Morgan Stanley

Client Conversations & Primers

Introduction to Cryptocurrencies

Important Information

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This material has been prepared for informational purposes only, based on publicly available factual information. It does not provide individually tailored or general investment advice whatsoever. It has been prepared without regard to the individual financial circumstances and objectives of persons who receive it. Investors seeking to evaluate particular investments and strategies in Digital Assets must seek the advice of their independent advisors. The appropriateness of a particular investment or strategy will depend on an investor's individual circumstances and objectives.

Buying, selling and using Digital Assets is highly speculative and may result in substantial losses in a short period of time. Risks include:

- Digital Assets are not legal tender. No law requires companies or individuals to accept the currency as a form of payment. Instead, Digital Assets use is limited to businesses and individuals that are willing to accept them. If no one were to accept digital currencies, Digital Assets would very likely become worthless.
- The exchange rate of Digital Assets versus the USD historically has been very volatile and the exchange rate could drastically decline. For example, the exchange rate of Bitcoin versus the USD has dropped more than 50% in a single day. Bitcoins may be affected by such volatility as well.
- 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. As a result, consumers can—and have—lost some or all of their holdings of digital currency.
- Digital Assets transactions can be subject to fraud and theft. For example, a fraudster could pose as a Digital Assets exchange, Digital Assets intermediary or trader in an effort to lure you to send it digital currency, which is then stolen.
- Unlike US banks and credit unions that provide certain guarantees of safety to depositors, there are no such safeguards provided to digital wallets by their providers or regulators.
- Payments in Digital Assets are irreversible. Once you complete a transaction, it cannot be reversed. Purchases can be refunded, but that depends solely on the willingness of the vendor-recipient to do so.
- In part because of the anonymity Digital Assets offer, it has been used in illegal activity, including drug dealing, money laundering 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 Assets.
- As a recent invention, Digital Assets do not have an established track record of credibility and trust. Digital Assets are evolving.

Futures contracts are volatile, leveraged and involve inherent risks. Futures transactions are not appropriate for every investor and clients should refrain from investing (or hedging) in futures unless they are knowledgeable, experienced and fully understand the terms and risks, including but not limited to:

1. Liquidity risks – even if a cash market position is properly hedged, the client might have to post additional "variation" payment for losses incurred on the futures contracts;
2. Basis risk- the futures positions might not effectively track the underlying cash commodity resulting in a hedged position that doesn't perform as expected;
3. Options – clients should be fully aware of the standardized terms, special vocabulary (delta, vega etc.) and the potential high risk characteristics of option transactions;
4. Potential of loss – because of the effect of leverage, a relatively small market movement will have a proportionately large impact on the funds you have deposited. This loss can be equal to, or some instances greater than the full amount of your initial investment.

Additional information regarding the potential risks associated with Digital Assets is available in FINRA and SEC Investor Alerts, links to which appears below:
http://www.finra.org/newsroom/2014/finra-issues-new-investor-alert-bitcoin-more-bit-risky
https://www.investor.gov/additional-resources/news-alerts/alerts-bulletins/investor-alert-bitcoin-other-virtual-currencyKA

Source: Morgan Stanley Wealth Management Global Investment Office

Introduction to Cryptocurrencies

As of February 28, 2022

- This client conversation and primer provides **background** on the history of the **Cryptocurrency market**, the emergence of regulatory clarity and institutional acceptance, and includes various frameworks to consider valuation and how cryptocurrency fits into an institutional portfolio. Cryptocurrency's unique characteristics are gaining new adherents in this unusual macro environment, providing a case for **portfolio enhancement** and **diversification** through currency debasement, rising institutional adoption, and reduced correlation.

- Cryptocurrencies are digital assets that use **Blockchain technology** to make secure payments without the need for a central clearinghouse. Cryptocurrency is created through mining, which involves using computer power to solve complicated math problems to create coins. Bitcoin demonstrated how a **decentralized payment** system could replace a centralized payment system, through **enabling digital scarcity**, **trustless**, **permissionless** source. Cryptocurrencies, as a whole, have matured as their own asset class, evolving into a **newfound digital realm** of modern-day financial services.

- Bitcoin was the first cryptocurrency, designed in 2008 by an anonymous person or group named Satoshi Nakamoto, and launched on January 3, 2009. Since 2013, there has been increasing regulatory clarity. Financial products started trading in 2015 with derivatives following shortly behind in 2017. At the turn of 2020, several mainstream financial institutions began to integrate Bitcoin, and in 2021, Morgan Stanley was the first bank to allow investments in crypto for their high-net-worth clients.

- This client conversation proceeds with outlining a valuation framework for Bitcoin, looking at the relative value of gold versus Bitcoin, emerging markets currency versus Bitcoin, Bitcoin operating metrics, the replacement value approach, and cycle positioning.

- The rate of growth in Bitcoin supply or "**Bitcoin's issuance**" is **cut in half every four years** in an event called "the halving," or sometimes "the halvening." This **reduction in supply growth** was written into the software from the very beginning. Although there are only three data points since the first halving, it is starting to seem like the halving causes the Bitcoin cycle of a **price spike** followed by a collapse.

- The three unique risks related to Bitcoin are encryption breaks, flaw in the code, and government attacks, with the traditional risks being heightened volatility and concentration risk. Concerns about Bitcoin mining's carbon footprint could lead to it being controlled or regulated, with Bitcoin receiving criticism on the potential lack of energy conservation from an **Environmental, Social, and Governance** (**ESG**) perspective.

- At the turn of the decade, Bitcoin has rallied with **interest sparking** among the entire crypto cohort, including (but not limited to) Ethereum, Binance Coin, and Tether, which, coupled with Bitcoin, account for **~69% of the market cap for all cryptocurrencies**.

Source: Morgan Stanley Wealth Management Global Investment Office, CFA Institute Research Foundation, "Cryptoassets: The Guide to Bitcoin, Blockchain, and Cryptocurrency for Investment Professionals" Jan 2021; Coindesk, Blockchain.info

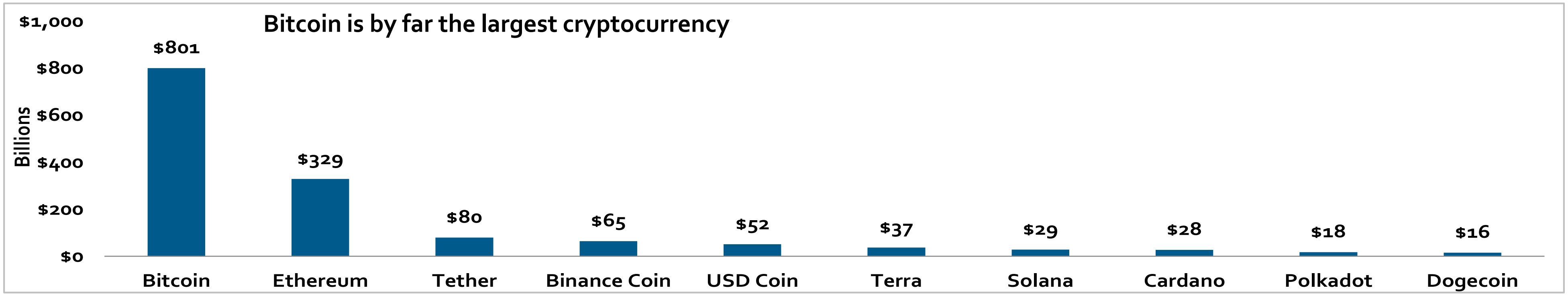
What Is Cryptocurrency?

- **Cryptocurrencies are virtual currencies with no physical form** that operate on a peer-to-peer basis without a central authority, such as the Federal Reserve. They are digital in that unlike the US dollar, they have no physical form and do not have a central repository.
- **The decentralized nature of cryptocurrencies requires computers to use cryptography**, computerized encoding and decoding of information, to verify transactions and attempt to prevent counterfeiting.
- Unlike traditional currencies, which use a trusted third party such as a credit card company or bank to verify that the funds are available to complete a transaction, **cryptocurrencies rely on a network of computers to confirm the transaction and that the spender has the coins to transfer**. 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.
- **Decentralized Savings Account**: Bitcoin is used to save, send, and receive digital currency, bitcoin.
- **Although there are 10,000 alternatives including nine over $14, only 2 are important, Bitcoin and Ethereum**. Cryptocurrencies have been in 3 categories. Some could be classified more as currencies; some more as equities; and others somewhere in between. Bitcoin is a cryptocurrency and Ethereum is a large smart contract platform.

There are more than 10,000 Cryptocurrencies but they can be grouped into three broad buckets: 1) Decentralized Savings accounts like Bitcoin; 2) Decentralized App Stores (or "Smart Contract Platforms") like Ethereum; and 3) coins associated with individual apps. Due to network effects, the largest cryptocurrency in each category is more important than the challengers. BTC is the largest cryptocurrency with roughly 40% of the total market value and Ethereum is the largest smart contract platform with 20% of the total market value. The largest apps are stable coins, Cryptocurrencies pegged to other assets such as the US dollar. After stable coins, the largest apps have market caps in the tens of billions versus BTC and ETH market caps in the hundreds of billions.

Top 10 Cryptocurrencies by Market Capitalization or Total Network Value

As of March 9, 2022



Source: Coinmarketcap.com, Morgan Stanley Wealth Management Global Investment Office. Note: This is not a recommendation or endorsement of Bitcoin or any other cryptocurrency.

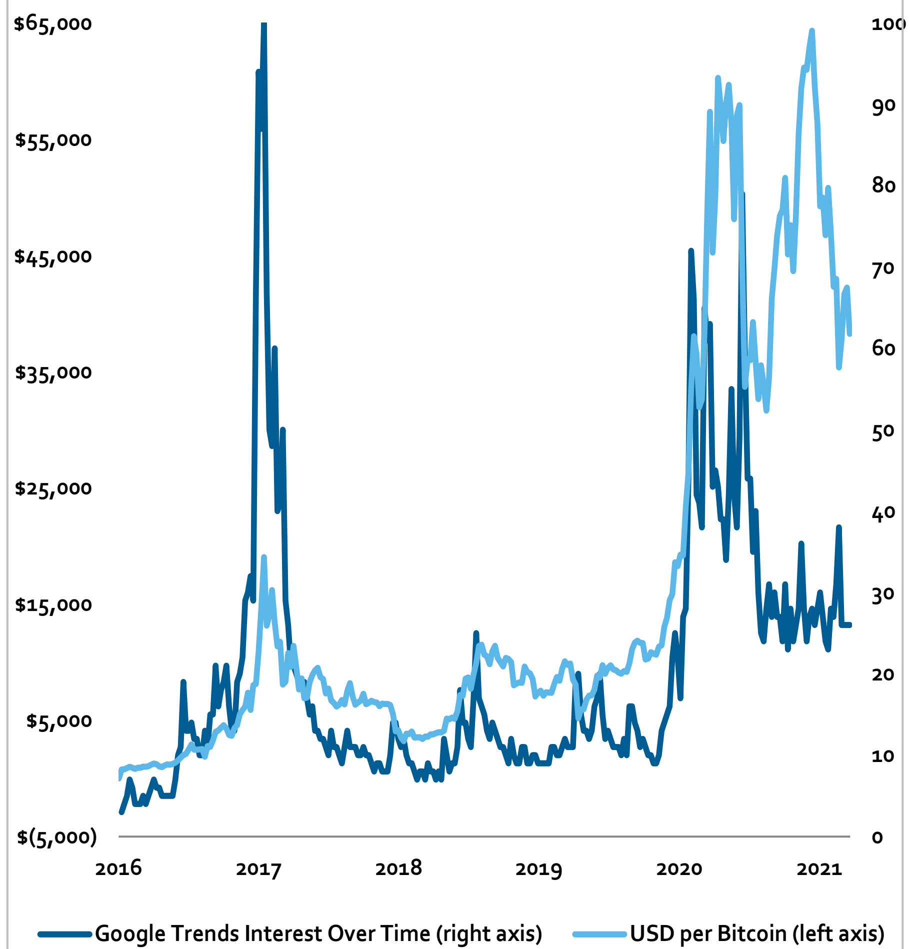
What Is Bitcoin?

Bitcoin Overview

- **Bitcoin is a digital cryptocurrency** that allows users to make peer-to-peer transactions without the use of a trusted third party by using algorithms to verify transactions.
- Bitcoin was invented in 2009 by Satoshi Nakamoto, an anonymous person or organization.
- There is a **fixed amount of 21 million bitcoins** that can be created. Close to 19 million have been mined so far.
- The design is public; **no one person/group owns or controls Bitcoin**, and anyone can participate.
- It is decentralized, meaning there is no one server, organization, or computer that "runs Bitcoin." Rather, different stakeholders control different aspects of Bitcoin.
- The **Bitcoin network** includes two main components:
    - The actual currency, bitcoin
    - Technology behind the transaction verification, the blockchain

Bitcoin Price Spiked in 2017, Surged Again in 2019

Weekly data as of February 27, 2022



Source: Bloomberg, Google Search Trends, Morgan Stanley Wealth Management Global Investment Office, buybitcoinworldwide.com Note: Per Google Trends: Numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. Likewise a score of 0 means the term was less than 1% as popular as the peak.

How Is Bitcoin Innovative?

- **Enabled Digital Scarcity –** This is the first way people can do 'digital scarcity' in a decentralized way. There is a limited supply of cryptocurrency. Before crypto, text, music and movie files could all be copied. There was no way to know who had the original copy of anything and no easy way to create scarcity.
  - Bitcoin & other 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.
- **Trustless –** Investors do not have to trust any entity at any step in the transaction.
- **Permission-less** – Anyone can access the network as a miner or user with minimal computing and connectivity requirements.

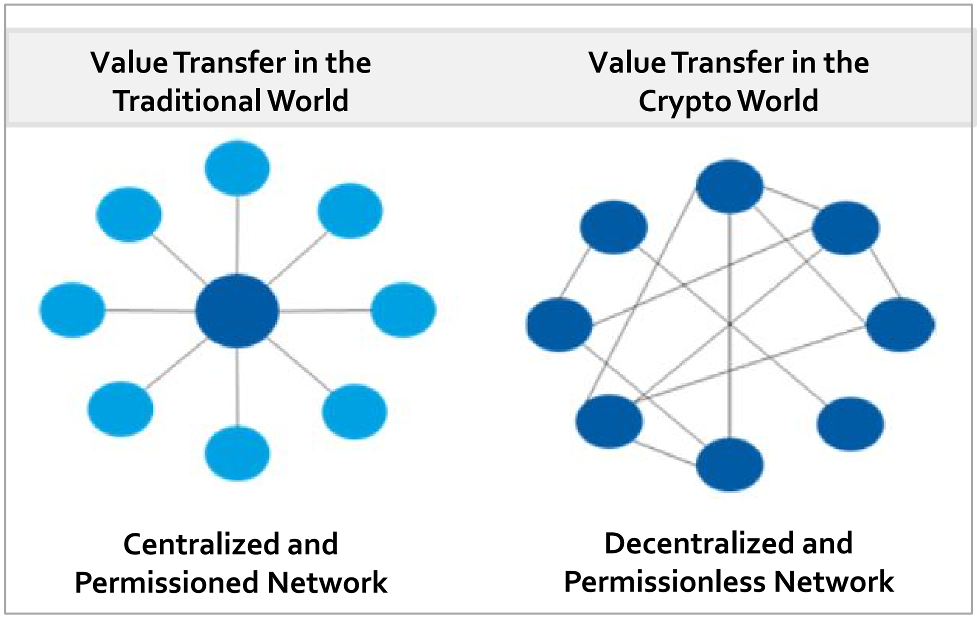
❖ **Enable New Incentive Structures:** cryptocurrencies are the "award metric" or economic incentive for work done to process and validate transactions on a distributed ledger network (or blockchain).

❖ **Leveraged for Myriad Applications:** Finally, because cryptocurrency is coded, it enables property rights information and value to be embedded on the same token, features that facilitate optimized peer-to-peer transactions.

Despite such challenges, crypto's unique attributes are unassailable and its value proposition must be acknowledged. Given these provocative and innovative properties and myriad potential applications, investor interest is understandable.

How Value Transfer Works in Traditional and Crypto Worlds

For Illustrative Purposes Only



Source: Bloomberg, Morgan Stanley Wealth Management Global Investment Office. **Fueled in part by its anonymity and disparate regulatory regimes, the financial crime-associated risks of cryptocurrencies are significant. Digital assets may have an illicit history or come from the proceeds of illegal activity. There is increasing evidence of countries using cryptocurrency to evade or violate economic sanctions laws. These abuses, and related enforcement actions, could impact the stability or legitimacy of digital assets.

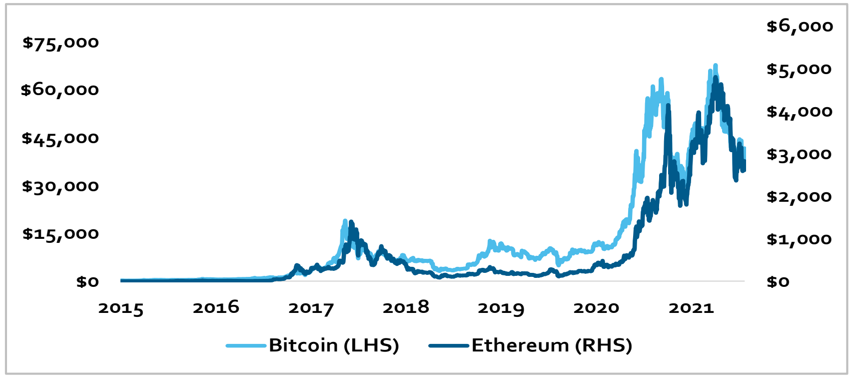
What Is Ethereum?

Ethereum Overview

- **The 2nd largest cryptocurrency is Ether**, the native currency of the Ethereum blockchain. The market cap of Ethereum accounts for 19% of total cryptocurrency market cap and it is the leading "smart contract platform."
- **Ethereum was invented in 2013 by Vitalik Buterin** and a team of developers to enable more complicated computer programs ("smart contracts") to be built on blockchain, the technology behind Bitcoin.
- **Ethereum allowed programmers to create complex programs called DAPPs (decentralized applications)** that would run on a decentralized, permissionless, censorship resistant "Ap Store" platform.
- **Ethereum launched in 2015** after raising money in an Initial Coin Offering (ICO) in 2014.
- **Ether the cryptocurrency, is used to pay transactions fees** on the Ethereum network. There have 119.2M Ether issued thus far.
- Some transaction fees are paid to the miner who validates the blockchain in a process similar to bitcoin and some transaction fees are "burnt" reducing the total amount of ether outstanding.

Ethereum Price Spiked in 2017, Surged Again in 2020

As of February 28, 2022



What are Smart Contracts used for?

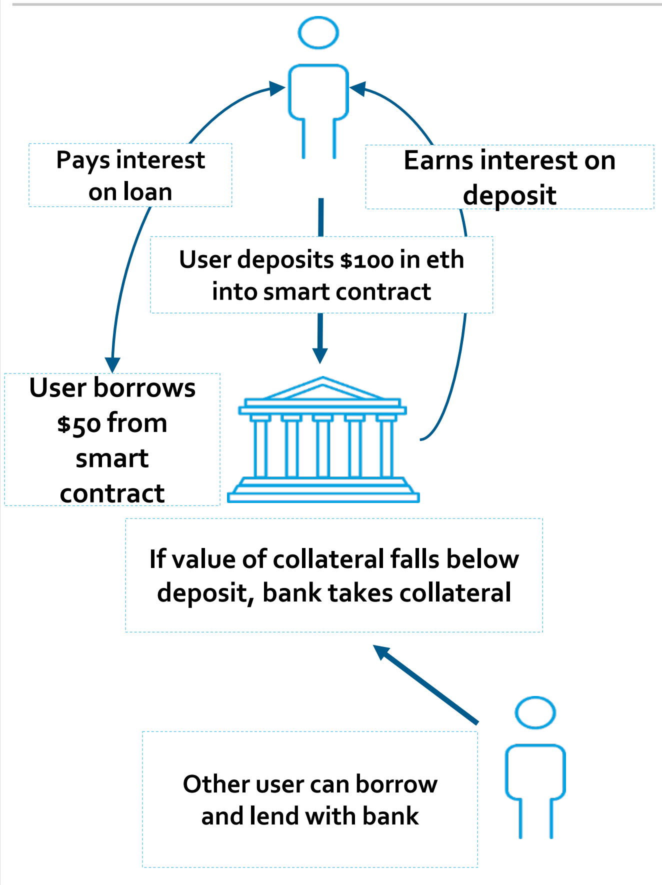
1. **Decentralized Finance (Defi) –** these smart contracts provide financial services such as exchanging, lending, and borrowing cryptocurrency. This is roughly 97% of volumes, but leading platforms have 400K users
2. **Art and Collectibles "NFTs" –** Collectors buy and sell collectibles and digital art. This is roughly 2% of volume but leading platforms have 160K users
3. **Games –** Blockchain based games - Roughly 1% of volume and leading platforms have 315K users

Source: Coindesk.com, Morgan Stanley Wealth Management Global Investment Office

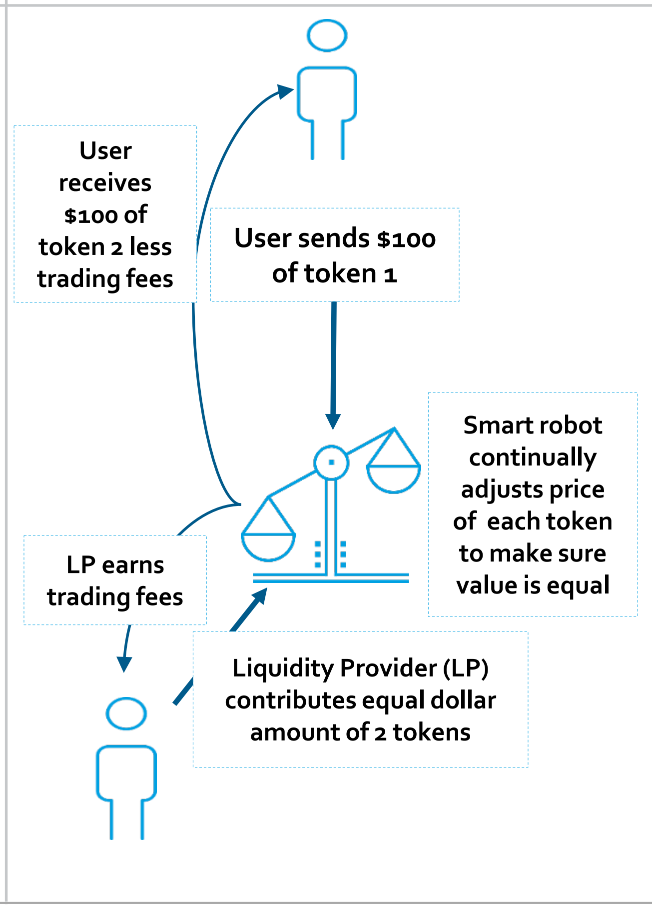
What Is DeFi ?

Decentralized finance (DeFi) is the decentralization of traditional elements of financial systems in order to facilitate or create new forms of fundraising, banks, exchanges, payments, insurance and derivatives on the blockchain.

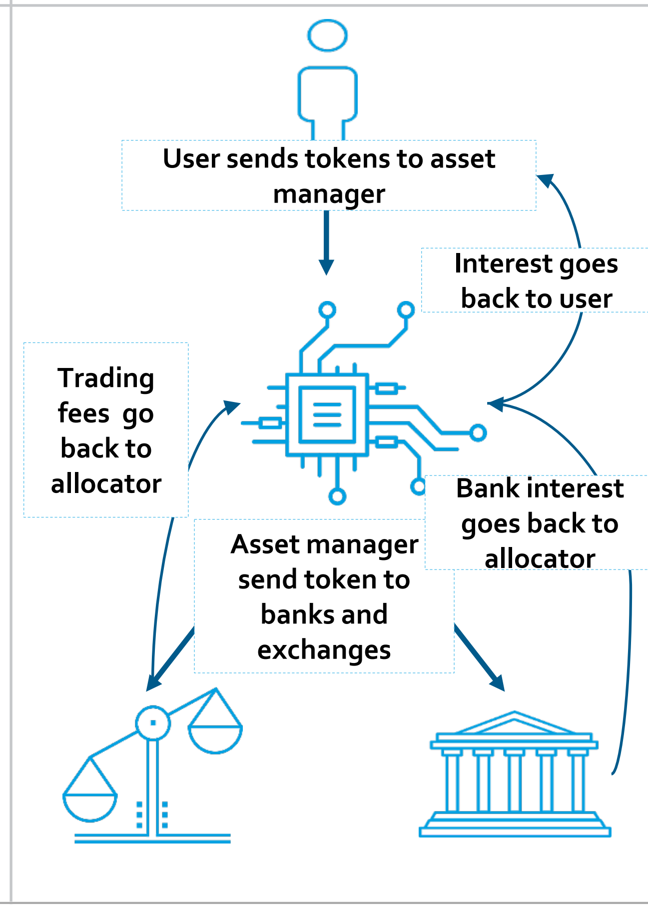
Decentralized Banking



Decentralized Exchange (Automated Market Maker)



Decentralized Fund Manager (Yield Aggregator)



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

What Is a Stablecoin?

- **A stablecoin is a digital asset, usually a cryptocurrency, where the creators aim to have the asset maintain a stable value versus something else.** Issuers own assets that they hold in reserve to manage the value of the stablecoin as market prices vary.
- **Over 99% of all stablecoins issued aim to keep a stable value versus the US dollar (USD).** Some companies have created stablecoins versus gold, and other fiat currencies like the euro.
- **The most common use of stablecoins is for trading of cryptocurrencies on exchanges as the most liquid crypto crosses are versus stablecoins and for crypto lending via decentralized finance platforms.**
- Will **Central Bank Digital Currencies (CBDC)** gain share vs these **private alternatives**?

Top 10 Stablecoins

As of March 9, 2022

Stablecoin	Code	Market Capitlization	Market Capitlization ($bn)	No. of Tokens (bn)	Volume traded in last day	Volume traded in last day ($bn)	Price (USD	% of stablecoin market cap	Daily volume/coins (%)
Tether	USDT	$80,047,494,183	80.05	77.95	65,479,312,631	65.48	1	4.33%	84.00%
USD Coin	USDC	$52,394,766,688	52.39	5.07	4,201,623,705	4.20	1	2.83%	82.93%
Binance USD	BUSD	$17,990,268,811	17.99	16.12	5,987,740,471	5.99	1	0.97%	37.14%
TerraUSD	UST	$14,123,638,355	14.12	11.28	780,741,235	0.78	1	0.76%	6.92%
Dai	DAI	$9,802,950,723	9.80	9.60	323,692,501	0.32	1	0.53%	3.37%
Frax	FRAX	$2,892,501,329	2.89	2.64	35,988,750	0.04	1	0.16%	1.36%
Magic Internet Money	MIM	$1,927,972,892	1.93	0.72	22,718,215	0.02	1	0.10%	3.16%
TrueUSD	TUSD	$1,467,400,392	1.47	1.51	136,343,718	0.14	1	0.08%	9.02%
Pax Dollar	USDP	$946,101,404	0.95	0.95	33,445,989	0.03	1	0.05%	3.54%
Liquity USD	LUSD	$722,797,325	0.72	0.72	31,997,756	0.03	1	0.04%	4.45%

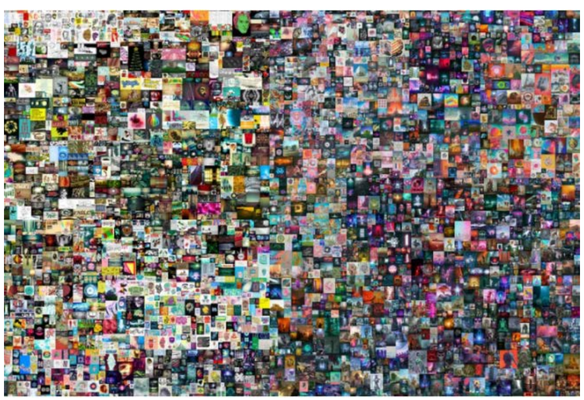
Source: Morgan Stanley & Co. Research; Coingecko

What Is an NFT?

Non-fungible tokens (NFTs) can be used to record **ownership** of any **digital item,** but only three uses cases have gained traction: **Digital Art**, **Gaming Items**, and **Collectibles**.

Digital Art

- There are **digital "prints" of traditional art**, **crypto native art,** and **generative art**.
- **Digital prints** are limited edition copies of pre-existing art. Similar to numbered and signed prints, scarcity gives them value.
- **Natively digital art –** Art that doesn't exist anywhere else has also been sold.
- **Generative art** is created based on a formula (**code**, **smart contracts**, **computer programming**).
- Like other art, value is **subjective, and dependent on cultural relevance.** Valuable Art NFTs can be used to **show off status**.



Gaming Items

- Items such **as weapons**, in **game currency**, **skins**, **skills** or **achievements** can be **owned** outside a game.
- **Crypto Kitties** is the fist big blockchain game and **Axie Infinities** is the largest play to earn game. It features players battling **Axies**, digital pet NFTs that can be battled, bought, and traded, to earn in-game tokens. Gaming items such as weapons, items or "skills" are routinely sold in other games so it's not surprising a more decentralized version might come onstream.
- **Blockchain gaming** with NFTs has been hindered by the high transaction cost of Ethereum.
- Blockchain games are often **decentralized**, but **centralized gaming companies** have sold digital items for years.

Collectibles

- **Collectibles** might be the most widely used category. It includes 1) **memorabilia**; 2) **generative art**; 3) **profile pics**.
- **Memorabilia** are often either crypto first, such as the first profile pic, first generative art, etc. or the first digital version of a pop culture or sports IP.
- **Generative art** is art created with an algorithm. Generative art has existed before, but since it's purely digital NFTs make it more scarce.
- **Profile pics** are pictures (usually personified) that people use as a logo or coat of arms in the digital world of social media, discord, etc. Like an **expensive watch or handbag**, a rare well-known profile pic can show status in the **digital world**. Profile pics also are a bit like membership in a **country club**. Clubs with more influential or famous members have a higher membership fee. **NFT club houses** are typically in the **virtual world**.

Source: Morgan Stanley Wealth Management Global Investment Office, Wikipedia, Axie Infinity

Why Are People Buying Bitcoin?

1	**BITCOIN AS A 'DIGITAL GOLD'**	Thesis offers the case for Bitcoin acting as a **Digital Gold**, operating as a "safe haven" from **fiat currency debasement**.
2	**CRYPTOCURRENCY AS DISRUPTIVE TECHNOLOGY**	Thesis offers the **opportunity** for cryptocurrency to be included as **disruptive technology** with increased value, as more institutional investors incorporate it into their portfolios.
3	**BITCOIN AS AN UNCORRELATED, VOLATILE ASSET**	Thesis offers the **potential benefits** of including Bitcoin in a modern portfolio from the standpoint of correlation and volatility.

Source: Morgan Stanley Wealth Management Global Investment Office

Understanding the Investment Case Within a Portfolio

Crypto indexes and the two largest coins by market capitalization, Bitcoin and Ethereum, have had modest three-year trailing correlations with major portfolio asset classes. However, Bitcoin and Ethereum are highly correlated to each other with 0.78 correlation over the last 3 years.

Crypto Indexes Have Exhibited Low Correlations with Traditional Asset Classes

Data as of February 28, 2022

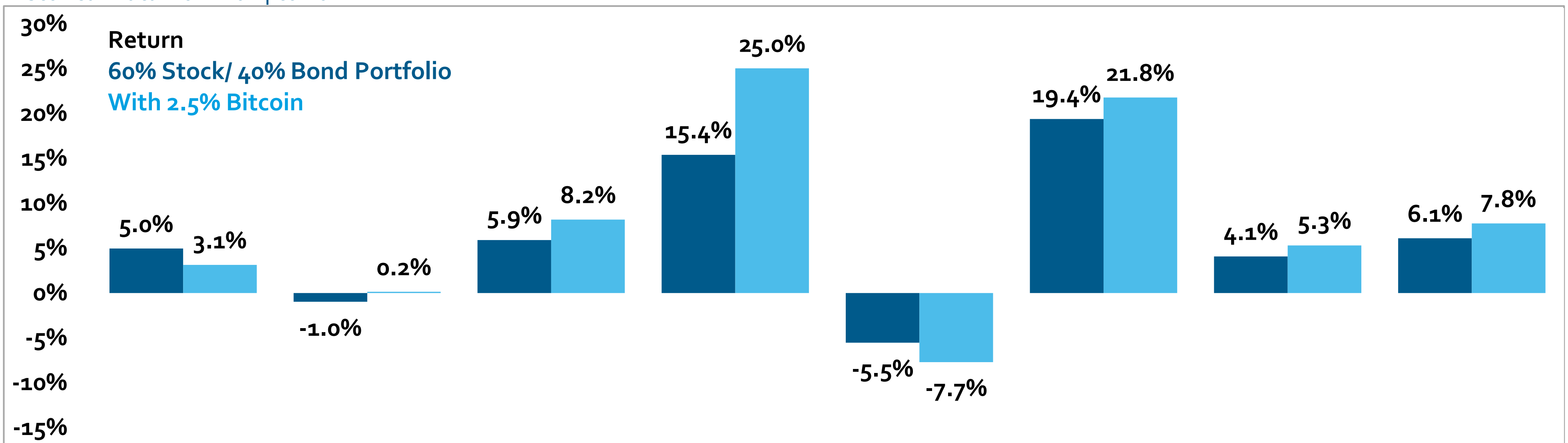
	Daily Correlations for Three Years					
	Cryptocurrency Indexes				Cryptocurrencies	
	BGCI	HODL5	BITX	CCMIX	BTC	ETH
US Dollar	-0.13	-0.16	-0.15	-0.13	-0.12	-0.13
S&P 500	0.25	0.18	0.10	0.21	0.22	0.25
Bloomberg Agg.	-0.02	0.01	-0.02	-0.01	-0.02	-0.03
Broad Comm.	0.23	0.22	0.10	0.23	0.21	0.22
Gold	0.14	0.13	0.07	0.16	0.15	0.13
Precious Metals	0.18	0.17	0.08	0.19	0.19	0.17

Source: Bloomberg; Morgan Stanley Wealth Management. Note: Bloomberg Galaxy Crypto Index (BGCI) is a capped market capitalization-weighted index designed to measure the performance of the largest digital assets traded in US dollars. 21 Shares Crypto Basket Index (HODL5) tracks the financial performance of the top and most-liquid cryptoassets as well as provides a professional benchmark for the broader crypto asset class. Bitwise 10 Large Cap Crypto Index (BITX) tracks the total return of the 10 largest cryptoassets as measured and weighted by free-float market capitalization. Crescent Crypto Market Index (CCMIX) is a rules-based cryptocurrency market index that is designed to measure the performance of the largest and most-liquid cryptocurrencies.

Preliminary Portfolio Modeling Is Constructive: Crypto Has Been Additive in a Traditional Portfolio

Assuming a 2.5% allocation to Bitcoin was added to a traditional 60%/40% equity/bond portfolio, with monthly rebalancing, the simulated portfolio improved returns on both an absolute and risk-adjusted basis in five of the past seven years; **it improved annualized returns by 164 basis points without significantly increasing volatility of maximum drawdowns.** It also positively affected the portfolio even in periods where the price of Bitcoin declined due to the high volatility and regular rebalancing.

Historical Data from 2014 to 2021



	2014		2015		2016		2017		2018		2019		2020		2021	
Volatility (%)	5.0	5.1	7.5	7.5	7.5	7.3	3.4	4.4	7.3	7.5	5.5	5.5	16.0	16.4	6.6	7.2
Sharpe Ratio	1.0	0.6	-0.1	0.0	0.8	1.1	4.3	5.6	-1.0	-1.3	3.1	3.6	0.8	1.0	1.5	1.6
Max Drawdown	-5.2	-5.7	-9.2	-8.8	-6.1	-6.2	-1.0	-1.4	-11.6	-12.9	-2.9	-3.1	-21.4	-21.8	-3.6	-3.8

Source: Bloomberg, Morgan Stanley Wealth Management Global Investment Office. Note: For illustrative purposes only. Equities are represented by the MSCI All Country World Index (USD-Unhedged), net of dividend withholdings. (For US-based investors, certain dividends are not paid or available due to the tax withholdings in foreign jurisdictions. As such, net of dividends is a more appropriate comparison in this instance.) Bonds are represented by the Bloomberg Barclays US Aggregate Index. The Bitcoin price is sourced from Bloomberg's XBTUSD Currency series, with a daily frequency. We utilized the 2014-2020 time frame, providing a comparative analysis to the CFA Institute Research Foundation's cryptoassets analysis over the same time period. Please see our report, *The Case for Cryptocurrency as an Investable Asset Class in a Diversified Portfolio*, March 17, 2021, for more details. Drawdown is the peak-to-trough decline during a specific period. Sharpe Ratio is a statistic that measures a portfolio's rate of return based on the risk it assumed and is often referred to as its risk-adjusted performance. Using standard deviation and returns in excess of the returns of T-bills, it determines reward per unit of risk. This measurement can help determine if the portfolio is reaching its goal of increasing returns while managing risk. Volatility 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.

Why Are People Avoiding Bitcoin?

Unique Risks

ENCRYPTION BREAKS

Increasing processing power and techniques like quantum computing could eventually crack encryption.

In a digital world, this could lead to chaos, particularly for cryptocurrencies, and hacking of some wallets.

While the chances are low in any given year, over 100 years it is a risk that is likely to emerge.

FLAW IN CODE

Flaws in the code occur frequently in a smart contract – the self-executing code that carries out the agreement between buyer and seller in the Blockchain.

Bitcoin has had two large inflation bugs since 2010 (bugs that result in more coins printed). This could lead to **further volatility** in price of the coins.

GOVERNMENT ATTACKS

Since the Bitcoin network is global, actions by a single large country or a group of countries could disrupt the working of the bitcoin network. This could occur through **regulation** or a more **direct attack**.

- **Regulatory Attack**: Through laws banning use of Bitcoin, or through raise in tax rate.
- **Direct Attack**: Through country's potentially limiting unwanted, unfavorable transactions.

Traditional Risks

CONCENTRATION RISK

The 95 largest Bitcoin addresses hold about 14% of total coins, many of which are institutions and crypto exchanges. Any movement in assets could impact price.

- **Barriers** to scaling to a larger user base
- **Capacity reached**? Transaction fees are typically used to allocate scarce capacity.
- **Heavy usage**: High fees, slow transactions can lead to users exit the network.

VOLATILITY

Bitcoin is one of the **most volatile assets**. While its beta is quite low due to low correlations (and sometimes negative correlations) with the broader economy, its historical realized volatility is among the **highest** of all assets.

- Bitcoin volatility was **251%** in late 2013 and is 88% currently.
- Significantly higher than the S&P 500 (12%) and the Nasdaq 100 (18%).

Source: Morgan Stanley Wealth Management Global Investment Office; Chainanalysis; Computerworld.com; Coindesk; BitInfoCharts; Digital Currency Initiative

What Are the Risks with Ethereum?

Unique Ethereum Risks

COMPETITION

Ethereum faces more competition than Bitcoin and competes in a tougher Smart Contract Platform market.

While Bitcoin is mostly used to store and move cryptocurrency, Ethereum can be used for many different types of applications. ***Different smart contract programs (DAPPs) might need different capabilities.***

Alternatives could gain share: Solana, EOS, Tezos, BSC, Polygon, Cardano, Polkadot, Cosmos, Internet computer, Flow and others offer different capabilities that might be useful for different smart contract niches.

BLOCKCHAIN BLOAT

Ethereum Blockchain consumes memory Ethereum's blockchain is ~262 GB and is growing at an average of ~80% each year, much faster than Bitcoin's blockchain.

As Ethereum demands more memory, ***it requires more expensive hardware to run the software.***

The required memory might pass the amount of memory on a single hard drive within the next couple of years, potentially growing faster than memory capabilities can keep up with. Risk mitigations might themselves introduce new risk.

DEMAND RESPONSE TO REGULATION

Ethereum's success depends on growing usage of DAPPs that generation transaction fees. Most activity today is in financial services, which is typically heavily regulated.

Regulatory pressure in the application of securities, banking, money laundering, or derivatives laws or other financial services rules could reduce network demand and lower transaction fees.

Regulatory enforcement actions in 2018 related to illegal security offerings in 2017 & 2018 dramatically reduced the network activity in 2019.

Cryptocurrency Risk

ENCRYPTION BREAKS

Similar to Bitcoin

Increasing processing power and techniques like quantum computing could eventually crack encryption.

This could lead to uncertainty if the blockchain is secure, hacking of some wallets, failed transactions, or a hastily deployed encryption upgrade.

While the chances are low in any given year, over 100 years it is a risk that is likely to emerge.

SOFTWARE BUG

More Risk for Ethereum

Frequent Ethereum changes through "forks" where nodes upgrade to new versions of the code. Bitcoin code is backward compatible with 2013 versions still running.

More code changes more risk: There have been 11 Ethereum hard forks and will be more as the cryptocurrency network is updated. Any changes could introduce a bug.

Large changes coming: Ethereum developers plan a massive change in code from "proof of work" to "proof of stake"

Source: Morgan Stanley Wealth Management Global Investment Office; Chainanalysis; Computerworld.com; Coindesk; BitInfoCharts; Digital Currency Initiative

Bitcoin Is Decentralized; No One Party Controls Entire Network

- The **decentralized nature of Bitcoin** means **no one party controls the entire network**. There are complex economic relationships between 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**:

Stakeholder	What They Do	How Decentralized?
Software Developers	All bitcoin software is open source. Bitcoin Core software, the most popular version, verifies transactions (no overdrafts, follows technical specifications), and includes a wallet to store coins. **Anyone can contribute, test, or verify the code** but roughly 100 developers contribute to "Core."	**Roughly 98% of nodes** (computers connected to the network) run "Bitcoin Core" nodes, but there are six teams with more than 25 nodes and at least 12 versions of software.
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.	**There are over 10,000 public nodes on the Bitcoin network**. Node operators choose which developer's Bitcoin software to run.
Miners	Anyone can theoretically download free software and mine bitcoin. Miners take transactions from nodes, verify transactions, combine them into blocks, and broadcast the new blockchain to the network.	Processing power and electricity are the main inputs to mining. **Currently, 10 groups mine ~91% of the blocks with the largest group mining ~15%**
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 up and exchange cash for bitcoin, and bitcoin ATMs.	**The top 10 exchanges globally account for around 85%** of bitcoin trades versus all fiat currencies – roughly $13 billion is traded per day.
Owners	**Bitcoin owners store their money in a "digital wallet."** Owners can store bitcoin with third parties such as exchanges or wallet providers, hardware wallets similar to USB drives, or on their computers or mobile devices.	Bitcoin ownership is hard to estimate because people can have many different accounts. **Based on data from the two largest wallet providers, there are 65+ million accounts**.

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

Miners: The Computers Behind the Bitcoin Network

- **Miners are the computers that make the Bitcoin network run** and as a reward they are awarded newly minted bitcoin. Roughly every 10 minutes, miners check pending transactions to confirm that the sender has the required amount of Bitcoin and that the transaction follows various technical specifications.
- The first miner to create a new block that is accepted by the nodes (computers on the network) has their new block added to the blockchain, making the chain one block longer. The miner receives bitcoin as a reward for its work. Most cryptocurrencies are mined, but there are other methods of verification.

Pending Transactions

Transaction 1 | Transaction 3 | Transaction 2 | Transaction 4

Old Blockchain

The **blockchain, currently a ~357 gigabyte file,** is a **record** of all bitcoin transactions since Bitcoin was introduced.

Miners combine the old blockchain with a new block of transactions to make a new blockchain. Thus far, there have been over 659 million total transactions.

Miners

Old blockchain + New block = New blockchain

1. Verify transactions (no overdrafts, follows technical specifications)
2. Combine transactions into a new block
3. Link the new block to the prior block
4. Expend processing power to produce "proof-of-work" to solve a difficult math problem
5. Broadcast the new blockchain to the network

Every 10 minutes, miners compete to take transactions from the **memory pool** (pool of transactions), check to make sure that the sender has the required amount of Bitcoin and that the transaction follows various technical specifications, encrypt them into a new block, and add the new block to the Blockchain.

When a new block is added to the blockchain, the first miner to create a new block receives **newly minted bitcoin** as a reward and broadcasts the new blockchain to the network. There are roughly around 693K blocks and growing

New Blockchain

Source: CoinDesk, Morgan Stanley Wealth Management Global Investment Office

Value Cryptocurrencies

- **Relative value** approaches are used in valuing equities and lend themselves to valuing **Bitcoin and other cryptocurrencies**. Using a relative value approach for equities, an analyst identifies similar companies and uses that to benchmark the valuation. Here we outline **five valuation approaches**, but we are not endorsing any of these methods.

Five Bitcoin Valuation Frameworks;

Ways to value Bitcoin and similar cryptos Col 1-5; Ways to Value Smart Contract Platforms and Apps Col 4-6

For Decentralized Savings Account like BTC			For Both Categories		For Smart Contract Platforms like Eth
Relative Value versus Gold	**Relative Value versus Currency**	**Replacement Value Approach**	**Operating Metrics Approach**	**Cyclical Approach**	**DCF**
Bitcoin as a "**Digital Gold**" Gold is the most popular relative benchmark on a **market-cap basis ($12.4 trillion)**. It's also popular with those investors who are attracted to Bitcoin as a **hedge** against the debasement of fiat currencies.	In looking at Bitcoin as a '**currency,**' it can be compared to the value of **money supply**, with M2 money supply ($22 trillion) the most appropriate proxy between **Switzerland** and **Russia**. If we think about Bitcoin as a country, it **imports electricity** and exports **digital gold**.	Analysts of some commodities often use the replacement value or **cost of production** frameworks. For Bitcoin, analysts track **mining profitability** to assess the cost of production.	Comparing total network value to average daily transaction **(1.4 x the average transaction in June)** captures how much a network is being utilized, and therefore how **profitable** it is. More transaction value should mean **higher value**. **Other Metrics** used: Transactions Fees, Total Value Locked (TVL), Annual Token supply burned, Cash flow multiple.	In currency markets, various technical or **cyclical indicators** are sometimes used for shorter-term projections. These techniques are particularly good for Bitcoin because its four-year cycle is known in advance.	Model **number of transactions**, **fees generated**, and **token burns**, and **discount** till the present at an appropriate discount rate.

Please see Appendix for more details.

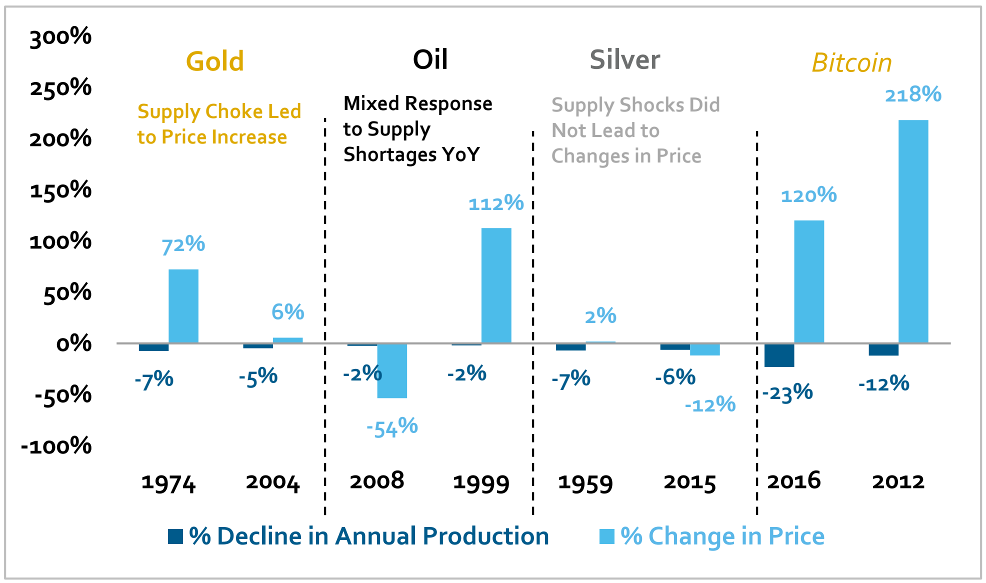
Source: Morgan Stanley Wealth Management Global Investment Office. M2 is a measure of the money supply that includes all elements of M1 as well as "near money." M1 includes cash and checking deposits, while near money refers to savings deposits, money market securities, mutual funds and other time deposits.

Why Is the Halving Important?

- **What is the halving?** The rate of growth in Bitcoin supply or "Bitcoin's issuance" is cut in half every four years in an event called "the halving,"
- **The May 2020 halving was the third bitcoin halving**. Similar to supply shocks in commodity markets, a decline in annual production of bitcoin could impact price.
- There is a debate on whether the halving can be priced in ahead of time and whether their will continue to be bitcoin cycles as people become more familiar with it. **The halving is one possible explanation for**:
  - Why correlations between other assets have been low or negative
  - Why Bitcoin Bubbles occur every four years (alternatively, this recent run may have been due to the pandemic).

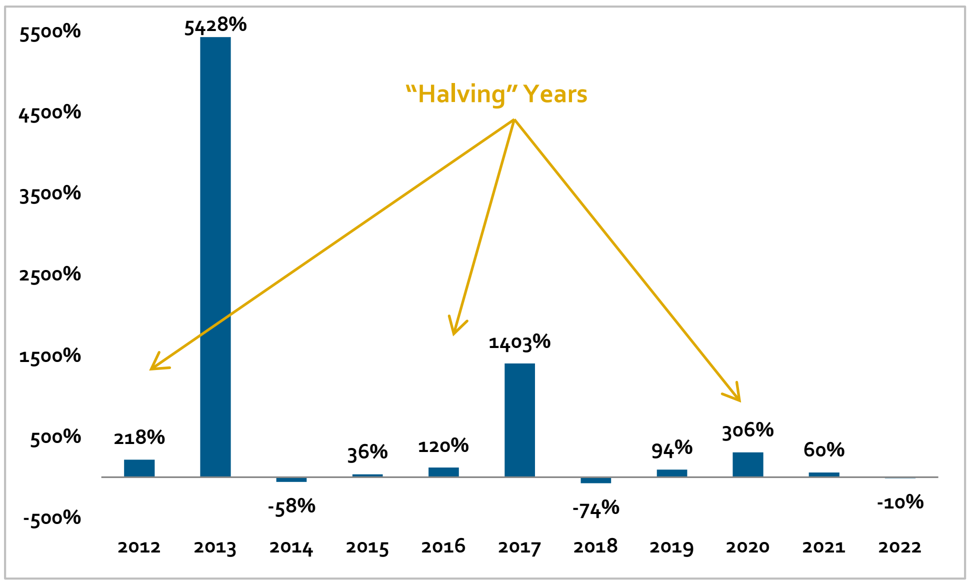
Performance of Commodities During and After Largest Supply Shocks

Historical Data as of December 31, 2016



Bitcoin Returns by Year

As of February 28, 2022



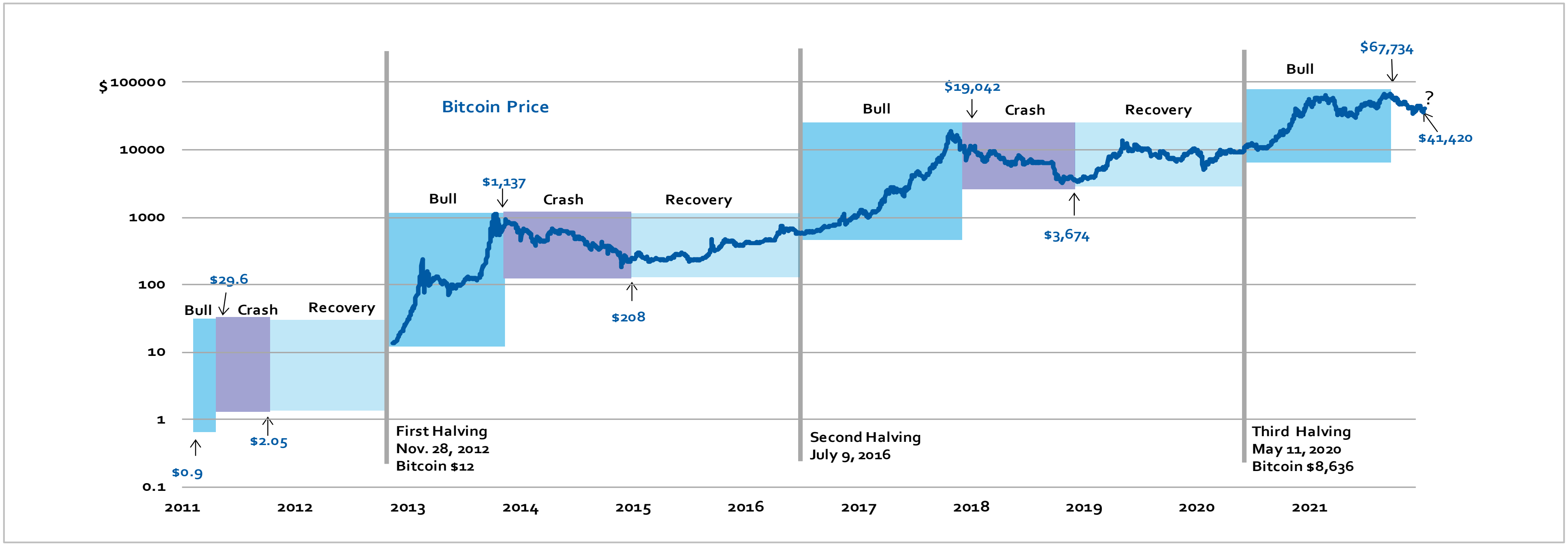
.Source: Coinmarketcap.com, Bloomberg, Morgan Stanley Wealth Management Global Investment Office. This is not a recommendation or endorsement of Bitcoin or any other cryptocurrency.

Cyclical Approach to Valuation

- One of the unique aspects of Bitcoin is its **four-year "halving" cycle**. A parabolic spike has followed each of the three halvings so far. Although there are only three data points, it is starting to seem like the halving causes the Bitcoin cycle of a price spike followed by a collapse.
- Bitcoin's fourth cycle has just begun and some clear patterns are starting to emerge (see chart below). We cannot be sure the cycle will repeat again, but looking at history there have been three clear phases:
    - Normal bull market/recovery
    - Parabolic Bull Market
    - Catastrophic Bear Market
- Investors use a cyclical valuation to try to guess which part of the cycle is most similar to the current time. They use metrics like the days since the halving, total return from the halving, return from the prior peak, and price to 200-day moving average.

3 Cycles Have Occurred Historically That Seem to Arise Around the Halving…

As of February 28, 2022

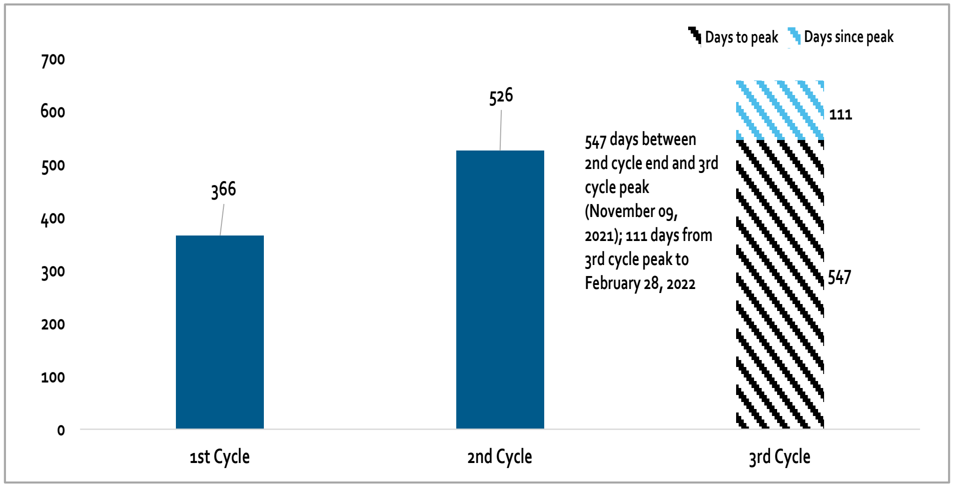


Source: Bloomberg, Blockchain.info. Note: Color changes at the peak

How Does This Cycle Compare to the Two Prior Cycles?

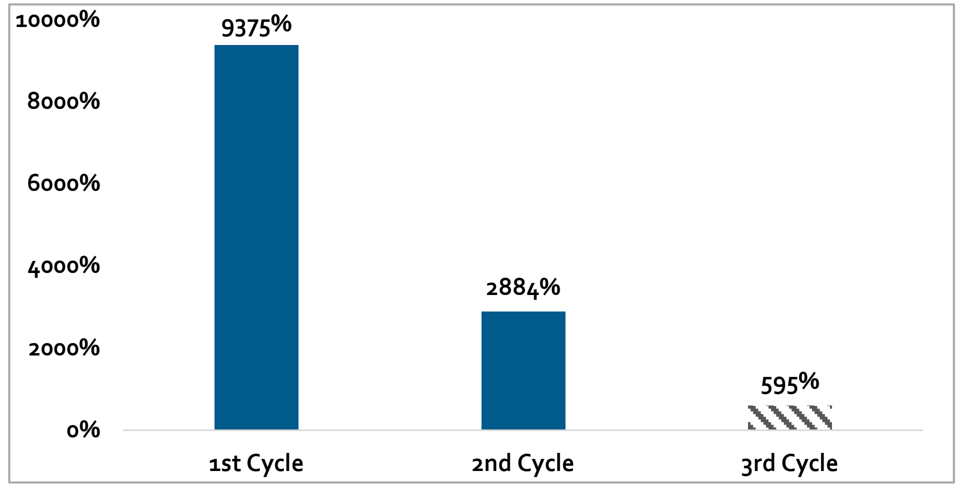
Bitcoin Cycle Day Count (days)

As of February 28, 2022



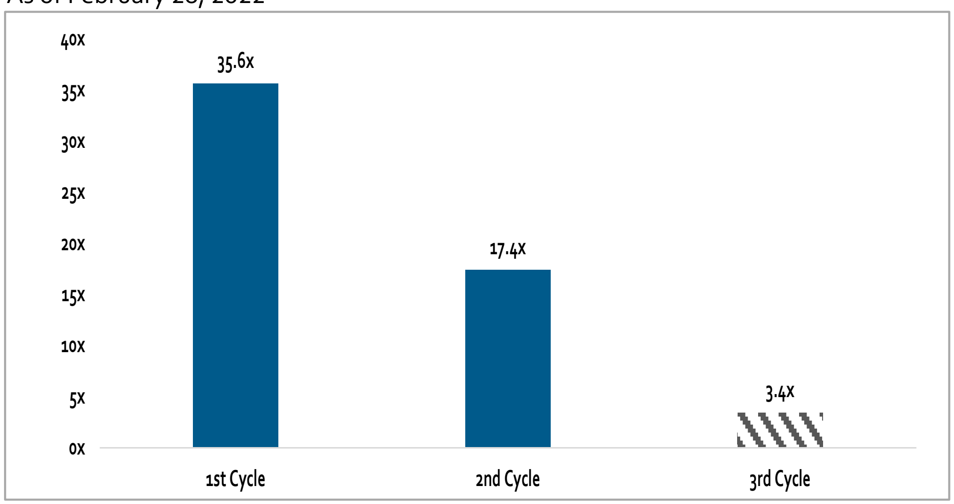
Bitcoin Cycle Return Analysis

As of February 28, 2022



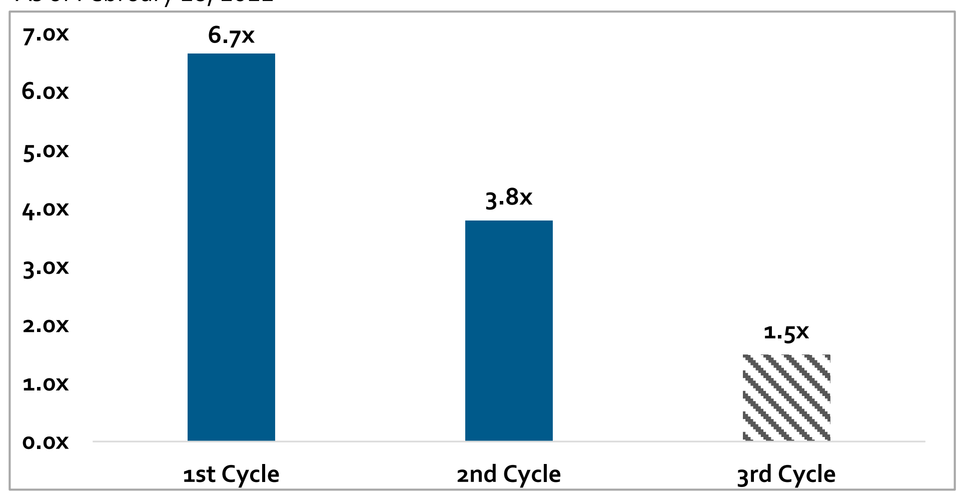
Bitcoin Cycle Peak vs Prior Peak

As of February 28, 2022



Bitcoin Cycle Peak vs 200 Day Moving Average

As of February 28, 2022



Source: Bloomberg

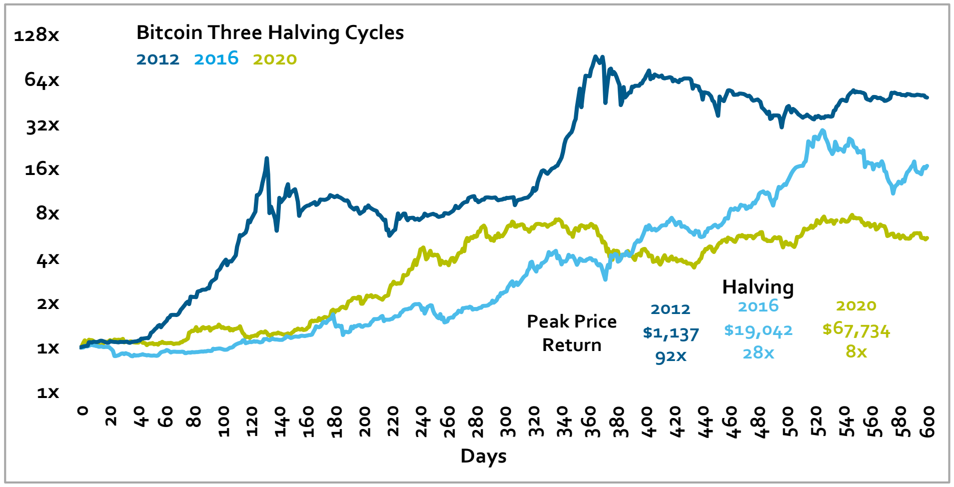
Understanding the Bitcoin Cycle

- The halving cycle might have ended in November. Perhaps it is a coincidence and the pandemic is the major driver of this cycle, but for now, there is no way to know. It's likely that this debate will be had in the years leading to the next halving in 2024.

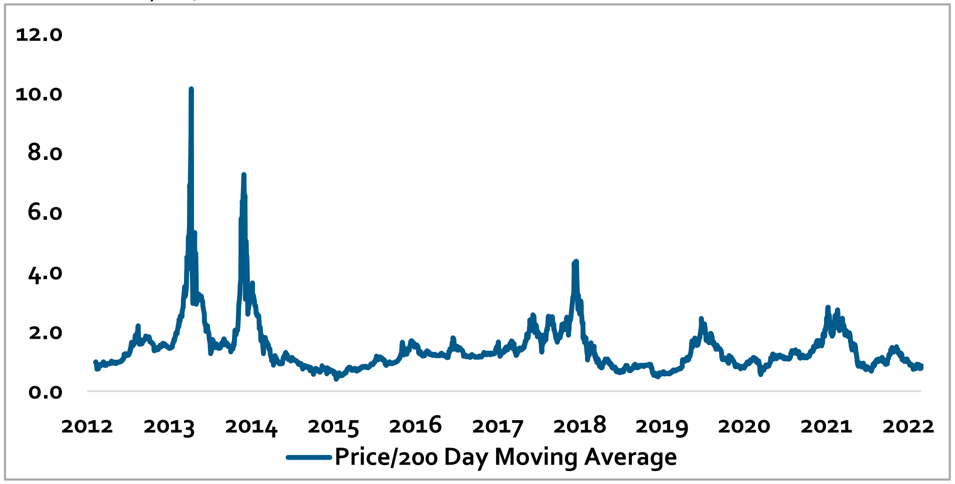
There Are Three Schools of Thought on Cycle Movement

Small Cycle Theory	• Some expect these parabolic moves to be one-time events and for crypto to revert to the return profile of other assets. As Bitcoin's market cap grows, it takes more money to lead to the same returns, and each bull market should get smaller.
Supercycle Theory	• This theory posits that Bitcoin's increased penetration and adoption coincides with the steepest ascent in valuation. Further, given the vast amounts of currency printed by global central banks, the Bitcoin cycle may be much bigger than expected.
Cycle is Irrelevant	• Bitcoin Halving cycle is no longer important. As market cap grows, the cycle becomes more complicated. There are always some parts of crypto growing and some shrinking. Cycles have both less upside and less downside and are less predictable.

There Are Various Schools of Thought on Cycle Movement
As of February 28, 2022



Bitcoin Multiple 200-Day Moving Average
As of February 28, 2022



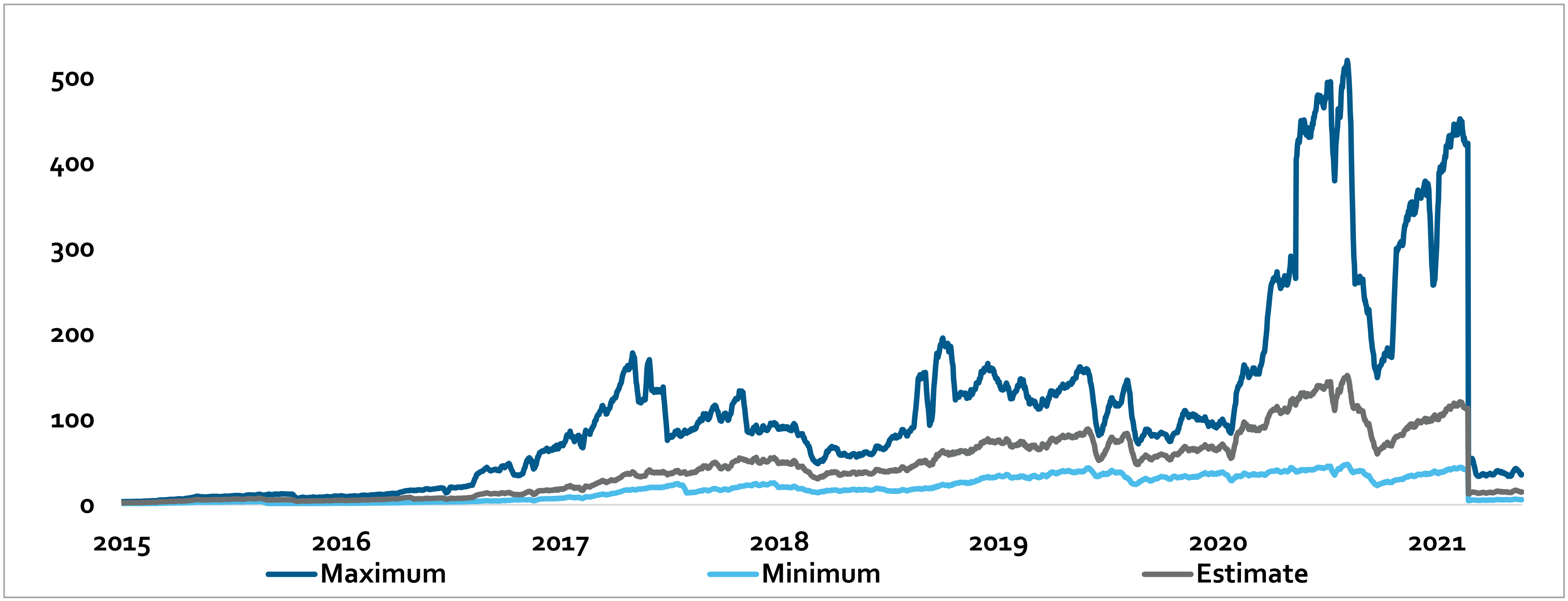
Source: Morgan Stanley Wealth Management Global Investment Office, Bloomberg, Coindesk.com

Bitcoin Environmental, Social, Governance (ESG) Considerations

- Bitcoin has received criticism on the potential lack of energy conservation from an ESG perspective. Estimates of Bitcoin's energy consumption range from **50 TWh** to **300 TWh** according to MS & Co. Research.
- Positively affected portfolio in some periods where price Bitcoin dropped due to high volatility and regular rebalancing (*volatility harvesting*).

Bitcoin Electricity Consumption (TWh, annualized)

As of February 28, 2022



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

How Do People Invest in Cryptocurrencies?

Ways to Invest in Cryptocurrency

Directly	Products	VC, HF and Fund of Funds	Equity ETFs	Stocks
• Buy them from an Exchange **directly** or receive them as rewards from **credit cards** or **e-commerce** website. • The **risk** is that they follow the **price directly**.	• Products that **track cryptocurrencies** or **groups** of **cryptocurrencies** for **tracking error** or **liquidity** purposes. • The **risk** is that they **directly** track the price but with less tracking error. • Examples: **ETFs**, **trusts**, **futures**, **mutual funds**, **structure notes**, **private placements**.	• **Venture Capital** funds or **Hedge Funds** that invest in new or **existing cryptocurrencies**. • Benefit from **deal flow** but products are **illiquid**.	• **Equity ETFs** that include companies participating in **cryptocurrency market**. • Examples: mining, marketing, consulting, payments equipment, financial services and other companies involved in **blockchain** related businesses. • Equity ETFs have **high correlation** with bitcoin.	• **Stocks** of companies that generate most of their money from products related to **cryptocurrency**. They move with the **industry** but also with **company specific developments** and **drivers**. • Stocks 1) **own** a lot of cryptocurrency, 2) **make money** from cryptocurrency 3) **market** with cryptocurrency or 4) **support** cryptocurrency companies. • **Crypto Equities** often **move together** with **Crypto** even though they have their own **stock specific dynamics**.

Source: Morgan Stanley Wealth Management Global Investment Office

Types of Private Organizations Involved in Cryptocurrency

Exchanges/brokers		BINANCE	
Blockchains/platforms	ethereum	SOLANA	polygon
Decentralized exchanges	PancakeSwap	Curve	UNISWAP
Crypto custody		NYDIG	
Crypto lenders (decentralized)	AAVE	MAKER	Compound
Crypto lenders (centralized)	BlockFi	celsius	nexo
Asset Management/investors		GRAYSCALE	
Payment ecosystem	METAMASK	CIRCLE	PAXOS
NFT marketplaces	OpenSea	Axie INFINITY	TOPSHOT
Crypto miners		BITMAIN	
Traditional banks		SEBA	
Analysis	Chainalysis	ELLIPTIC	
Retailer Payments		flexa	

Source: Morgan Stanley & Co. Research; Company websites

Risks of Cryptocurrency Investments

- **Encryption Breaks** – Increased processing power and new techniques could eventually crack the encryption.
- **Flawed Code** – Flaws in the code occur frequently in a smart contract – the self-executing code that carries out the agreement between buyer and seller in the Blockchain.
- **Government Action** – Risk of government attack on Bitcoin and other cryptocurrencies with the network being global.
- **Volatility** – Bitcoin is among the most volatile assets. While beta may be low due to its low correlation, with the broader market, its historical realized volatility is among the highest of all assets.
- **Liquidity Mismatch** – Some cryptocurrency product offerings trade less frequently than the underlying asset. Thus, there is no guarantee that a secondary market or buyer will exist even if the asset continues to trade.
- **Product Selection** – The number and types of Bitcoin offerings are limited and products that are available currently may be less favorable as new structures are approved.
- **Lack of central governance** – Bitcoin does not have a governing body, which presents challenges when users face issues or theft.
- **Valuation Risk** – The lack of time-tested valuation framework makes fundamental research difficult.
- **Environmental Concerns** – Concerns about Bitcoin mining's carbon footprint could lead it to be controlled or regulated.
- **Association with Illegal Activities** – Crypto has known use in illegal activity, accounting for only 0.34% last year, but could rise if usage increases.
- **Internet Reliability** – Crypto networks are dependent on the internet, and a global or regional disruption could affect the ability to transfer assets.
- **Forking Risks** – Acceptance of a controversial software upgrade by a large minority could result in a "fork" in the network.
- **Governance Risk** – Bitcoin network is an open source, so there may be no consensus about how to face certain code change challenges.
- **Competitive Risk** – A rival cryptocurrency could gain share of adoptions or mining power, leading to a decline in the original cryptocurrency and possibly a less secure network.
- ***Concentration Risk** – If one or more of the addresses that hold the majority of total coins was forced to sell its assets, or had their bitcoin stolen and sold, the price could be impacted.
- **Risk of 51% attack** – Bitcoin's unique software depends on consensus to operate. If a malicious group attempts to disrupt the Blockchain, it might be able to reverse or erase transactions, or double-spend bitcoins.
- **Processing Risk** – If the rewards for miners are not high enough to cover their mining cost, there might not be enough miners on the network to process transactions in a timely manner or it might become easier to perform a 51% attack.
- **Unforeseen Risk** – Because cryptocurrencies are relatively new, there may be unforeseen risks in the future that are not evident now.

Source: Morgan Stanley Wealth Management Global Investment Office, Chainanalysis, Computerworld.com, Coindesk, BitInfoCharts, Digital Currency Initiative. Note: *indicates these risks were outlined on slide 7.

The Bottom Line: Cryptocurrencies

As of February 28, 2022

Proceed With Caution…

Our embrace of cryptocurrency as an asset class should not be misconstrued as a recommendation for any one coin. Like other new emergent technologies before it, first movers may not prove to be the best or most long-lasting movers. Certainly, Bitcoin is currently dominant in the space, capturing roughly two-thirds of current asset class market capitalization, but use cases continue to evolve at lightning speed. From our vantage point, coin trading remains in its infancy with still-to-be-addressed challenges, especially around finding true price discovery and best execution. We have yet to be convinced about these topics and advise clients to proceed with caution.

… And Get Educated

Our recommendation is for investors to get educated and consider how and whether to gain exposure to this bourgeoning asset class in their portfolio. We suggest investors become familiar with the unique crypto terminology, use cases, investment arguments, valuation regimes, investment product alternatives and risks of the asset class. For those informed and qualified* investors ready to gain exposure, we recommend starting with registered fund products—preferably those that are multi asset and potentially accessing the growth opportunities through a VC/Private Equity investment in the Blockchain ecosystem.

Source: Morgan Stanley Wealth Management Global Investment Office. *Please check specific investment documents, if applicable, for eligibility requirements.

On a Path Toward Financial Market Maturation

The strong price appreciation, together with greatly increased trading volume, forced a material acceleration in crypto's path toward financial market maturation. Currently, all cryptocurrencies carry a market capitalization nearly the size of the entire high yield bond market and half the size of the small-cap universe.

Cryptocurrencies Still Small but Rapidly Relevant

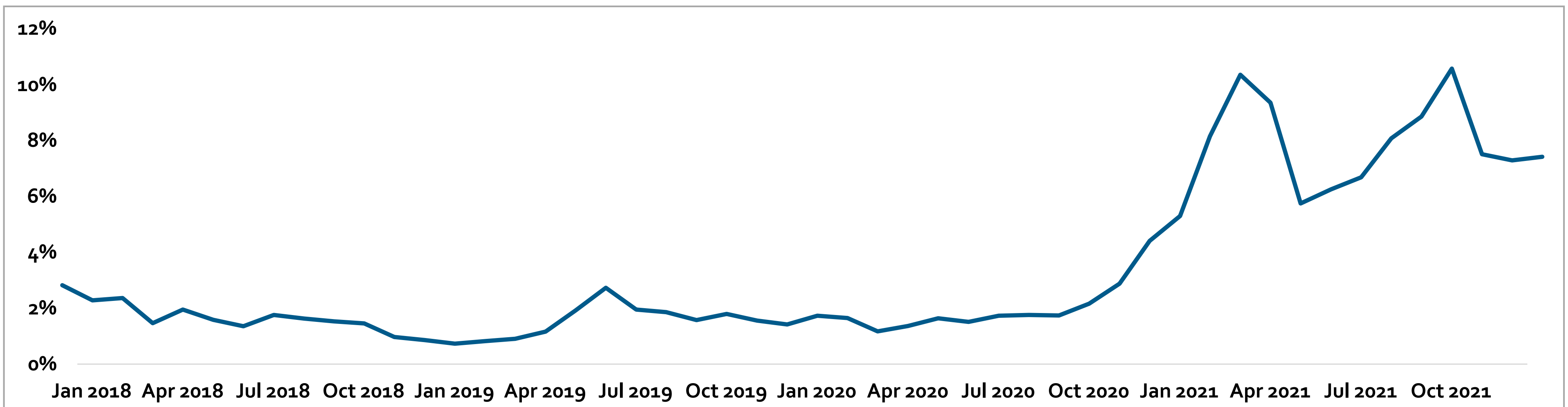
Data as of February 28, 2021; Bitcoin price $46,340

	Market Capitalization (USD, bn)		Daily Average Volume (USD, bn)	
Asset	**Dec-17**	**Feb-21**	**Dec-17**	**Feb-21**
Gold (OTC+Exchanges+Gold ETFs)	7,916	11,325	129	169
Gold (Exchanges)			43	54
Russell 2000	2,454	3,293	24	53
High Yield	1,339	1,595	N/A	N/A
Bitcoin	225	864	14	81
BTC % of Gold	*3%*	*8%*		

Note: Bitcoin daily average volume includes trades versus fiat, stable coins and other cryptocurrencies. CryptoCompare volume data, which excludes cryptocurrency transactions, shows volume of $6 billion and $13 billion in December 2017 and February 2021.

Bitcoin as a Percentage of Gold Market Capitalization

Data as of December 31, 2021



Source: Bloomberg, World Gold Council, Morgan Stanley Wealth Management Global Investment Office

Appendix

Which Are the Most Valuable Cryptocurrencies?

As of February 28, 2022

These top 4 cryptocurrencies account for ~70% of the market cap of all Cryptocurrencies

1. **Bitcoin** - $801B – The first, and most liquid cryptocurrency with the largest market capitalization. Primarily used as a store of value and for making censorship-resistant payments. Many advocates market Bitcoin as Digital Gold because of the low growth in supply.

2. **Ethereum** - $329B – The second most liquid cryptocurrency. The Ethereum network is a decentralized cloud-based software that creates a virtual computer that allows third parties to create applications (called smart contracts) that run on the "computer." These application developers use Ether, the currency of the network, to pay the network for the processing power and data storage their applications require.

3. **Tether** - $80B – Tether is a token that represents one US dollar. As the leading "stablecoin," tether generally has very little volatility, though it has ranged between $0.92 and $1.06 since 2017. The company behind Tether, Bitfinix, a cryptocurrency exchange, claims it has $1 in bank accounts for each unit of tether.

4. **Binance Coin - $65B –** Binance Coin was launched in 2017. Binance Coin can be used as a payment method, a utility token to pay for fees on the Binance exchange, and for participation in token sales on the Binance launchpad. Binance Coin also powers the Binance DEX (decentralized exchange).

.
Source: Coinbase. This is not a recommendation or endorsement of Bitcoin or any other cryptocurrency.

How Does Bitcoin Compare to Ethereum?

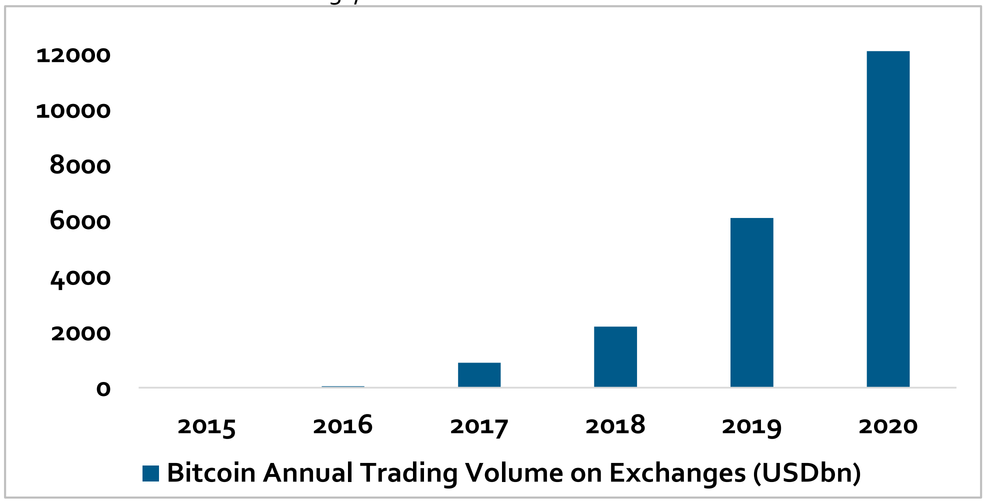
	Bitcoin (~19m BTC issued +2% y/y)	Ethereum (~119m ETH issued +3% y/y)
Target Market	***Decentralized Savings Account:*** Bitcoin is used to save, send, and receive digital currency, bitcoin.	***Decentralized App Store:*** Ethereum is used to run programs. Users must pay a fee in the Ether (eth) digital currency, to use the programs known as Decentralized Apps (DAPPs).
Structure	***Unspent Transaction Outputs*** (***UTXO) Based System***: Like a physical wallet contains bills of different denominations, a bitcoin wallet is comprised of all the bitcoin transactions it has received and the "change" from the previous transactions sent. If you have 1 bitcoin (btc) and send 0.7 btc to a friend, you will receive 0.3 btc in change.	***Account Based System***: Ethereum maintains accounts for each address. The account "balance" of Ether and/or other tokens is saved on the blockchain. When an account sends or receives cryptocurrency, the balance is updated. Ethereum addresses can be either an externally owned account controlled by a user, or an account controlled by a "smart contract" that runs code.
Consensus Mechanisms	***Proof of work***: After checking to make sure a transaction follows all the rules, computers use lots of energy to guess a number that fits in a certain formula. The first computer to solve the equation receives new bitcoin in return. Bitcoin uses the SHA-256 hashing function.	***Currently Proof of Work but transitioning to Proof of Stake***: Proof of stake (POS) validators are required to own a large stake of the native cryptocurrency, Ether. If they harm the network by breaking the rules, they lose some of their staked Ether. Ethereum uses the ETHash hashing function.
Size of the Blockchain	***Bitcoin's Blockchain is ~392 GB***. Each block contains up to 1MB of data, and the memory required to run software does not grow that fast (~19% each year), making it easier to run a node. BTC has 12,807 nodes.	***Ethereum's Blockchain is not as old but is already ~1,126GB***. Blocks occur more frequently and include more data than bitcoin blocks. It's more memory intensive and expensive to run an Ethereum node. Ethereum has 8,670 nodes.
Scalability	***Bitcoin can handle 7 transactions per second***. Additional scale comes from layer 2 networks such as lightning.	***Ethereum can handle 30 transactions per second***. Additional scale comes from "sidechains" and "rollups."
Transaction Costs	***Bitcoin fees are based on the bytes of memory a transaction uses***. Using a wallet analogy, if you have to pay with three bills rather than one bill, the transaction is more expensive. Bitcoin fees are denominated in Satoshis per byte. A satoshi is 1 / 100,000,000th of a bitcoin.	***Ethereum uses gas***. Each Ethereum transaction is a small piece of code. Rather than paying by how long the string of code is like Bitcoin, the fee is based on how much the code does. Fees are higher for code that uses more memory and processing power. Fees are denominated in volume of Gas (like gallons) and a price per "gallon" denominated in Gwei. There are 1B Gwei in one ether.

Sources: Bitcoin.org, Etherscan.io, Ethereum.org, Bitnodes.io, Morgan Stanley Wealth Management Global Investment Office

Interest in Bitcoin Sparks After 2020 Rally

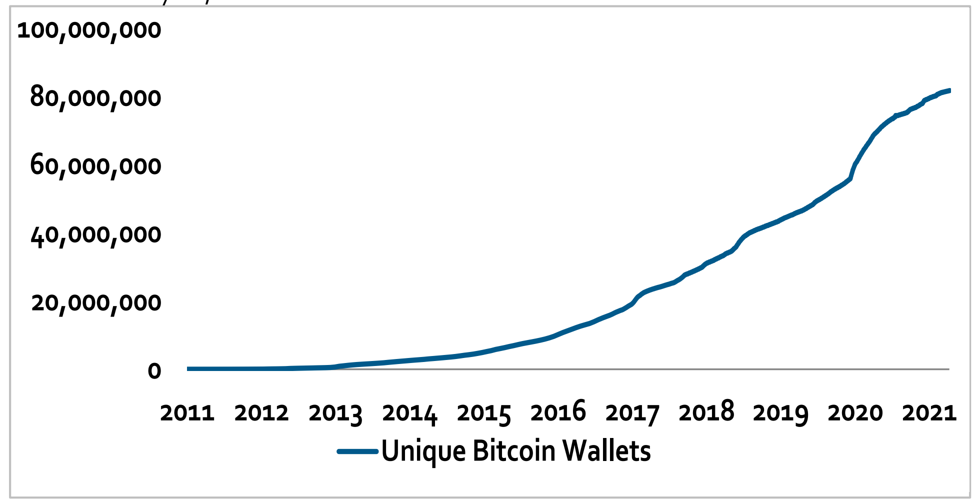
Trading Volume Volume[1]

Annual data as of December 31, 2020



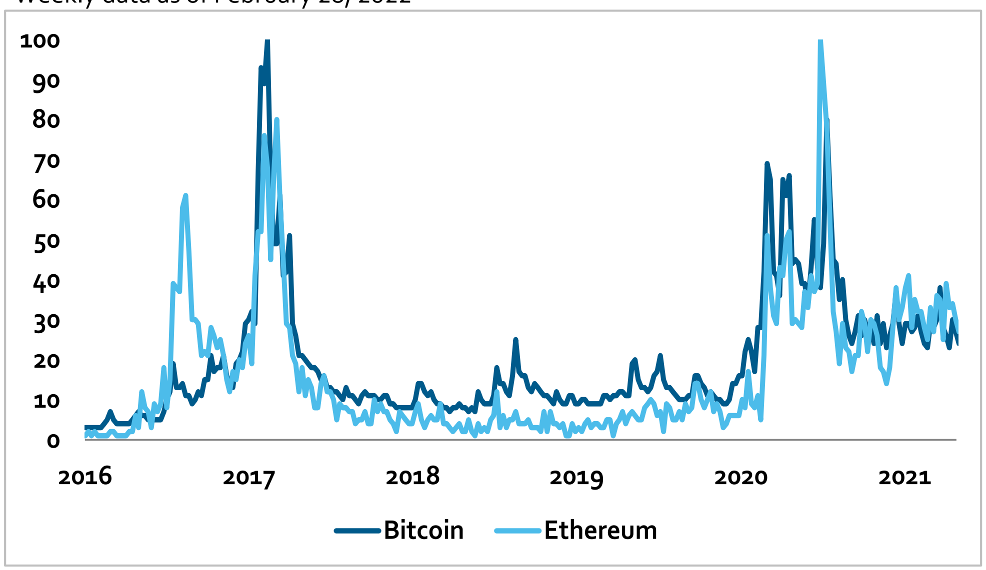
Unique Bitcoin Wallets

As of February 28, 2022



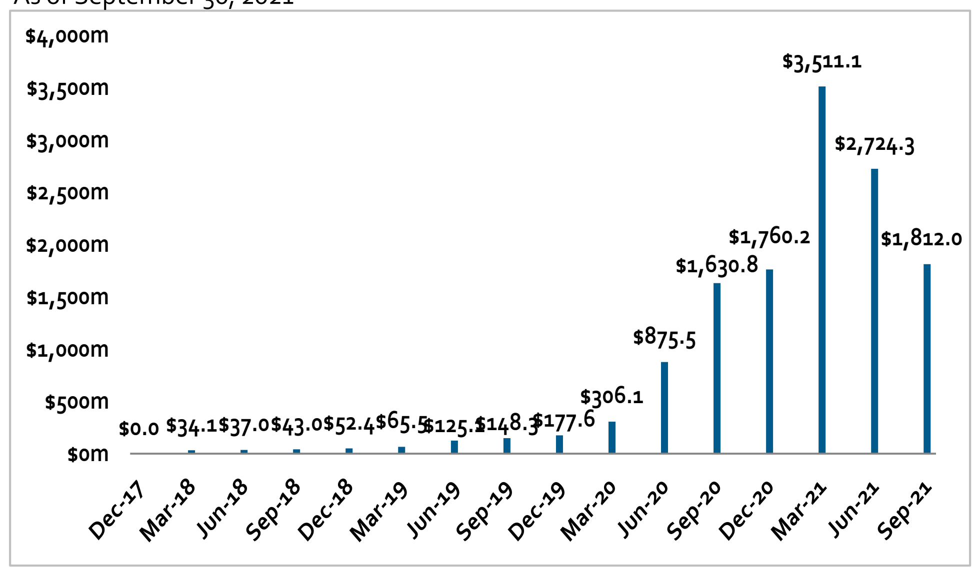
Google Trends Searches for Top Two Cryptocurrencies

Weekly data as of February 28, 2022



Bitcoin Transactions Revenue on the Square Platform

As of September 30, 2021



Source: Google Trends, Bloomberg, Square, Note 1. Weekly Volume and Open Interest from Bakkt and CME. This is not a recommendation or endorsement of Bitcoin or any other cryptocurrency.

Why Would Someone Use Gold to Value Bitcoin?

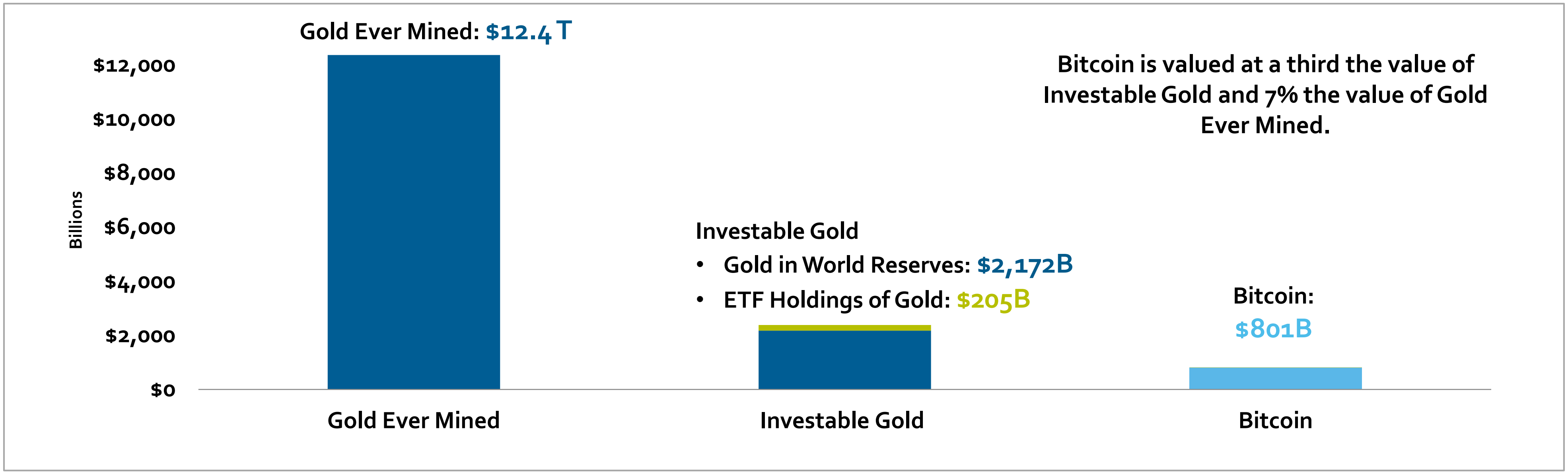
- Many new users have begun to see cryptocurrency as more of a "**digital gold**" store of value
- If Bitcoin is thought of as a 'commodity,' it has similar properties to gold:
  - ✓ **Scarce** in supply
  - ✓ Supply growth **~2%** per year
  - ✓ Divisible and fungible

- Both Bitcoin and gold make it easy to store **large amounts of value in small places**. Bitcoin is easier to store, move globally and break into smaller pieces, which some advocates say make it better than gold.

- **Gold advocates say that gold is superior to Bitcoin** for reasons such that gold has been around millennia, works without electricity, and has a more stable regulatory framework and is not subject to hacks, code bugs or the failure of encryption technology.

Bitcoin Market Cap vs Gold Ever Mined and Investable Gold

Data as of February 28, 2022; Gold Reserves Data as of March 2021

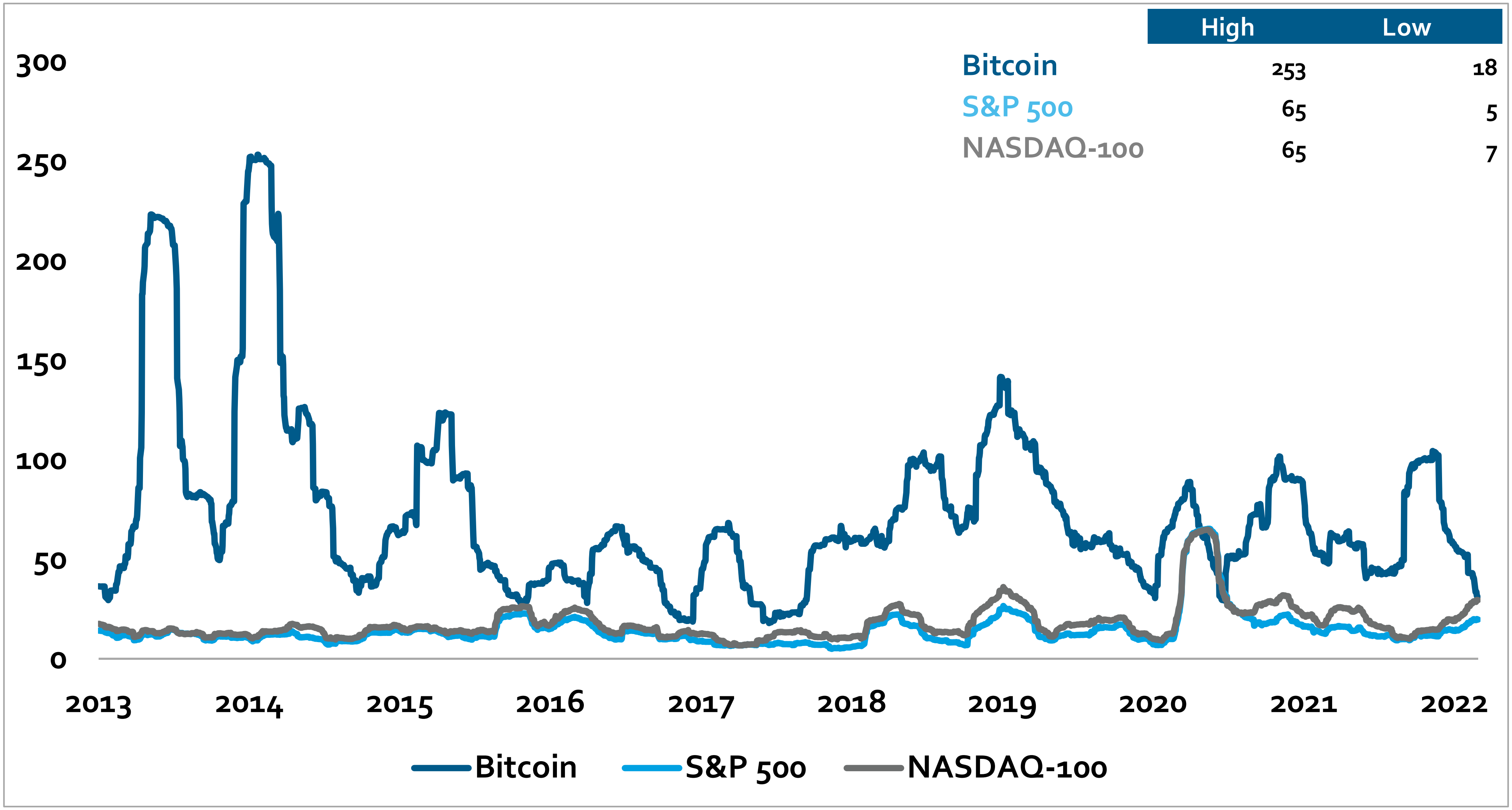


Source: Morgan Stanley Wealth Management Global Investment Office, Bloomberg, Haver Analytics, Jstor.org , thelocal.no (The Long History of Gold Trading)

Bitcoin Continues to Be One of the Most Volatile Asset Classes

60-Day Annualized Volatility of Bitcoin, S&P 500, and Nasdaq

Historical Data from January 2013 to February 28, 2022

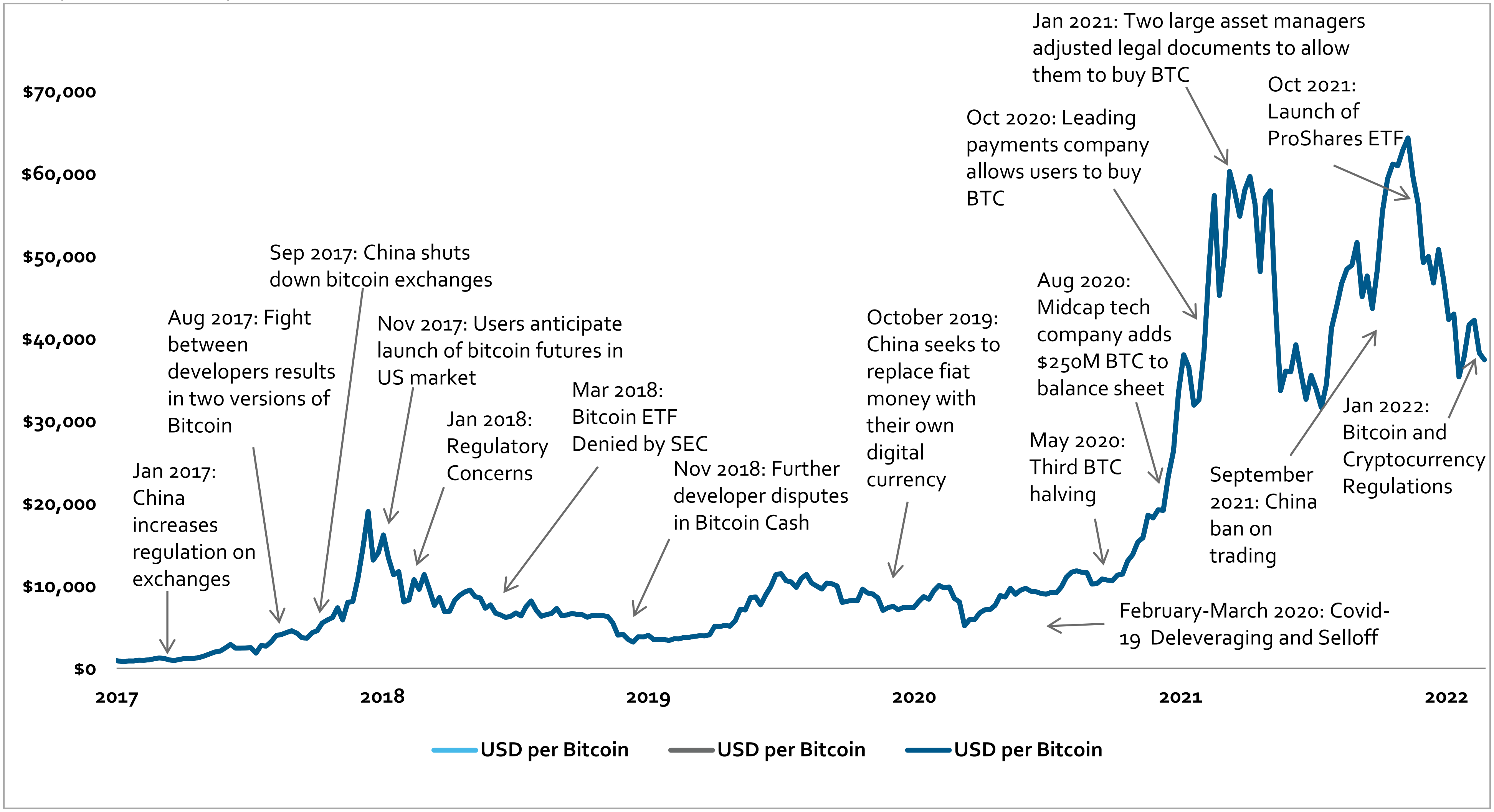


Source: Bloomberg

Crypto Has Evolved Since Hitting the Mainstream Media in 2013

Bitcoin Price

Weekly data as of February 28, 2022



Source: Bloomberg, Morgan Stanley Wealth Management Global Investment Office

Valuing Bitcoin as an Emerging Market's Currency

Think about Bitcoin as a "country," importing electricity and exporting digital gold…

- **Bitcoin 'Money Supply'**: The total supply of BTC is similar to M2 Money Supply of other countries.
    - Bitcoin held at a custodian is like vault cash/savings
    - \+ Bitcoin held by a holder is like M1 cash in circulation
    - **M2** = **Savings** + **Cash** (traditionally)
- **Bitcoin's 'Population'**: The population for the country is the number of addresses, or users. If a country's population grows, it generally has higher demand for money.
- **Bitcoin 'GDP'**: Growth in mining profits is a good analogy for Bitcoin GDP, like growth in new home sales

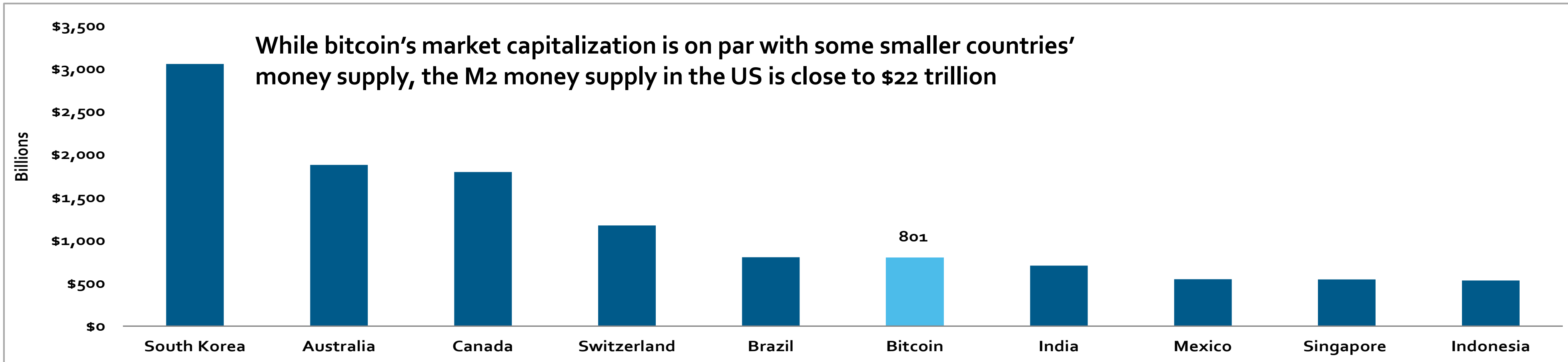
M2 Money Supply Comparison

GDP Data as of December 31, 2019 ; M2 and Population Data as of December 31, 2020

Country	M2 ($ billion)	M2 Growth YoY	GDP Growth	Population Growth	25 Yr vs US Dollar
South Korea	2881	10%	2.3%	0.1%	-30%
Canada	1676	19%	2.0%	1.2%	8%
Switzerland	1192	7%	1.5%	0.7%	29%
Bitcoin	860	3%	13.6%	11.1%	n/a
Russia	755	14%	2.9%	0.0%	-94%
Brazil	716	29%	1.6%	0.6%	-78%
India	663	20%	3.3%	0.8%	-55%
Singapore	542	11%	1.3%	1.2%	5%
Mexico	515	13%	-0.3%	1.0%	-63%
Indonesia	480	12%	5.0%	1.2%	-83%

Bitcoin Market Capitalization vs. Select Country's Money Supply (M2)

Data as of January 31, 2022; Bitcoin data as of February 28, 2022



Source: Morgan Stanley Wealth Management Global Investment Office, Bloomberg; Haver Analytics, Ceicdata.com. 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 used for Australia

Additional Reading

Click here to access additional reading for more information:

- The Case for Cryptocurrency As an Investable Asset Class in a Diversified Portfolio – Global Investment Committee, Morgan Stanley Wealth Management
- Investing in Cryptocurrency – Wealth Management Global Investment Office, Morgan Stanley Wealth Management
- Ethereum Whitepaper - Vitalik Buterin
- Original Bitcoin Whitepaper – by Satoshi Nakamoto
- IBM Blockchain – Business and Industry use cases
- Blockchain Research – McKinsey Global Institute
- The Truth About Blockchain – Harvard Business Review
- What You Should Know About Bitcoin - FINRA
- Bitcoin Basics – 9 Things You Should Know About the Digital Currency – FINRA
- AlphaCurrents: Blockchain Belief – Morgan Stanley Wealth Management Global Investment Office
- Cryptocurrency Trading Platforms: Do Your Homework – FINRA
- Decentralized Finance: On Blockchain – and Smart Contract-Based Financial Markets – Federal Reserve Bank of St. Louis
- Cryptoassets: The Guide to Bitcoin, Blockchain, and Cryptocurrency for Investment Professionals – CFA Institute

Source: Morgan Stanley Wealth Management Global Investment Office

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It should be noted that the majority of hedge fund indexes are comprised of hedge fund manager returns. This is in contrast to traditional indexes, which are comprised of individual securities in the various market segments they represent and offer complete transparency as to membership and construction methodology. As such, some believe that hedge fund index returns have certain biases that are not present in traditional indexes. Some of these biases inflate index performance, while others may skew performance negatively. However, many studies indicate that overall hedge fund index performance has been biased to the upside. Some studies suggest performance has been inflated by up to 260 basis points or more annually depending on the types of biases included and the time period studied. Although there are numerous potential biases that could affect hedge fund returns, we identify some of the more common ones throughout this paper.

Self-selection bias results when certain manager returns are not included in the index returns and may result in performance being skewed up or down. Because hedge funds are private placements, hedge fund managers are able to decide which fund returns they want to report and are able to opt out of reporting to the various databases. Certain hedge fund managers may choose only to report returns for funds with strong returns and opt out of reporting returns for weak performers. Other hedge funds that close may decide to stop reporting in order to retain secrecy, which may cause a downward bias in returns.

Survivorship bias results when certain constituents are removed from an index. This often results from the closure of funds due to poor performance, "blow ups," or other such events. As such, this bias typically results in performance being skewed higher. As noted, hedge fund index performance biases can result in positive or negative skew. However, it would appear that the skew is more often positive. While it is difficult to quantify the effects precisely, investors should be aware that idiosyncratic factors may be giving hedge fund index returns an artificial "lift" or upwards bias.

Hedge Funds of Funds and many funds of funds are private investment vehicles restricted to certain qualified private and institutional investors. They are often speculative and include a high degree of risk. Investors can lose all or a substantial amount of their investment. They may be highly illiquid, can engage in leverage and other speculative practices that may increase volatility and the risk of loss, and may be subject to large investment minimums and initial lockups. They involve complex tax structures, tax-inefficient investing and delays in distributing important tax information. Categorically, hedge funds and funds of funds have higher fees and expenses than traditional investments, and such fees and expenses can lower the returns achieved by investors. Funds of funds have an additional layer of fees over and above hedge fund fees that will offset returns. 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. An investment in a **target date portfolio** is subject to the risks attendant to the underlying funds in which it invests, in these portfolios the funds are the Consulting Group Capital Market funds. A target date portfolio is geared to investors who will retire and/or require income at an approximate year. The portfolio is managed to meet the investor's goals by the pre-established year or "target date." A target date portfolio will transition its invested assets from a more aggressive portfolio to a more conservative portfolio as the target date draws closer. An investment in the target date portfolio is not guaranteed at any time, including, before or after the target date is reached. **Managed futures** investments are speculative, involve a high degree of risk, use significant leverage, are generally illiquid, have substantial charges, subject investors to conflicts of interest, and are appropriate only for the risk capital portion of an investor's portfolio. Managed futures investments do not replace equities or bonds but rather may act as a complement in a well diversified portfolio. Managed Futures are complex and not appropriate for all investors. **Rebalancing** does not protect against a loss in declining financial markets. There may be a potential tax implication with a rebalancing strategy.

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.

Asset allocation and diversification do not assure a profit or protect against loss in declining financial markets. Past performance is no guarantee of future results. Actual results may vary.

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Annuities and insurance products are offered in conjunction with Morgan Stanley Smith Barney LLC's licensed insurance agency affiliates.

Indices are unmanaged and investors cannot directly invest in them. They are not subject to expenses or fees and are often comprised of securities and other investment instruments the liquidity of which is not restricted. A particular investment product may consist of securities significantly different than those in any index referred to herein. Composite index results are shown for illustrative purposes only, generally do not represent the performance of a specific investment, may not, for a variety of reasons, be an appropriate comparison or benchmark for a particular investment and may not necessarily reflect the actual investment strategy or objective of a particular investment. Consequently, comparing an investment to a particular index may be of limited use.

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We may act in the capacity of a broker or that of an advisor. As your broker, we are not your fiduciary and our interests may not always be identical to yours. Please consult with your Private Wealth Advisor to discuss our obligations to disclose to you any conflicts we may from time to time have and our duty to act in your best interest. We may be paid both by you and by others who compensate us based on what you buy. Our compensation, including that of your Private Wealth Advisor, may vary by product and over time.

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

GLOBAL INVESTMENT COMMITTEE (GIC) ASSET ALLOCATION MODELS: The Asset Allocation Models are created by Morgan Stanley Wealth Management's GIC.

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FEES REDUCE THE PERFORMANCE OF ACTUAL ACCOUNTS: None of the fees or other expenses (e.g. commissions, mark-ups, mark-downs, fees) associated with actual trading or accounts are reflected in the GIC Asset Allocation Models. The GIC Asset Allocation Models and any model performance included in this presentation are intended as educational materials. Were a client to use these models in connection with investing, any investment decisions made would be subject to transaction and other costs which, when compounded over a period of years, would decrease returns. Information regarding Morgan Stanley's standard advisory fees is available in the Form ADV Part 2, which is available at www.morganstanley.com/adv. The following hypothetical illustrates the compound effect fees have on investment returns: For example, if a portfolio's annual rate of return is 15% for 5 years and the account pays 50 basis points in fees per annum, the gross cumulative five-year return would be 101.1% and the five-year return net of fees would be 96.8%. Fees and/or expenses would apply to clients who invest in investments in an account based on these asset allocations, and would reduce clients' returns. The impact of fees and/or expenses can be material.

Variable annuities are long-term investments designed for retirement purposes and may be subject to market fluctuations, investment risk, and possible loss of principal. All guarantees, including optional benefits, are based on the financial strength and claims-paying ability of the issuing insurance company and do not apply to the underlying investment options. Optional riders may not be able to be purchased in combination and are available at an additional cost. Some optional riders must be elected at time of purchase. Optional riders may be subject to specific limitations, restrictions, holding periods, costs, and expenses as specified by the insurance company in the annuity contract. If you are investing in a **variable annuity** through a tax-advantaged retirement plan such as an IRA, you will get no additional tax advantage from the variable annuity. Under these circumstances, you should only consider buying a variable annuity because of its other features, such as lifetime income payments and death benefits protection. Taxable distributions (and certain deemed distributions) are subject to ordinary income tax and, if taken prior to age 59½, may be subject to a 10% federal income tax penalty. Early withdrawals will reduce the death benefit and cash surrender value.

Equity securities may fluctuate in response to news on companies, industries, market conditions and general economic environment. **Ultrashort-term fixed income** asset class is comprised of fixed income securities with high quality, very short maturities. They are therefore subject to the risks associated with debt securities such as credit and interest rate risk.

Master Limited Partnerships (MLPs) are limited partnerships or limited liability companies that are taxed as partnerships and whose interests (limited partnership units or limited liability company units) are traded on securities exchanges like shares of common stock. Currently, most MLPs operate in the energy, natural resources or real estate sectors. Investments in MLP interests are subject to the risks generally applicable to companies in the energy and natural resources sectors, including commodity pricing risk, supply and demand risk, depletion risk and exploration risk. Individual MLPs are publicly traded partnerships that have unique risks related to their structure. These include, but are not limited to, their reliance on the capital markets to fund growth, adverse ruling on the current tax treatment of distributions (typically mostly tax deferred), and commodity volume risk. The potential tax benefits from investing in MLPs depend on their being treated as partnerships for federal income tax purposes and, if the MLP is deemed to be a corporation, then its income would be subject to federal taxation at the entity level, reducing the amount of cash available for distribution to the fund which could result in a reduction of the fund's value. MLPs carry interest rate risk and may underperform in a rising interest rate environment. MLP funds accrue deferred income taxes for future tax liabilities associated with the portion of MLP distributions considered to be a tax-deferred return of capital and for any net operating gains as well as capital appreciation of its investments; this deferred tax liability is reflected in the daily NAV, and, as a result, the MLP fund's after-tax performance could differ significantly from the underlying assets even if the pre-tax performance is closely tracked.

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. 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.

REITs investing risks are similar to those associated with direct investments in real estate: property value fluctuations, lack of liquidity, limited diversification and sensitivity to economic factors such as interest rate changes and market recessions. Risks of **private real estate** include: illiquidity; a long-term investment horizon with a limited or nonexistent secondary market; lack of transparency;

volatility (risk of loss); and leverage. Principal is returned on a monthly basis over the life of a **mortgage-backed security.** Principal prepayment can significantly affect the monthly income stream and the maturity of any type of MBS, including standard MBS, CMOs and Lottery Bonds. **Asset-backed securities** generally decrease in value as a result of interest rate increases, but may benefit less than other fixed-income securities from declining interest rates, principally because of prepayments.
Yields are subject to change with economic conditions. Yield is only one factor that should be considered when making an investment decision. **Credit ratings** are subject to change. **Duration**, the most commonly used measure of bond risk, quantifies the effect of changes in interest rates on the price of a bond or bond portfolio. The longer the duration, the more sensitive the bond or portfolio would be to changes in interest rates. The majority of $25 and $1000 par **preferred securities** are "callable" meaning that the issuer may retire the securities at specific prices and dates prior to maturity. Interest/dividend payments on certain preferred issues may be deferred by the issuer for periods of up to 5 to 10 years, depending on the particular issue. The investor would still have income tax liability even though payments would not have been received. Price quoted is per $25 or $1,000 share, unless otherwise specified. Current yield is calculated by multiplying the coupon by par value divided by the market price. The initial interest rate on a **floating-rate security** may be lower than that of a fixed-rate security of the same maturity because investors expect to receive additional income due to future increases in the floating security's underlying reference rate. The reference rate could be an index or an interest rate. However, there can be no assurance that the reference rate will increase. Some floating-rate securities may be subject to call risk. The market value of **convertible bonds** and the underlying common stock(s) will fluctuate and after purchase may be worth more or less than original cost. If sold prior to maturity, investors may receive more or less than their original purchase price or maturity value, depending on market conditions. Callable bonds may be redeemed by the issuer prior to maturity. Additional call features may exist that could affect yield. Some $25 or $1000 **par preferred securities** are QDI (Qualified Dividend Income) eligible. Information on QDI eligibility is obtained from third party sources. The dividend income on QDI eligible preferreds qualifies for a reduced tax rate. Many traditional 'dividend paying' perpetual preferred securities (traditional preferreds with no maturity date) are QDI eligible. In order to qualify for the preferential tax treatment all qualifying preferred securities must be held by investors for a minimum period – 91 days during a 180 day window period, beginning 90 days before the ex-dividend date.
Companies paying **dividends** can reduce or cut payouts at any time.

Nondiversification: For a portfolio that holds a concentrated or limited number of securities, a decline in the value of these investments would cause the portfolio's overall value to decline to a greater degree than a less concentrated portfolio. The **indices selected by Morgan Stanley Wealth Management** to measure performance are representative of broad asset classes. Morgan Stanley Wealth Management retains the right to change representative indices at any time. Because of their narrow focus, **sector investments** tend to be more volatile than investments that diversify across many sectors and companies.

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. **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.
Any type of **continuous or periodic investment plan** does not assure a profit and does not protect against loss in declining markets. Since such a plan involves continuous investment in securities regardless of fluctuating price levels of such securities, the investor should consider his financial ability to continue his purchases through periods of low price levels.
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