series of cryptographic rules and puzzles. Newly verified blocks are broadcast to the network and appended to the blockchain.

To incentivize participation, new bitcoins are minted automatically and rewarded to the participant(s) that successfully complete the cryptographic puzzle first. This "mining" process continually creates new "blocks" in the blockchain with new transaction data, forming a "distributed ledger" where each participant has record of every transaction.*

A Blockchain in Motion



* Technically, only nodes carry the full history of the blockchain; validators do not necessarily need to be nodes.

Source: Invesco. For illustrative purposes only.

Understanding Blockchain Technology

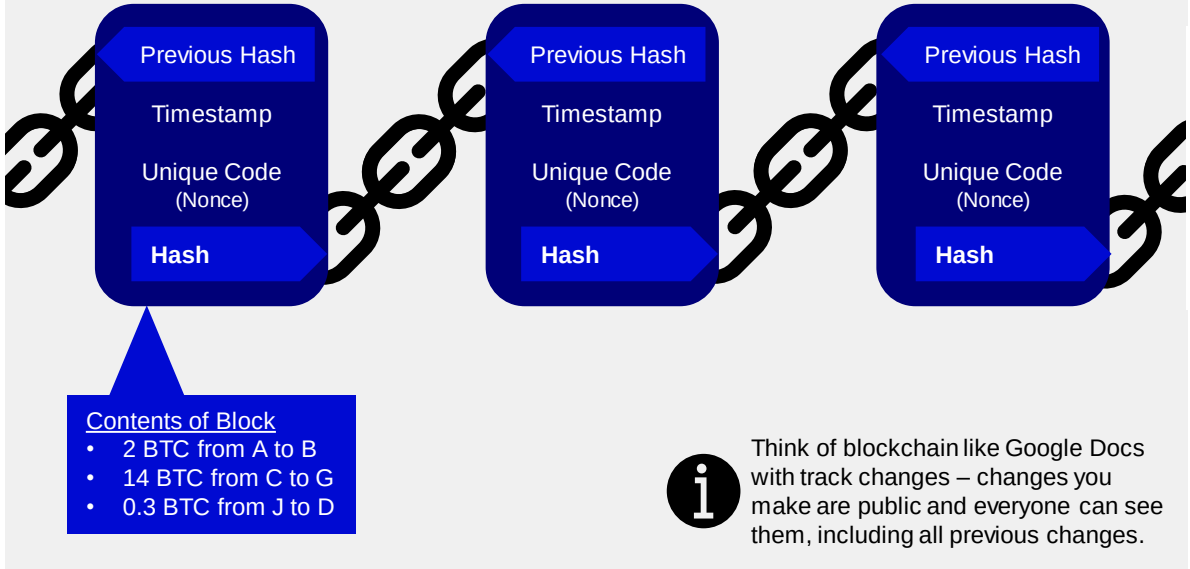
A blockchain is a linear log of records to which we append parcels of data

A blockchain is a growing list of records, or "blocks", linked using cryptography. This linkage makes use of a hashing function, which is a tool in cryptography that takes input data and translates it into a unique, fixed-size code. Any input of data will have a unique hash. Identical data inputs produce identical hash outputs; different data inputs produce different hash outputs.

Each block contains a cryptographic hash of the previous block. If previous data is changed, the corresponding hash will change, breaking the chain and invalidating it. This principle is essential in maintaining the integrity of all past records.

Blocks also contain other data elements, including a timestamp, a unique identifier, and the transaction data contained within that block. Over time, new blocks are added, creating a linear log of data. For Bitcoin, the data stored in each block is transaction data, with a block containing around 2,000 transactions each. By design, a new block is created roughly once every 10 minutes.

Visualizing A Blockchain and Its Contents



*This statement applies to Proof-of-Work blockchains. The Proof-of-Stake consensus mechanism is more computationally efficient. We define these terms in the Glossary.
Source: Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, 30 October 2008. For illustrative purposes only. Please refer to glossary for further definitions.

Understanding Blockchain Technology

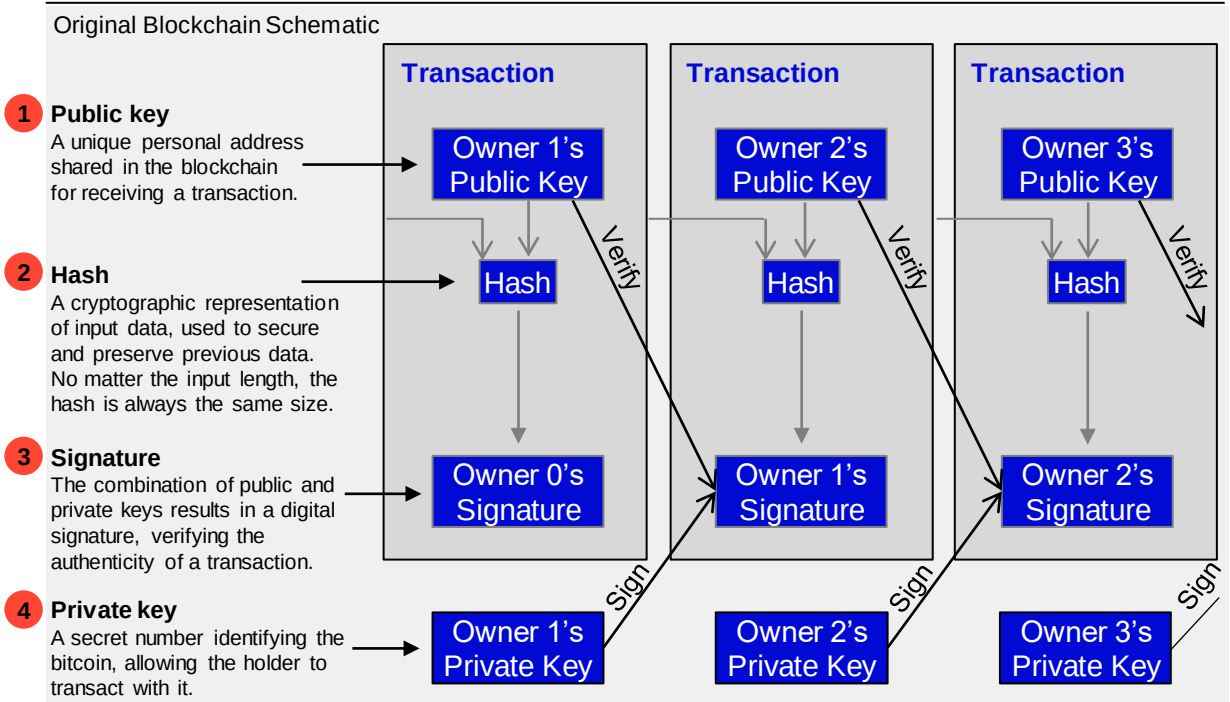
A blockchain's data can restrict access to data through private "keys"

In the original Bitcoin paper, Satoshi described the schematic of a blockchain transaction, reproduced on the right (with added notes). The idea was to create a ledger of transactions as private as the banking system and as public as the internet.

As al discussed, digital assets use cryptography to secure transactions. On a blockchain, each user has a public identity—a public key—associated with their transactions. This public key is like your blockchain username.

To spend crypto or transfer digital assets, you must authorize it by submitting your private key as part of a transaction. This private key is like a bank PIN. Pairing your private and public keys allows the blockchain to verify that you are the legitimate owner of that digital asset and can transact with it.

But can someone guess your private key? It is extraordinarily unlikely: a supercomputer running since the Big Bang would still not have guessed a private key. The security of one's Bitcoins, therefore, depends on how well kept one's private keys are.



Source: Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, 30 October 2008. Icons and notes are added. Please refer to glossary for further definitions.

Weighing the Benefits and Drawbacks of Blockchain

Blockchain appears innovative, but there are tradeoffs to consider

	Fast	Distributed	Immutable	Open
+ Strengths	Unlike banking systems in which transactions may take days to verify, blockchain transactions allow rapid trade settlement (commonly termed "atomic settlement").	Cryptocurrencies were designed to be decentralized – there is no issuing authority and no centralized transaction processor. Third-parties and intermediaries are unnecessary. This may help the network appear more transparent in its governance and therefore trustworthy.	Bitcoin is theoretically impossible to counterfeit. All transactions are irreversible and unchangeable. To override the ledger, an attacker must obtain a majority of computing power used in maintaining the ledger, a tremendously arduous task given the scale of mining participation*.	All transactions can be tracked and verified on a blockchain; it is a public ledger.† It is also possible to analyze how much each address contains and with whom they have transacted.
Weaknesses	Rapid settlement comes at the expense of irreversible transactions – after the blockchain has confirmed a transaction, it cannot be reversed. Moreover, some blockchains have relatively limited network throughput, creating settlement delays during heavy blockchain activity.	'Distributed' does not necessarily mean efficient. For example, changes to the protocols that govern the system can be slow to implement, even if they are beneficial. In terms of scalability, distributed systems tend to be slower than equivalent centralized systems.	Immutability comes at great cost in terms of electricity and capital equipment (expensive mining computers that solve the cryptographic problems powering the blockchain).*	You can see the contents of an address, but you may not be able to identify its owner. Each user may even have multiple addresses. To the extent that users are visible, there are privacy concerns.

*Note: The above points on electricity use refer specifically to the Proof of Work blockchain model. Other consensus mechanisms exist.
†Exceptions exist, as is the case with so-called privacy coins that are designed to hide the transacting parties' information (e.g.: Monero).
Source: Invesco.

Putting Bitcoin into Perspective

Back

Limited Supply

Bitcoin Is A Truly Non-Inflationary Asset

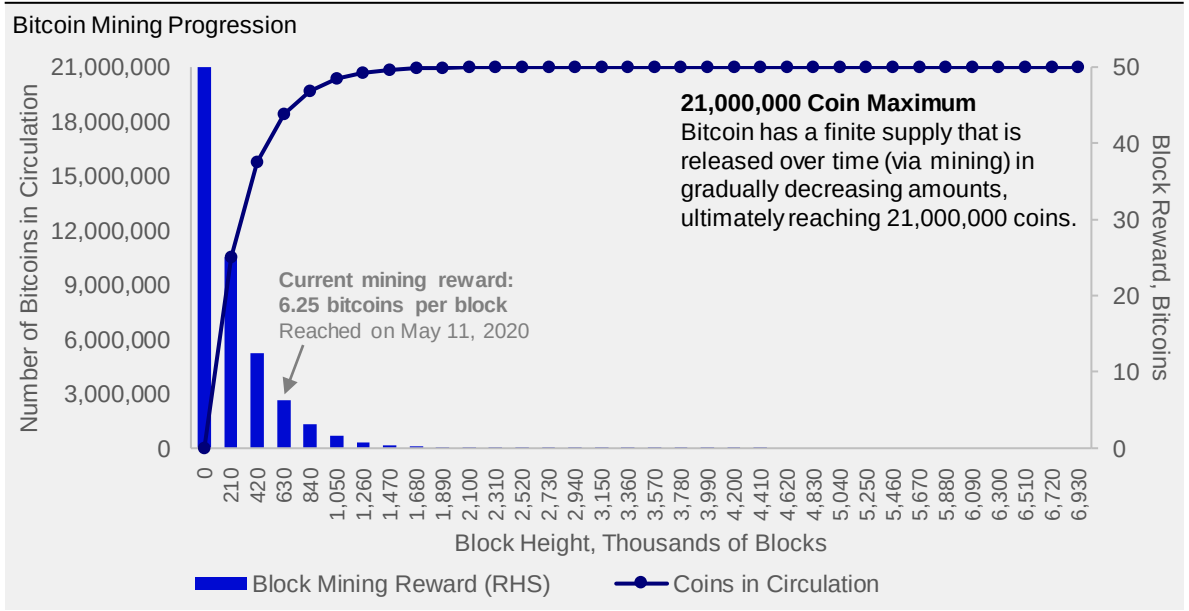
Estimates indicate that all bitcoin will be mined by around the year 2140

Bitcoin is a truly non-inflationary asset, with a total supply of 21,000,000 coins, due to be fully mined by around the year 2140. This finite supply element is important – investments views about Bitcoin are often centered around this idea of scarcity.

As of today, about 19.1 million bitcoins exist, of which an estimated 3.7 million coins are lost forever due to users forgetting their unique keys, losing access to their wallets.

New bitcoins are released according to a predetermined schedule. As the network reaches certain numbers of blocks, the mining reward decreases in what is called a “halving.”

As new bitcoins are the incentive for miners to participate, one might expect transactions fees to rise as compensation for a decreasing number of newly minted bitcoins. Indeed, transaction fees are al a part of Bitcoin and are paid to miners.



Source: Blockchain.com, latest available data as of 31 December 2022. Chart reproduced from bitcoin.it. For illustrative purposes only.

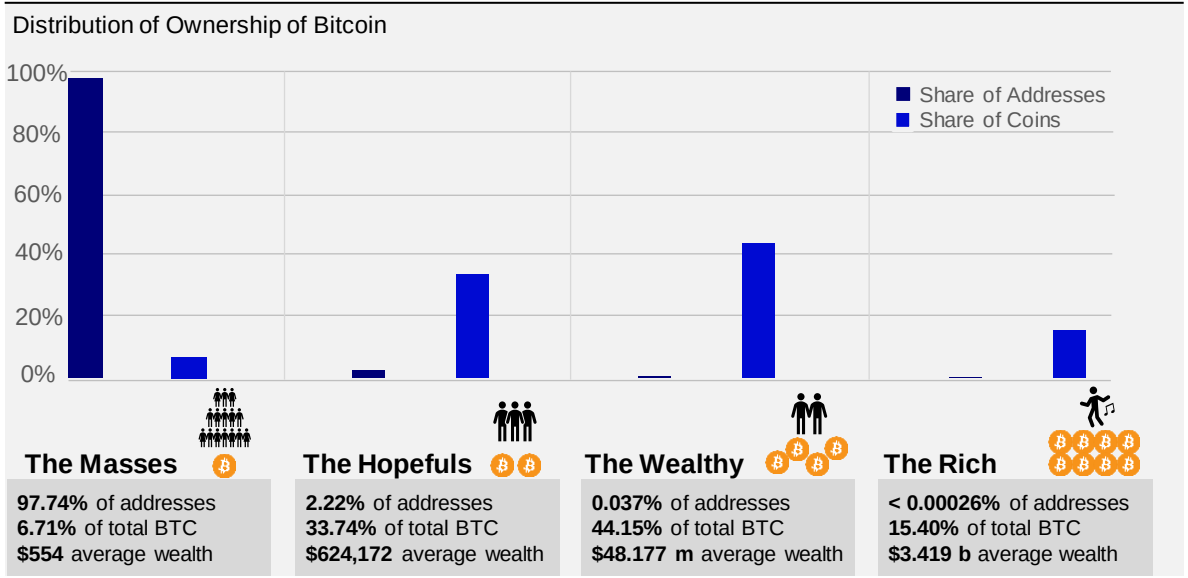
Bitcoin Is Concentrated Among Few Wallets

Billionaires have been minted, but not many

Unlike the traditional banking system, the transparent nature of the Bitcoin blockchain shows exactly how many bitcoins are in each wallet. Some striking data we have found include the following:

- Satoshi owns roughly 5% of the wealth.
- 50.11% own less than 0.001 BTC.
- 97.74 % of addresses own less than 1 BTC.
- Only 2.26% of addresses have more than 1 BTC. Combined they own 93.59% of all bitcoin.

However, wallet data is inherently limited. First, a person may own more than one wallet. Second, centralised exchanges typically hold cryptocurrencies on behalf of their clients, sometimes in just one or a handful of wallets, which would increase the average size of wallets.



Sources: https://bitinfocharts.com/top-100-richest-bitcoin-addresses.html and Invesco, as of 12 January 2023. Figures are based on a spot price of approximately $17,000 USD per bitcoin. Numbers of coins, wallets, and US dollar values are rounded amounts. Note: Here, we use “wallets” and “addresses” interchangeably as a simplification.

Bitcoin: Who's Mining?

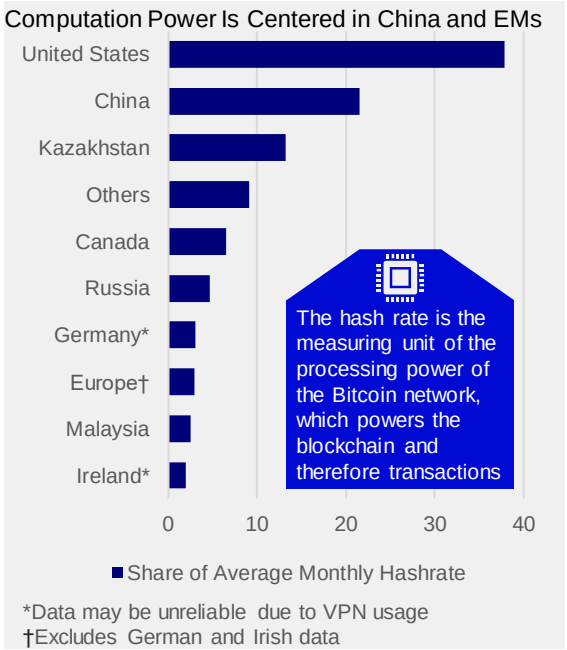
Mining has shifted from emerging markets to more developed economies

Bitcoin's blockchain is powered by "miners," or those users who contribute computational power to verify and maintain the blockchain ledger. By tracing the internet addresses of participating miners, it is possible to estimate the geographical shares of computational power.

Based on an analysis of the Cambridge Centre for Alternative Finance's data, more than 45% of the bitcoin hash rate in 2022 originated from emerging markets, down from its 70% high before China cracked down on cryptocurrency mining.

Why is this? We believe that lower capital costs, cheap electricity, and the desire to capture mining revenue creates the appropriate incentives for miners to focus on a particular locality. Increasingly, miners are moving into developed markets where they can capitalize on cheap renewable energies.

Ultimately, the location of mining power is of little consequence for the Bitcoin network.



What drives the location of miners?

- Lower Capital Costs
- Cheap Electricity
- Lower Fixed Costs (e.g., land)

What happens when mining power is turned off?

As mining power goes offline, the amount of computing power necessary to mine (confirm) a block decreases automatically. However, blocks may be mined more slowly for a brief period until this mechanism takes effect, meaning temporarily slower transaction speeds.

Sources: Bitcoin Mining Map from the Cambridge Centre for Alternative Finance, and Invesco, latest available data is from January 2022.
Past performance does not guarantee future results.

The Anti-ESG Asset? Electricity Consumption Poses Risk

Energy costs of computing power present a key issue

The electricity needs of Bitcoin are difficult to understate. If the Bitcoin network were a country, it would be the 34^{h} largest electricity consumer in the world. As energy prices surged in 2022, the electricity needs of cryptocurrencies have again become a hot-button issue.

So, just how "green" is Bitcoin? The debate is nuanced. Some state that comparisons against traditional payments processors are unfair as the electricity intensity cited (as on the right) fails to account for ATMs, physical location costs, and other facets of traditional financial services that consume resources. Proponents may also suggest that renewables power a large portion of crypto mining.

Whatever one's view, it is worth noting that the amount of electricity used by a cryptocurrency is dependent on the consensus mechanism used. For Bitcoin, this is the mining process described earlier. Other cryptocurrencies can accomplish decentralized ledgers with far less energy inputs.

Mapping Transaction Speeds and Costs

Medium	Transactions per Second	KWh per Transaction	Electricity Cost Per Transaction*
Cash†	Unlimited	0.08 KWh	$ 0.0089
Visa	56,000	0.0008	$ 0.0001
Mastercard	45,000	0.0008	$ 0.0001
Ripple (XRP)	1,500	0.0079	$ 0.0009
Bitcoin Cash	300	18.96	$ 2.1046
PayPal	193	–	–
Litecoin	56	18.52	$ 2.0557
Ethereum	25	87.29	$ 9.6892
Bitcoin	7	1,173	$ 130.20

Striving for efficiency
Ethereum 2.0 as an example

To illustrate how electricity use can vary across crypto designs, the Ethereum Foundation is seeking to transition Ethereum to a new consensus mechanism that would increase transaction throughput while significantly cutting electricity consumption.

They claim the below will be achieved in Ethereum 2.0:

- **2,000+** transactions per second (vs. 25 today)
- **99.9% less** energy consumption (vs. today)

*Prices in USD, assuming 11.10 cents per KWh latest data available as of Jan. 2023 based on the US Energy Information Administration (US EIA): www.eia.gov/electricity/state/. Prices are estimates and for illustrative purposes only. †Electricity intensity of printing a single bill. Sources: Deutsche Bank study, "Future of Payments: When digital currencies become mainstream", MoneySuperMarket.com, Ripple, Coinanalysis.io, Blockchain.com and Cambridge University Centre for Alternative Finance. Past performance does not guarantee future results.
Note that "electricity cost per transaction" should be taken as the upper range of an estimate as multiple transaction settlements may be contained within a single on-chain transaction.

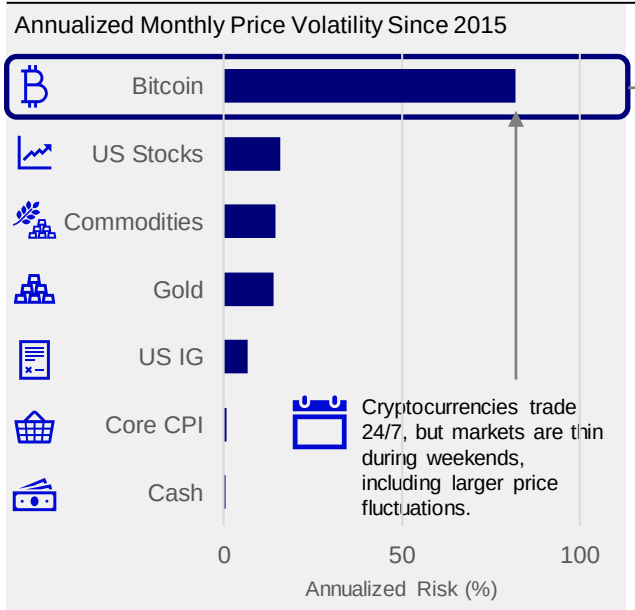
Bitcoin: Is It a Currency? We Don't Think So

"I can't buy a latte with bitcoin"

In viewing Bitcoin as a financial instrument, it is necessary to decide how to categorize it. We take two perspectives in assessing whether Bitcoin – and other cryptocurrencies – is feasible as a currency: (1) an economic test, as on the right, and (2) its potential for scale as a means of transacting.

On the first point, we take the view that money is typically thought of in economics as satisfying three functions: a store of value, a unit of account, and a medium of exchange. Here, on all three accounts, we are left wanting, pointing us more to look at Bitcoin and similar cryptocurrencies as commodities.

On the second point, most cryptocurrencies fall victim to a specific scalability limitation. Cryptocurrencies are limited within their respective blockchains by the combination of block size and the average block creation time, which combine to yield a limited transaction throughput. In other words, each crypto is constrained to a certain maximum pace of transactions – which is often quite limited.*



Store of Value

- Bitcoin is far too volatile to be considered a reliable store of value
- Price behavior is erratic with 82% annualized volatility

Unit of Account

- Product prices are not quoted in bitcoin amounts. Instead, pricing is based on a fiat currency amount converted using bitcoin's spot rate

Medium of Exchange

- While some platforms permit the use of Bitcoin for payment, there is little evidence to suggest that this is what makes it attractive

*So-called "layer 2" scaling solutions can act as an additional settlement layer to batch transactions, thereby increasing network throughput. However, such solutions present their own limitations and challenges, including for privacy and interoperability of blockchains.

Sources: Bloomberg, as of 31 December 2022, and *Bitcoin – Currency of the Future or Speculative Asset*, John Greenwood and Adam Burton. Please see page 42 for index definitions. Note that "Core CPI" refers to the United States consumer price index, less the effects of food and energy. Past performance does not guarantee future results.

Bitcoin: Is It Digital Gold? Maybe, Maybe Not

Investors like Bitcoin's fixed supply, but ultimately the asset remains untested

Another possible – and common – analogy for Bitcoin is that it is a kind of digital gold. But is this the right comparison?

Crypto investors tend to group cryptocurrencies by their functions and consensus mechanisms. Bitcoin is usually thought of as "digital gold" due to the asset's strong security protocols, limited supply, and a history of low correlations with traditional assets (including commodities like gold itself).

To investigate this thesis, we assess key qualities of gold against qualities of Bitcoin in the table on the right. We are unconvinced by the 'digital gold' thesis; Bitcoin does not appear to share gold's most important qualities. An additional challenge for Bitcoin is that gold has a very long history that has cemented its role as an asset, whereas Bitcoin has only existed for a paltry 14 years.

Perhaps the 'digital gold' thesis is a product of post-hoc reasoning, retrospectively justifying Bitcoin's limited scalability, comparatively slow transaction speed, and energy intensive mining.

	Gold	Bitcoin
Finite Supply	Supply increases about 2% per year ✓	✓ Supply increases less over time, with terminal limit of 21,000,000 coins
Liquid Markets	Gold has a highly liquid market with a huge variety of participants and contracts ✓	✓ Bitcoin appears to have liquid markets, including futures contracts*, though this can vary
Uncorrelated	Correlations with other assets are typically low, especially in times of economic distress ✓	? Price behavior is still evolving, and correlations with other asset classes have increased recently
Inflation Hedge	Historically, gold tends to perform well in inflationary environments ✓	? Finite supply is attractive, but the asset has failed to prove itself so far as a hedge against inflation
Global Acceptance	Gold is a globally recognized store of value, held as reserve assets by most central banks ✓	✗ Bitcoin is banned in a number of countries and is regarded with skepticism by many authorities
Use in Goods	Gold is commonly used in high-tech manufacturing and jewellery ✓	✗ Bitcoin has no obvious uses beyond its value as an asset

*Bitcoin trades 24/7, resulting in periods of relative illiquidity. This appears to be especially true on Sundays, resulting in greater price volatility on these days.
Sources: Bloomberg and Invesco, latest data available as of 31 December 2022.

How Do You Value a Cryptocurrency?

Back

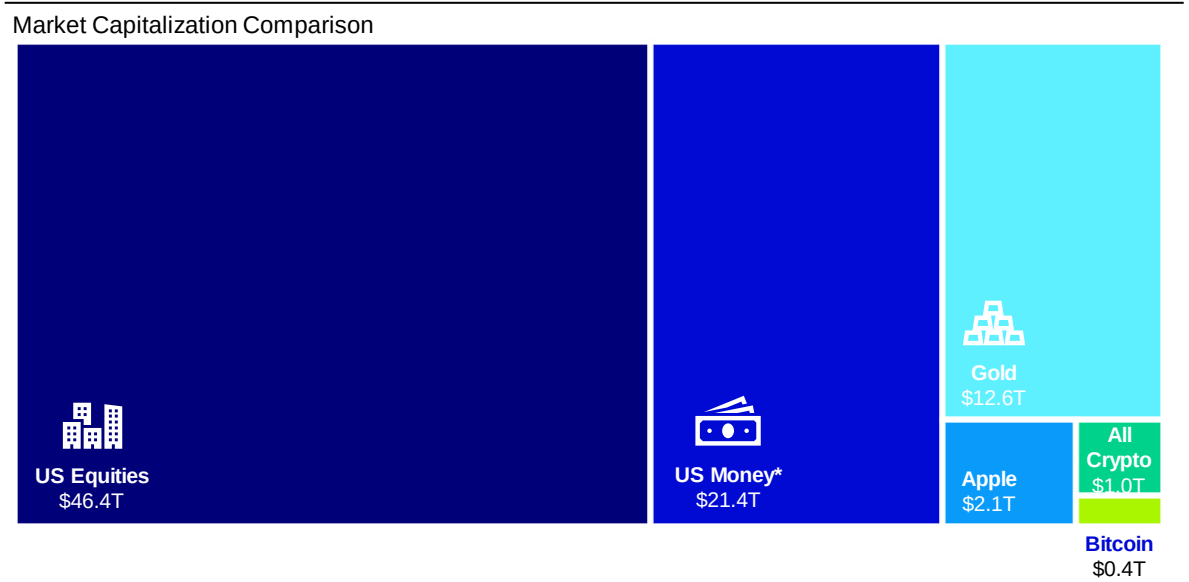
Cryptocurrency Market Capitalization Remains Small

As cryptos grow, we expect traditional market drivers to dominate behavior

In the chart on the right, cryptocurrency market cap at $1.0 trillion is relatively small compared to other asset classes, such as US equities where the total market capitalization is around $46.4 trillion. However, there is potential for this to grow, as we have seen in the 14-year history of cryptocurrencies. Most recently, cryptocurrencies hit an all-time high market capitalization of around $3.0T in November 2022.

As cryptocurrencies have grown in popularity, we believe that crypto market capitalization has increasingly behaved more in line with traditional market drivers rather than idiosyncratic factors. Maturity, in other words, may make crypto less of a diversifier than once thought.

With this in mind, we will now turn our attention to methods of and approaches to valuation in the cryptocurrency space.



*US Money is represented by M2 for the United States, which measures highly liquid dollar deposits and select small-denomination time deposits and money market fund deposits
Sources: Macrobond, SIFMA, CoinMarketCap.com, and US Federal Reserve December 31, 2022; M2 as of November 30, 2022; US Equities and Cryptocurrency market cap as of January 17 2023

What Is the Value Proposition of Cryptocurrencies?

Every buyer has a thesis – which may include speculation

Digital means of transacting?

Cryptocurrencies can be spent and received by anyone, anywhere, and at any time without the need for an intermediating institution. Some assert that cryptos have value for this reason.

Others counter that Bitcoin is an inefficient mechanism of exchange due to its inability to scale. We note that other cryptocurrencies offer significantly faster network throughput.

Decentralized finance?

Cryptocurrencies are emblematic of distrust in the traditional financial services industry. Some envision a new financial system in which the nature of fees and intermediaries is reconceived. Others counter, however, that decentralized finance is al centralizing around key players, in essence recreating a paradigm similar to today's financial system.

New format of trust?

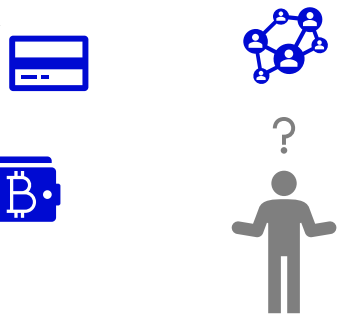
Some argue that Bitcoin and other cryptocurrencies have value because they present a new method of establishing trust. The backstop of such systems is trust in the underlying cryptography. In fiat currencies, trust in the issuing government is the ultimate backstop.

This mechanism of trust may be appealing in a variety of use cases not limited to payments.

A store of value?

Bitcoin has exhibited substantial price movements that have made it difficult to consider it as a store of value. Other cryptocurrencies also fluctuate dramatically in value, often moving in tandem with Bitcoin.

Interestingly, some digital assets resolve this issue by tying their value to an underlying asset, such as is the case with stablecoins.



… or just speculation?

Avoiding government institutions?

Those desiring a financial system devoid of government and central bank involvement value the decentralized, internet-based nature of cryptocurrencies. For some, avoidance of government reach, including borders, regulation and taxation, is an attractive feature.

However, regulators are increasingly stepping into the space and imposing controls.

Source: Invesco. For illustrative purposes only.

Principles of Valuation in the Crypto World

"Not everything can be valued, but almost everything can be priced." *

Valuing cryptocurrencies is a challenging topic, not least because of the immense variety of them. While typical financial valuation models rely on assumptions about expected cash flows and discount rates, investors in Bitcoin tend to look to supply and demand dynamics, not dissimilar to commodity valuation.

Other cryptocurrencies have different designs and consensus mechanisms. In these cases, some cryptos may even generate cash flows through a process known as "staking." In these cases, investors may earn cash flows denominated in a cryptocurrency by participating in the consensus mechanism.

Ethereum provides an interesting example, where users must spend Ether in order to make use of the platform's computing resources. These capabilities can justify use of these cryptos and contribute to their valuation.

On the right, we explore a sample of the variety of considerations involved in valuing cryptocurrencies.

Considerations and Questions to Ask of Each Cryptocurrency

Supply Dynamics

- How many coins are available?
- How often are new coins minted?
- How difficult is it to mine new coins?
- Is there an issuing authority or company?
- Are coins ever "burned" (destroyed)?
- Who receives transaction fees?

Demand Drivers

- Is there significant reputation and/or press coverage (as is the case for Bitcoin)?
- How scalable is the crypto? Does it suffer from limited network throughput?
- Is demand driven by speculation or for use?
- Do similar or undifferentiated coins exist?

Security Features

- Is the blockchain design secure and resistant to tampering?
- What consensus mechanism is used?
- Is ownership concentrated?
- Are the original developers the primary decisionmakers?
- Is the design of the crypto transparent?

Use Case Considerations

- Does the crypto support decentralized applications? If so, is there an active development community?
- Does the crypto serve a specific use case (e.g. payments facilitation, or value pegged to an asset like gold or the dollar)?

*Quote attributed to Aswath Damodaran, 24 October 2017.
Source: Invesco. Past performance does not guarantee future results.

Principles of Valuation in a Formulaic Approach

Can empirical models describe Bitcoin's price behavior? Not likely

Network Effects: Metcalfe's Law

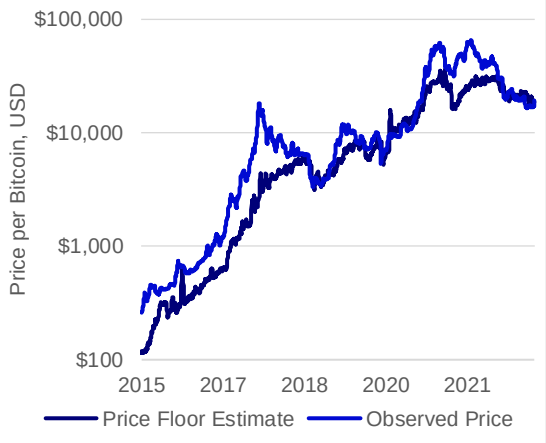
Metcalfe's law argues that value originates from network effects. As adoption increases, the value of the network – in this case, Bitcoin – also rises as the number of possible connections increases exponentially.

This approach is interesting but flawed as value is not defined within this model.

$$\text{Value of a Network} = \#\ \text{of Nodes}^2$$

?

Embodied Costs of Production



A theory put forward by Adam Hayes argues for the value of Bitcoin having a floor of *at least* its costs of production – in other words, the marginal cost of mining each bitcoin.

We are skeptical of this approach – just because costs went into producing something does not mean it has value.*

$$\text{Cost of Production} = \frac{\text{Electricity Cost of Hash Rate}}{\text{Bitcoins Mined Per Day}}$$

*From *Bitcoin – Currency of the Future or Speculative Asset*, John Greenwood and Adam Burton.

Sources: *Bitcoin price and its marginal cost of production: support for a fundamental value* by Adam S. Hayes, CFA, and *Metcalfe's Law as a Model for Bitcoin's Value* by Timothy F. Peterson, CFA, CAIA. Model recreated using estimates from Cambridge University Centre for Alternative Finance and data from Coinmetrics. Values on the right-hand chart are seven-day moving averages. Data as of 15 January 2023. Past performance does not guarantee future results.

An Overview of Major Cryptocurrencies

Back

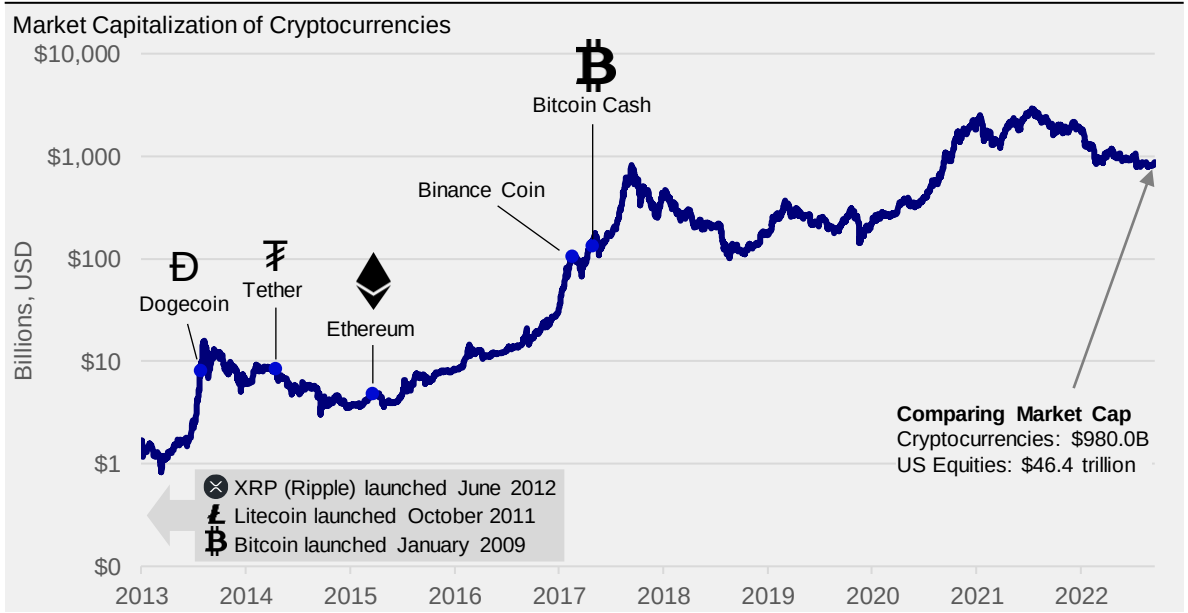
Not Just Bitcoin: Cryptocurrencies Are Numerous and Varied

Since Bitcoin's launch in 2009, more than 20,000 "altcoins" have appeared

There are more than 20,000 cryptocurrencies out there* in various sizes and uses, and many more go unaccounted for or abandoned. In total, the market capitalization of all cryptocurrencies is about $1.0T.

Why so many? Each crypto is differentiated from every other by several factors, including…

- the way in which their blockchain works, including the speed and scalability of the platform
- total supply cap (capped, like Bitcoin, or uncapped, like Dogecoin)
- mining difficulty (and whether coins are mined or distributed by an entity) and release pattern of new coins
- whether the coin is tied to a business, such as XRP (Ripple) or Binance Coin (Binance)
- The ability to embed miniature, decentralized applications (called "dapps"), such as is the case with Ethereum



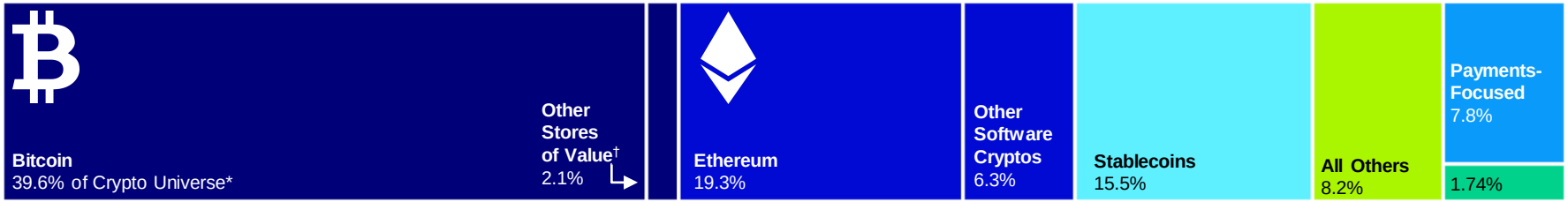
*The market capitalization above includes the data of 22,309 cryptocurrencies that CoinMarketCap tracks. Additional coins exist, but their market capitalization is likely to be tiny. Survivorship bias may be present as the methodology of coin tracking may shift and reconstitute the available coin history.

Sources: CoinMarketCap.com and Macrobond, as of 12 January 2023. Past performance does not guarantee future results.

Not All Cryptos Are Made Equal

Cryptocurrencies are varied by design, use, and value propositions

Top Cryptocurrency Types by Market Capitalization



Stores of Value†

These cryptos seek to offer methods of storing value securely through a crypto, yet their values are quite volatile.

Top Contenders:
1. Bitcoin (39.61%)
2. Litecoin (0.68%)

Software Platforms

Such "software" cryptos act like a decentralized computer, with programs stored on and executed via blockchains.

Top Contenders:
1. Ethereum (19.26%)
2. Cardano (1.27%)
3. Solana (0.67%)

Stablecoins

Stablecoins sidestep the store of value debate by pegging their value to an underlying, such as the US dollar.

Top Contenders:
1. Tether (7.53%)
2. USD Coin (5.00%)
3. Binance USD (1.85%)

Payments-Focused

These cryptos focus on scalability for the sake of rapid payments and are often run or created by a business.

Top Contenders:
1. BNB (5.12%)
2. XRP (2.11%)

Memecoins

Born out of their namesake, memecoins are perhaps the easiest to criticize for lacking a key value proposition.

Top Contenders:
1. Dogecoin (1.17%)
2. Shiba Inu (0.57%)

* Market Share indicates the relative share of the market capitalization of the cryptocurrency universe, including both coins and tokens.

† As we discussed earlier in this deck, the claim that any of these cryptos is a store of value is a dubious one with numerous considerations.

Sources: CoinDesk, CoinGecko, CoinMarketCap.com, Coin.Dance and Invesco as of 12 January 2023. Cryptocurrency count is sourced from CoinMarketCap and CoinGecko.

Cryptos as a "Software Platform"?

At least 28% of crypto market cap is in decentralized software

While throughout this deck we have focused on Bitcoin, other developments in the digital assets space seek goals beyond a digital store of value or payments solution. Here we explore cryptocurrencies who's underlying blockchains act as a platform for software.

The idea appears complex at first but is ultimately simple: Rather than a central server fetching information and executing tasks, we have a decentralized network of computers that carry out those same functions in exchange for a small fee.

This is the same technology that powers a lot of the developments behind buzzwords we hear today, such as decentralized finance ("DeFi"), Web 3.0, and non-fungible tokens (NFTs). We explore briefly how this works on the right.

Exploring "Software Platform" Cryptos

How can a blockchain power software?
The blockchain hosts applications and their data via participating computers. To run your application, you must have the right to utilize computing resources within the protocol.

Where does crypto come in?
The protocol prices computing power in terms of its native token (e.g. for Ethereum, this is Ether) based on the level of demand for computing resources. The price of this computing power is commonly called **gas fees** and are paid to the computers that carry out such computations.

What gives it value?
The market price of a blockchain's native token is based ultimately on demand for it, whether for the token for application execution or speculation.

Examples of Applications Built on Blockchains

- **Decentralized automated exchanges**: Automatically match buyers and sellers.
- **Non-fungible tokens (NFTs)**: Represent ownership of an asset via a bearer-form token.
- **Lending platforms**: Provide credit via crypto.
- **Video games**: Execute in-game events, rules and transactions.

Top "Software Platform" Cryptos by Market Cap

Ethereum **ETH**
Market Cap: $148 billion
First-mover and most popular software crypto.

Solana **SOL**
Market Cap: $4.9 billion
Relatively centralized but ultra-fast and efficient.

Cardano **ADA**
Market Cap: $8.7 billion
Prioritizes speed and interoperability of projects.

Polkadot **DOT**
Market Cap: $5.2 billion
Focuses on interoperability of blockchains.

Sources: Invesco and CoinMarketCap.com. As of 3 January 2023.

A World of Crypto: Digital Assets Infrastructure Takes Many Forms

Tokens can be designed for a wide variety of uses and functions

Non-Fungible Tokens

Non-Fungible Tokens (NFTs) are a highly popular—if perhaps controversial—use of blockchain.

An NFT is a unique identifier representing a particular underlying asset. Hypothetically, owning an NFT denotes ownership of the underlying asset. Therein lies the controversy; without real-world legal protections and property rights, some would suggest you can only own an NFT and not the asset it represents.

Security Tokens

Security Tokens are like a hybrid between NFTs and ordinary cryptocurrencies.

Like an NFT, Security Tokens represent an underlying asset. Like a cryptocurrency, Security Tokens of the same kind may be fungible with one another. For example: stocks could be tokenized, creating a Security Token which represents the underlying asset – the stock – and which is fungible within that set of assets.

Governance Tokens

Governance tokens aid collective decision-making and support 'Decentralized Autonomous Organisations' where token holders can vote on protocol changes A prominent example is MakerDAO, an open-source project on the Ethereum blockchain. MakerDAO users who hold its governance token, MKR, collectively make decisions about how the Maker Protocol operates and how their native currency, Dai, is valued and created.

Utility Tokens

Utility Tokens are used to pay for and/or access services on a specific blockchain.

FileCoin, for example, is used to access the FileCoin peer-to-peer cloud storage network.

Another example is Brave's Basic Attention Token (BAT). BAT pays Brave users for turning off ad-blocking in their browsers, while touting a higher-quality marketing data for advertisers.

Sources: Documentation of FileCoin.io, MakerDao.com/en/whitepaper, and BasicAttentionToken.org. Commentary from Invesco. For illustrative purposes only.

The Many Meanings of Currency

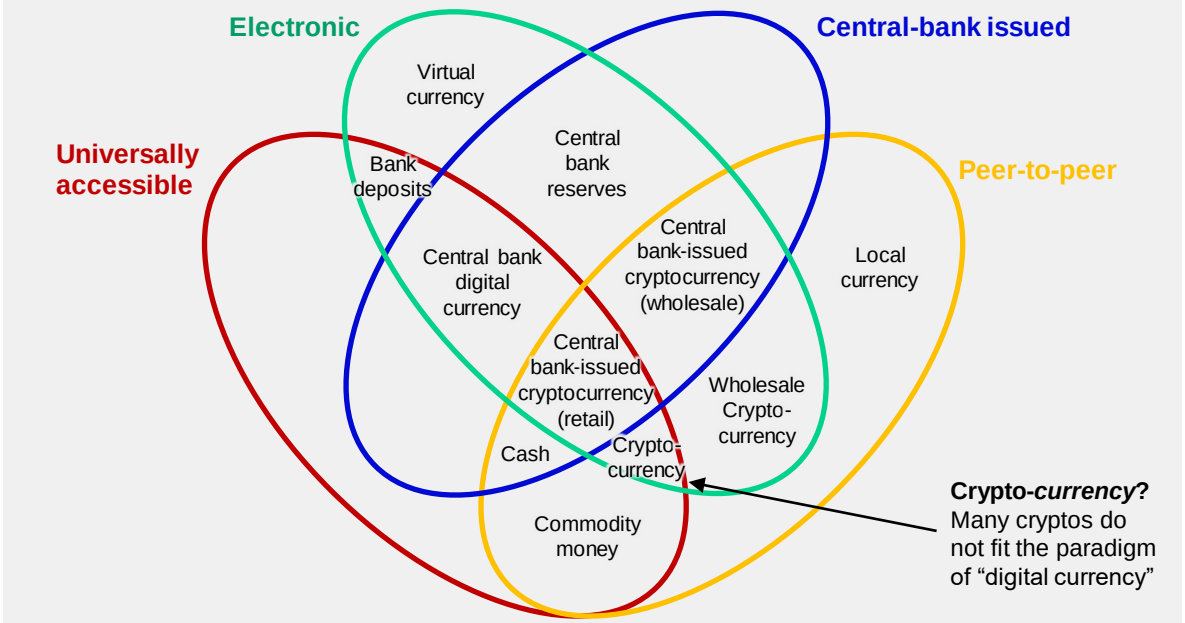
Are cryptocurrencies currency or just another kind of token?

While Bitcoin is ostensibly a "currency," it lacks key features to be valid as a currency in the traditional economic sense, as we explored earlier. But other forms of cryptocurrency may very well play this role, with better transaction throughput and greater supply. There is also talk about central bank digital currencies, which may or may not use blockchain technology.

Ultimately, "crypto*currency*" may be a misnomer as many cryptocurrencies were designed with intentions beyond a currency-like instrument.

Thinking about different cryptocurrencies (Bitcoin, Ethereum, etc.) like different fiat currencies (USD, EUR, GBP, etc.) is misleading. Instead, cryptocurrencies are united by the technology that underlies them, but each is seeking to accomplish a different objective. In this way, it may be helpful to think of each crypto like a software product rather than a currency. Keeping this in mind is helpful in considering other so-called cryptocurrencies.

"The Money Flower" – Categorizing the Kinds of Money



Sources: Bank for International Settlements, Wikipedia. Adapted and reproduced from *Central bank cryptocurrencies* by Morten Linnemann Bech and Rodney Garratt.

Cryptos in a Portfolio Perspective

Back

Is Bitcoin A Diversifier? At First Glance, Maybe…

Crypto assets are often viewed as a portfolio diversifier

Bitcoin is often viewed as “digital gold” with enormous return potential and as a safety from the tribulations of inflation. And for asset allocators, it is often initially viewed as a portfolio diversifier. Indeed, if one reviews the history of bitcoin performance on a monthly basis versus other asset classes, it does appear to offer uncorrelated returns.

That said, as Bitcoin and other cryptocurrencies have grown in popularity, their behavior has transformed into more of a traditional risk-on asset, as we explore in the next slide.

Monthly Asset Return Correlations, Since 2011

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Cash	1.00															
2	DXY	-0.10	1.00														
3	S&P 500	-0.13	-0.40	1.00													
4	Int'l Stocks	-0.06	-0.60	0.87	1.00												
5	EM Stocks	-0.03	-0.63	0.69	0.82	1.00											
6	Global Gov Bonds	0.06	-0.76	0.35	0.46	0.52	1.00										
7	Tsy Bonds (7-10)	0.07	-0.05	-0.11	-0.12	-0.06	0.55	1.00									
8	US IG	-0.01	-0.32	0.47	0.48	0.50	0.70	0.63	1.00								
9	US HY	-0.11	-0.43	0.79	0.81	0.72	0.49	0.04	0.69	1.00							
10	Gold	0.10	-0.47	0.10	0.19	0.33	0.58	0.35	0.36	0.20	1.00						
11	TIPS	-0.06	-0.29	0.34	0.34	0.36	0.67	0.72	0.77	0.51	0.48	1.00					
12	Commodities	-0.09	-0.49	0.47	0.55	0.55	0.28	-0.24	0.15	0.54	0.37	0.22	1.00				
13	Oil	-0.14	-0.31	0.41	0.47	0.37	0.13	-0.29	0.13	0.52	0.08	0.06	0.63	1.00			
14	US REITs	-0.13	-0.28	0.74	0.68	0.56	0.43	0.19	0.62	0.71	0.20	0.55	0.37	0.25	1.00		
15	REITs ex. US	-0.07	-0.58	0.76	0.88	0.80	0.59	0.09	0.63	0.79	0.28	0.52	0.53	0.38	0.79	1.00	
16	Bitcoin	-0.12	-0.07	0.17	0.16	0.07	0.10	0.04	0.13	0.17	-0.01	0.10	0.05	0.00	0.08	0.14	1.00

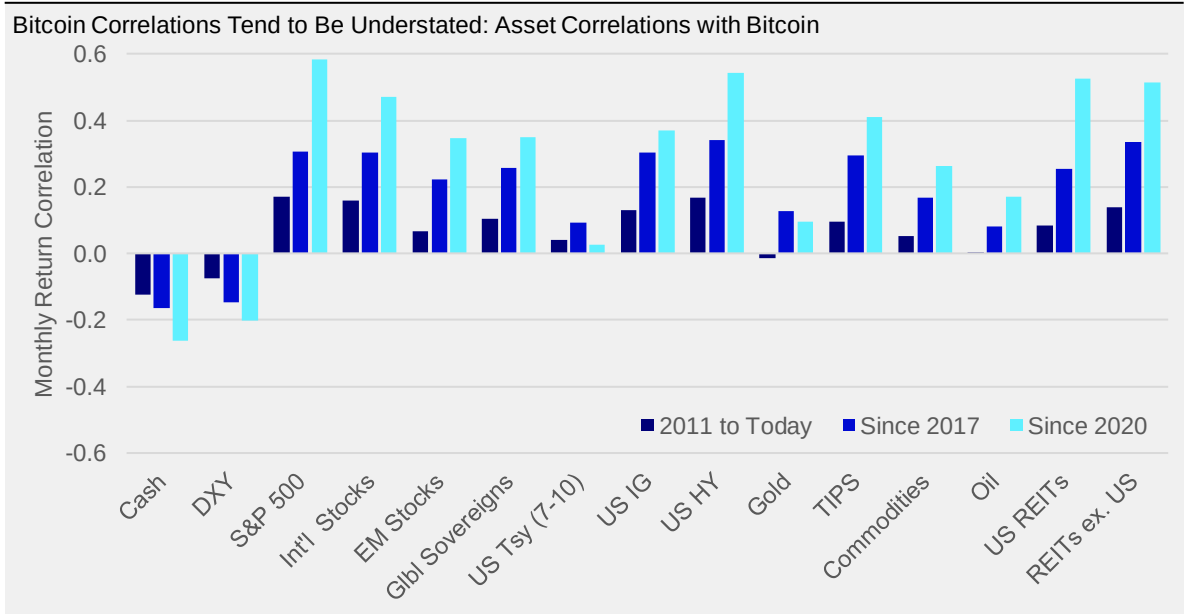
Sources: Bloomberg and Invesco, as of 31 December 2022. See page 42 for index definitions. Past performance does not guarantee future results.

Beware the Correlations of Bitcoin

Drawing correlations since Bitcoin's inception can be misleading

Bitcoin bulls tend to praise the virtues of the asset's uncorrelated returns since its launch in 2009. However, over this timeframe Bitcoin had a market cap less than the net worth of many individuals. For example, in 2011 (when many correlation studies begin for Bitcoin), its market cap was just $1.4 million at the start of the year. In 2013, the market cap started the year at $142 million and reached as high as $11.9 billion, a level not reached again until the end of 2016.

As Bitcoin has grown, it has become more correlated with traditional asset classes. We caution against measuring correlations for Bitcoin and any young crypto. Indeed, with Bitcoin's inception in 2009 – and its market cap only becoming truly significant in 2017 – we have only a few years of data with which to draw conclusions. In the chart on the right, we analyze bitcoin correlations in different slices of time since 2011.



Note: We chose 2011 to start as Bitcoin became transacted more regularly on exchanges. It is possible, however, to go all the way back to the very first transaction on 12 January 2009.
Sources: Bloomberg and Invesco, as of 31 December 2022. Past performance does not guarantee future results.

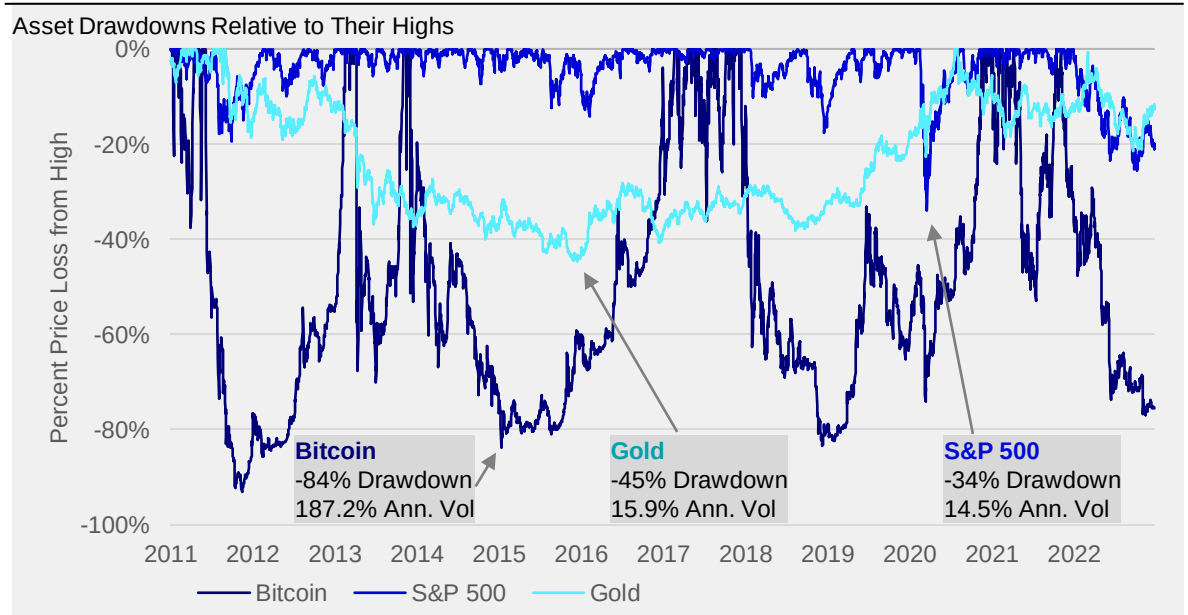
Bitcoin: A Store of Value?

The volatility of bitcoin may understate the severity of drawdowns

Is Bitcoin a viable store of value? To answer this question, we look to price volatility and, in this case, how frequently and at what magnitude it loses value.

First, we ask how often prices change. Since 2011, Bitcoin has spent 95.0% of days trading beneath its highs. This compares favorably to gold over the same period, which spent 98.6% of days trading beneath its highs. But for the S&P 500, this statistic was just 86.7%. In other words, US equities notched new price peaks far more often than Bitcoin or gold.

We also consider how far prices fall when they're not registering new highs. When Bitcoin has traded beneath its highs, it was trading on average -51.2% below its highs. For gold, the same measure was -23.5%. For the S&P 500, this was just -4.7%. In other words, when Bitcoin prices fall, they tend to fall hard, making equities – an asset class known to be volatile – appear far less risky in comparison.



Note: We chose 2011 to start as Bitcoin became transacted more regularly on exchanges. It is possible, however, to go all the way back to the very first transaction on 12 January 2009. Annualized volatility is based on monthly returns.

Sources: Bloomberg and Invesco, as of 31 December 2022. Past performance does not guarantee future results.

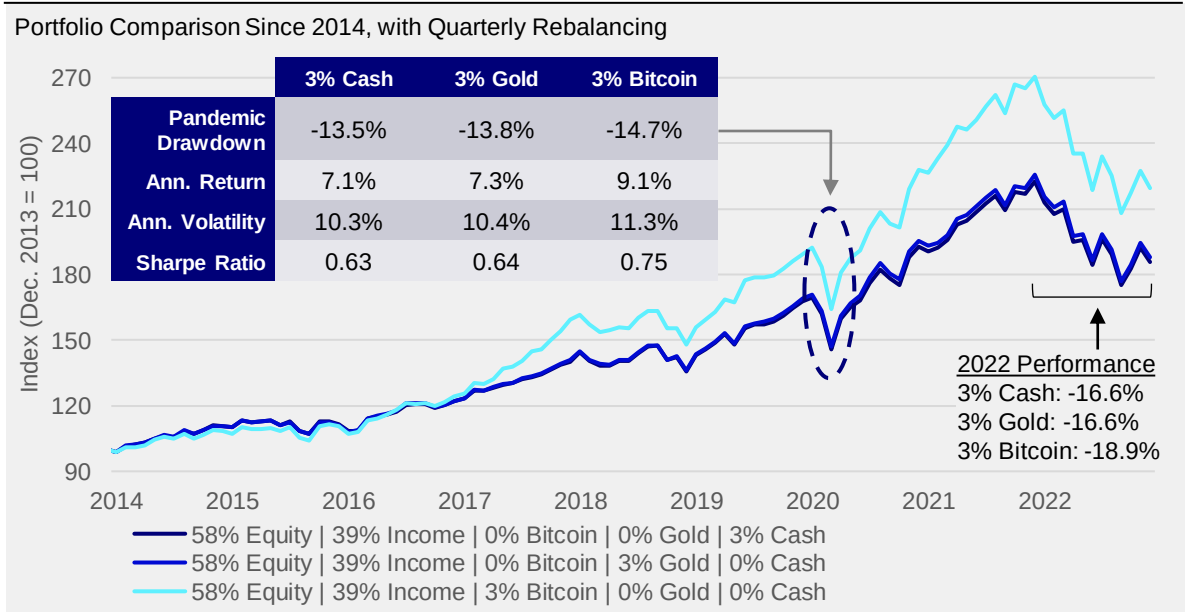
The Bitcoin Portfolio Perspective: Rebalancing Is Essential

Bitcoin introduces volatility, but regular profit-taking can lock-in gains

In reviewing Bitcoin's performance in a portfolio context, we compared a hypothetical portfolio of US Treasury bills (3% of a total investment), a diversified portfolio of US bonds (39%), and US stocks (58%) against a portfolio of the same composition but with the Treasury bills swapped out for a 3% allocation to bitcoin.

We found that this allocation to bitcoin contributed a percentage point of annualized risk relative to the baseline portfolio. We find that this is extra risk is compensated with an additional 2.0 percentage points of annualized return. However, we do caution that, given the volatility of bitcoin prices, this metric can quickly be reversed – as has al been happening since the November 2021 peak in crypto prices.

Therefore, we view regular profit-taking as essential for capitalizing run-ups in bitcoin prices. Indeed, our example on the right uses quarterly rebalancing.



"Equity" is represented by the S&P 500 Index. "Income" is represented by the Bloomberg Barclays Aggregate Bond Index. "Cash" is represented by the Bloomberg Barclays 1-3 Month US Treasury Bill Index. Returns displayed are total returns with quarterly rebalancing. No transaction fees are considered. For illustrative purposes only. Sources: Bloomberg and Invesco, as of 31 December 2022. An investment cannot be made directly into an index. Past performance does not guarantee future results.

Bitcoin – What the Bulls Think

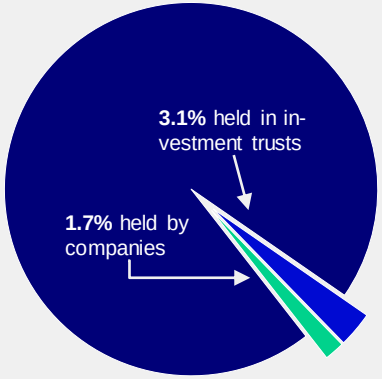
Decentralized finance triumphs, with Bitcoin as the digital store of value

Our bull case for Bitcoin supposes increasing adoption of the cryptocurrency. With Bitcoin's limited supply, it is straightforward to draw sky-high price targets after assuming a level of demand.

As a 2021 report from JP Morgan points out, if the private investment exposure to bitcoin were equal to that of gold, the price per bitcoin would reach almost $140,000. Meanwhile, in ARK Investment Management's 2021 Big Ideas report, they showed that bitcoin's price can increase dramatically if S&P 500 companies allocated their cash to the asset. As they had shown, 1% of cash would grow the price by $40,000 per bitcoin, and 10% would bring the price up to nearly $460,000.

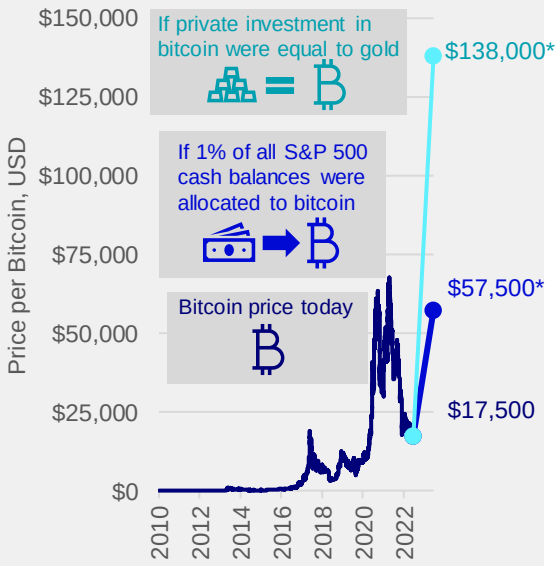
These lofty figures can be tempting for even the most disciplined investor, and word of these targets appears to contribute to price upswings. With all the attention on cryptocurrencies in recent years, the excitement about its future adoption almost seems palatable.

Distribution of Bitcoin Ownership



Private companies, investors, and even governments are increasingly exposed to Bitcoin, with an estimated **1.6 million BTC** held by institutional investors—equivalent to **$34 billion USD**.

Bitcoin Price Projections, Selected Studies



*Prices shown are simple projections only.

Sources: Bloomberg, JP Morgan, ARK Investment Management Big Ideas 2021 and 2022, CoinGecko, BitcoinTreasuries.org, and public filings. Bitcoin price is calculated as $20,000 USD. As of 31 December 2022. For illustrative purposes only. Past performance does not guarantee future results.

Bitcoin – What the Bears Think

Regulations loom, and the long-term outlook is uncertain

No discussion of cryptocurrency is complete without reviewing the regulatory outlook. “[Bitcoin] is not a stable store of value and it doesn't constitute legal tender," said Janet Yellen in the US. The UK’s Financial Conduct Authority previously warned investors “should be prepared to lose all their money”. In the EU, the European Securities and Markets Authority noted some cryptos are “highly risky and speculative.” China has effectively banned cryptocurrencies. Clearly regulators are taking a hard look at crypto assets, especially in light of recent crypto market ructions.

In addition, there are other reasons to be hesitant on cryptocurrencies, including but not limited to:

- Rising correlations with traditional assets.
- The long-term outlook is uncertain and rapidly evolving. Each coin is not special and can be replaced by a better-executed version.
- Bitcoin is massively energy intensive. How will ESG focuses and tight energy supplies affect it?

The Regulatory Landscape Is Shifting, Especially as Interest Grows

United States ✓

- Mining revenues are taxed as income; capital gains also taxed when cryptos sold/ exchanged
- Exchanges are permitted
- AML reporting applies to high value transactions & mining
- Minimal restrictions on mining

Eurozone ?

- Member states have varying rules & treatments for cryptos
- EU law requires AML & counter-terrorist financing reporting for crypto transactions across member states
- Bitcoin exempt from VAT

Global Outlook

- **14** have banned or restricted crypto-currencies.
- **29** have not addressed cryptocurrencies.
- **132** currently permit cryptocurrencies with specific guidance for their treatment.

United Kingdom ✓

- Mining revenues are taxed as income; capital gains also taxed when cryptos sold/ exchanged
- Derivatives and exchange-traded notes (ETNs) are banned for retail investors
- No restrictions on mining

China ✗

- Trading on exchanges banned
- ICOs are banned
- Mining is banned, with enforcement increasing

Sources: United States Internal Revenue Service, United Kingdom Financial Conduct Authority and Her Majesty’s Revenue and Customs, European Parliamentary Research Service, and various government agencies. The above is for illustrative purposes only and does not constitute legal or tax advice and is by no means a full summary of the existing regulatory structure. The cryptocurrency regulatory environment is subject to rapid change. Please see the glossary in the Appendix for definitions of terms. Data as of 31 December 2022.

Accessing Exposure to Digital Assets

Degree of exposure varies with different entry points

Exposure to cryptocurrencies and the ecosystem being developed around them may be an attractive opportunity. The range of exposure methods—from direct ownership of particular cryptocurrencies to broader market approaches—involves varying considerations and trade-offs.

Physical ownership typically provides the most direct exposure to movements in crypto prices at the expense of greater concentration and volatility. Fears of theft, proper custodianship, and liquidity tend to dominate physical ownership considerations.

Derivative products traded on financial markets whose underlying are based on cryptocurrencies tend to fall under existing regulatory frameworks, yet their return structure (see roll yield) adds a layer of complexity to accessing crypto market exposure.

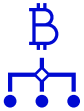
Finally, the broadest exposure approach is in accessing cash flows resulting from the crypto ecosystem. This is a vast area but one that is perhaps more diversified and accountable. The so-called “picks and shovels” approach falls under this bucket as well.

Overview of Exposure to Digital Assets

Broad Exposure ← → **Targeted Exposure**

Ecosystem Exposure

Access to growth of the overall digital assets ecosystem (e.g., Blockchain technology, cryptocurrency) by investing in companies that engage in mining, enabling technology, and exchanges, among others



Derivative Ownership

Access to cryptocurrencies via derivative instruments (e.g., exchange-traded futures, OTC swaps)

Physical Ownership

Direct ownership of crypto-currencies, typically through a major crypto exchange; today, access is typically not available at major intermediaries

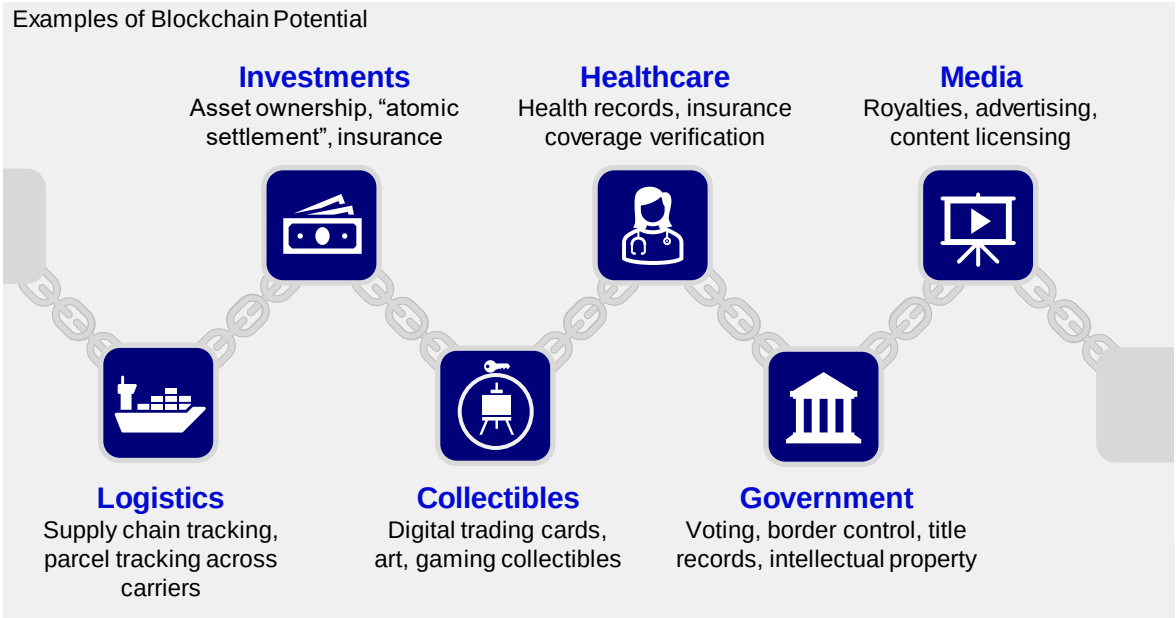
Source: Invesco. For illustrative purposes only. The risk and return considerations here capture only a selection of factors and do not constitute investment advice.

Food for Thought: Blockchain May Be a Longer Play

Distributed ledgers are the basis of more than just digital currencies

If we take a step back from cryptocurrencies for a moment, we can appreciate blockchain for what it is: a decentralized authority of data, capable of exchanging and passing along data in a secure fashion and only with the permission of the data's owner (as identified by a private key). If we also include smart contracts in this picture, we can see a variety of applications of this database technology which could be disruptive. We view this as an exciting space, as we briefly explore on the right.

While blockchain technology suffers some limitations as we have discussed, there are nevertheless a growing number of businesses that are building products using distributed ledger technology. If you are skeptical of the ups-and-downs of cryptocurrencies, it is still worthwhile to consider the applications of blockchain technology and the ways in which it may disrupt industries and current methods of doing business.



Source: Invesco. For illustrative purposes only.

Appendix

Common Terms Used in the Cryptocurrency World

Cryptocurrency	A non-traditional, digital medium of exchange that uses cryptography to validate and secure transactions, typically through a blockchain. Importantly, some cryptocurrencies vary on this definition.
Bitcoin	The first and most popular cryptocurrency that is a reward for participating in the Bitcoin blockchain network.
Altcoin	Any cryptocurrency other than Bitcoin.
Token	A token is a crypto asset whose underlying value is based on another asset (e.g. gold or a title). This is different from a coin in that a coin's value is not directly related to the value of an underlying asset. Unfortunately, "token" and "coin" are often used interchangeably, perhaps improperly.
Stablecoin	A stablecoin is a cryptocurrency in which its market value is intended to be pegged to another asset, such as US dollars.
Blockchain	A digital ledger maintained by computers worldwide in a decentralized manner, where each "block" is a packet of data.
Mining	Users can participate in a blockchain network by verifying transactions and, in exchange, are rewarded with a particular cryptocurrency in a specified amount.
Wallet	Wallets are where Bitcoin and other cryptocurrencies are, in essence, held for use. Note that *wallets* facilitate holding cryptocurrencies, whereas an *address* is specific to each blockchain and is used in transactions, serving as an identity.
Exchanges	Where cryptocurrencies can be transacted with other people or currencies for a fee. • Decentralized Exchange – Users are matched with buyers/sellers algorithmically. Such exchanges tend to be less liquid compared to centralized exchanges but are generally more secure and involve lower fees. • Centralized Exchange – Users create an account with an exchange which typically holds their cryptoassets. These are considered more liquid and regulated, but less secure as the exchange acts as your custodian and can be hacked.

Source: Invesco.

Common Terms Used in the Cryptocurrency World (continued)

1 "Satoshi"	A unit of measurement equal to one hundred millionth of a single bitcoin (0.00000001 BTC), often abbreviated as SATS.
Initial Coin Offering	An Initial Coin Offering (or ICO) is like an IPO but with digital coins. At the time that they became popular, they required no formal filings but served a similar purpose to equity securities. Today, they are almost non-existent.
Hash	The hash rate is the measuring unit of the processing power of a blockchain network operating with a Proof-of-Work consensus mechanism. It is essentially the number of guesses made per second in attempting to solve a cryptographic puzzle that is part of the mining process in Proof-of-Work cryptocurrencies.
Proof-of-Work (PoW)	A consensus mechanism that powers blockchains without a central party. Miners solve increasingly complex cryptographic problems and are rewarded with an amount of cryptocurrency for finding the correct solution. This process acts as a verification of the blockchain's integrity. To compensate for the costs involved in this computation, miners sell their earned cryptocurrency. The PoW model is notorious for being massively energy intensive and is most often associated with Bitcoin.
Proof-of-Stake (PoS)	An alternative to PoW, PoS requires that participating miners hold an amount of the cryptocurrency—their "stake"—in order to qualify for the ability to verify blockchain transactions. PoS is significantly less energy intensive than PoW.
Consensus mechanism	A consensus mechanism is required for every implementation of distributed ledger technology. It is the process by which state changes of the ledger are verified and validated by involved parties.

Source: Invesco.

Common Terms Used in the Cryptocurrency World

Web 1.0	The first iteration of the Internet. In this era, web applications were simply read-only displays of information, such as a business webpage. Generally, users could not interact with such websites beyond searching for and reading information.
Web 2.0	The second generation of web experiences, commonly referred to as Web 2, was a revolution in the way in which users could interact with a website and web servers. In this case, users could participate and generate content, such as is the case with social media platforms, blogs, wiki pages, and more. It is commonly criticized for the centralization of data structures, where companies with large repositories of data could benefit by keeping such data for its own use and sale.
Web 3.0	Definitions of Web 3 are often nebulous and variable. However, the commonality across definitions and uses of the phrase is an idea of disintermediation of data structures, where decentralization is key. Cryptocurrencies are one expression of this, where no central party or actor governs the use and distribution of data.
Decentralized Finance (DeFi)	As with Web 3, definitions may vary. The general idea of DeFi is to change financial markets and products operated by transparent crypto-based protocols rather than by financial institutions.

Source: Invesco.

Index Definitions

Cash is represented by the Bloomberg Barclays 1-3 Month U.S. T Bill Index, which is designed to track the market for US Treasury bills with 1 to 3 months to maturity.
DXY is an index designed to capture the general international value of the US dollar by averaging exchange rates between the USD and major world currencies.
The S&P 500 Index is a market capitalization weighted index of the 500 largest domestic U.S. stocks.
Int'l (International) Stocks is represented by the MSCI World exluding US Index, which is designed to measure large and mid market capitalization stocks in developed markets, excluding the United States.
EM (Emerging Market) Stocks is represented by the MSCI Emerging Markets Index, which is designed to measure large and mid market capitalization stocks in emerging markets.
Global Gov Bonds is represented by the FTSE World Government Bond Index (ex-USD) index, which is designed to measure the performance of international developed bonds excluding US dollar denominated bonds.
Tsy (Treasury) Bonds (7-10) is represented by the Bloomberg Barclays US Treasury: 7-10 Year Index, which is designed to measure the US dollar-denominated, fixed-rate, nominal debt issued by the US Treasury with 7-10 years to maturity.
US IG (Investment Grade) is represented by the Bloomberg Barclays US Aggregate Bond Index, which is designed to measure the performance of investment grade bonds in the United States.
US HY (High Yield) is represented by the Bloomberg Barclays US High Yield Bond Index, which is designed to measure the performance of US corporate high yield bonds.
Gold is measured by the gold spot price quoted as US Dollars per Troy Ounce.
TIPS is represented by the Bloomberg Barclays US Treasury Inflation Notes Index, which is designed to measure the performance of the US Treasury Inflation Protected Securities (TIPS) market, excluding Federal Reserve holdings.
Commodities are represented by the Bloomberg Commodity Index, which uses futures contracts to reflect the returns on a basket of diversified commodities investments.
Oil is represented by the West Texas Intermediate spot price in US dollar terms.
US REITs (Real Estate Investment Trusts) are represented by the FTSE NAREIT All Equity REITS Total Return Index, which seeks to measure all tax qualified REITs listed in the NYSE, AMEX, and NASDAQ National Market.
REITs ex. US are measured by the FTSE EPRA/NAREIT Developed ex US Index, which is a market capitalization weighted index designed to measure the performance of real estate investment trusts in developed markets, excluding the United States.

Indices are unmanaged and cannot be purchased directly by investors. Index performance is shown for illustrative purposes only and does not predict or depict the performance of any investment. **Past performance does not guarantee future results.**

Important Information

This document is intended only for investors in Hong Kong, for Institutional Investors and/or Accredited Investors in Singapore, for certain specific sovereign wealth funds and/or Qualified Domestic Institutional Investors approved by local regulators only in the People's Republic of China, for certain specific Qualified Institutions and/or Sophisticated Investors only in Taiwan, for Qualified Professional Investors in Korea, for certain specific institutional investors in Brunei, for Qualified Institutional Investors and/or certain specific institutional investors in Thailand, for certain specific institutional investors in Malaysia upon request, for certain specific institutional investors in Indonesia and for qualified buyers in Philippines for informational purposes only. This document is not an offering of a financial product and should not be distributed to retail clients who are resident in jurisdiction where its distribution is not authorized or is unlawful. Circulation, disclosure, or dissemination of all or any part of this document to any unauthorized person is prohibited.

This document may contain statements that are not purely historical in nature but are "forward-looking statements," which are based on certain assumptions of future events. Forward-looking statements are based on information available on the date hereof, and Invesco does not assume any duty to update any forward-looking statement. Actual events may differ from those assumed. There can be no assurance that forward-looking statements, including any projected returns, will materialize or that actual market conditions and/or performance results will not be materially different or worse than those presented.

All material presented is compiled from sources believed to be reliable and current, but accuracy cannot be guaranteed. Investment involves risk. Please review all financial material carefully before investing. The opinions expressed are based on current market conditions and are subject to change without notice. These opinions may differ from those of other Invesco investment professionals.

The distribution and offering of this document in certain jurisdictions may be restricted by law. Persons into whose possession this marketing material may come are required to inform themselves about and to comply with any relevant restrictions. This does not constitute an offer or solicitation by anyone in any jurisdiction in which such an offer is not authorised or to any person to whom it is unlawful to make such an offer or solicitation.

This document is issued in the following countries:

- in Hong Kong by Invesco Hong Kong Limited景順投資管理有限公司, 45/F, Jardine House, 1 Connaught Place, Central, Hong Kong. This document has not been reviewed by the Securities and Futures Commission.
- in Singapore by Invesco Asset Management Singapore Ltd, 9 Raffles Place, #18-01 Republic Plaza, Singapore 048619.
- in Taiwan by Invesco Taiwan Limited, 22F, No.1, Songzhi Road, Taipei 11047, Taiwan (0800-045-066). Invesco Taiwan Limited is operated and managed independently.