



MEGATRENDS

CRYPTOCURRENCY INVESTING

Powerful Diversifier or Portfolio Kryptonite?

SUMMER 2022

For professional investors only.
All investments involve risk,
including possible loss of capital.

INTRODUCTION

Red dogs, stump tails and blue pups were just some of the creative names for the ultimately doomed currencies issued by poorly capitalized state-chartered banks during the wildcat banking era in U.S. monetary history from 1837 to 1863 – until Congress finally passed legislation that created a single centrally backed national U.S. currency.^{1,2}

History rarely repeats itself, but it often rhymes – and 150 years later we are in an era with thousands of unregulated cryptocurrencies and digital tokens with a collective market cap over \$1 trillion.³ These cryptocurrencies offer the promise of a frictionless, inclusive and decentralized network powered by blockchains and operated completely independently of central banks, which are increasingly seen as debasing fiat currencies by “printing money.”*

For institutional investors, cryptocurrencies also offer the allure of extraordinary and diversified returns in a market that is now of sufficient size and liquidity for meaningful institutional positions. Indeed, some market participants estimate that about 5% of total Bitcoin supply are now held by institutional investors via custodial intermediaries.⁴

To understand the investment implications of the evolving cryptocurrency landscape, we have drawn on the insights of more than 30 investment professionals across PGIM’s fixed income, equity and private alternatives managers – as well as leading economists, venture capitalists and crypto investors. Our resulting conclusions:

- While a few cryptocurrencies will endure on the fringes of the monetary system, **the broad replacement of fiat currencies globally by cryptocurrencies is unlikely to materialize. Functionally, cryptocurrencies are unable to meet the basic prerequisites of either a currency**

or a precious-metal substitute – shortcomings exacerbated by the powerful headwinds from increasing regulatory scrutiny and the growing likelihood of central bank digital currencies (CBDCs) which provide almost all the functional benefits of fiat-linked cryptocurrencies, but with no liquidity or credit risk.

- Beyond hedge funds exploiting inefficiencies to generate alpha on the other side of “FOMO”-driven, largely retail and speculative flows, there is currently no compelling case for direct ownership of cryptocurrencies as a meaningful share of an institutional portfolio. Theoretically, cryptocurrencies have no ex-ante foundational underpinnings for delivering robust risk-adjusted returns in the future. Empirically, after examining the brief historical data available on crypto, **we find little real-world evidence that cryptocurrencies deliver diversification vs. mainstream assets, are effective inflation hedges, possess the intrinsic characteristics of a safe-haven asset, or advance ESG objectives.** Of course, it goes without saying that bitcoin and many other cryptocurrencies have delivered awe-inspiring returns over the last decade – albeit with frequent and substantial drawdowns – and this speculative momentum could continue for some time.
- In contrast to direct cryptocurrency ownership, **there are attractive institutional investment opportunities in the broader crypto ecosystem and the incidental innovation that has flourished in the creation of bitcoin and other cryptocurrencies.** These include private applications of distributed ledger technology and smart contracts used in financial services (like clearing and settlement of securities and international payment systems) as well as

* To sharpen our focus, we limit our analysis to crypto assets intended as substitutes for fiat currencies, such as bitcoin, ether and sol, which collectively represent close to 60% of the sector’s market cap. Digital tokens specific to a particular application or sidechain are not our primary focus. We also explicitly exclude regulated central bank digital currencies (CBDCs) and non-fungible tokens (NFTs) from our analysis, except where they intersect with and influence our view on crypto opportunities and risks.

in logistics and supply-chain management. Tokenization could be a next-generation securitization mechanism for real assets. Additionally, the companies providing the essential infrastructure for crypto innovation will have a head start in underpinning CBDCs and other blockchain-powered applications. This collateral innovation has the potential to generate attractive returns for owners of the companies that provide these services but will not necessarily accrue to the owners of cryptocurrencies.

We share analysis to support our hypotheses and unpack the critical investment implications of these conclusions in the rest of this report. Chapter 1 summarizes the cryptocurrency landscape, cutting through the breathless media hype. Chapter 2 explains why cryptocurrencies are deeply inadequate as

currencies. Chapter 3 lays out the empirical evidence for why cryptocurrencies fail to meet most institutional investor objectives around portfolio diversification, risk-adjusted returns, inflation protection and ESG. To “stress test” our conclusions, we also lay out the potential scenarios that would need to materialize for the extraordinary price trajectory of bitcoin and other cryptocurrencies to continue. Our base case is these scenarios are highly unlikely to materialize.

Finally, Chapter 4 argues that enduring value for long-term investors will be found not in cryptocurrency holdings themselves, but in the use cases and applications from the remarkable breakthroughs that are the accidental by-products of the heroic but potentially doomed quest to build a viable decentralized, unregulated peer-to-peer payment system.

About PGIM

PGIM, the investment management business of Prudential Financial, Inc. (PFI), has a history that dates back over 145 years and through more than 30 market cycles.* Built on a foundation of strength, stability and disciplined risk management, PGIM's more than 1,300 investment professionals are located in key financial centers around the world. Our firm is comprised of six autonomous asset management businesses, each specializing in a particular asset class with a focused investment approach. This gives our clients diversified solutions from a leading global asset manager with global depth and scale across public and private asset classes, including fixed income, equities, real estate, private credit and other alternatives.

* 30 market cycles represents PFI's asset management expertise through PGIM, its affiliates and its predecessors.

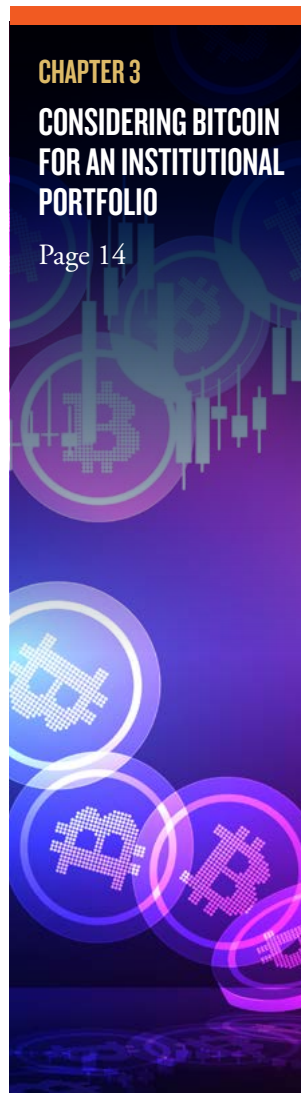
TABLE OF CONTENTS



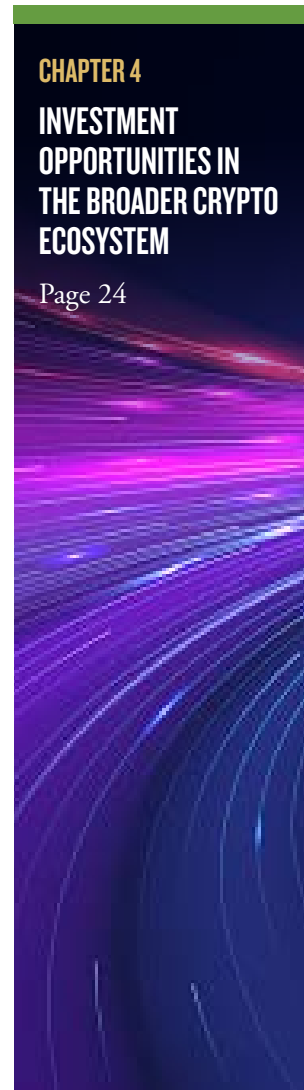
CHAPTER 1
UNDERSTANDING THE CRYPTOCURRENCY ECOSYSTEM
Page 4



CHAPTER 2
NOT QUITE A CURRENCY
Page 10



CHAPTER 3
CONSIDERING BITCOIN FOR AN INSTITUTIONAL PORTFOLIO
Page 14



CHAPTER 4
INVESTMENT OPPORTUNITIES IN THE BROADER CRYPTO ECOSYSTEM
Page 24

CHAPTER 1

UNDERSTANDING THE CRYPTOCURRENCY ECOSYSTEM

“

The ingenuity displayed in bringing together distributed ledgers and cryptographic methods represents a real technological breakthrough.”

CHAPTERS

1

2

3

4

CHAPTER I

UNDERSTANDING THE CRYPTOCURRENCY ECOSYSTEM

On October 31, 2008, a user with the pseudonym Satoshi Nakamoto posted a link on a cryptography mailing list to a short white paper on bitcoin, setting off the cryptocurrency revolution.⁵ The paper envisioned an electronic payment system that allows “any two willing parties to transact directly with each other without the need for a trusted third party.”

Bitcoin’s focus on real-time transparency, anonymity, security and trustless ownership without government or legacy banking system involvement was perfectly timed for a world still reeling from the Global Financial Crisis and the collapse of Lehman Brothers six weeks before.⁶

Whatever bitcoin’s ultimate destiny, the ingenuity displayed in bringing together distributed ledgers and cryptographic methods represents a genuine technological breakthrough.* Indeed, fast forwarding to 2022, bitcoin remains the dominant cryptocurrency in circulation, with a market share greater than 40%. And if imitation is the sincerest form of flattery, bitcoin has spawned over 10,000 cryptocurrencies and digital tokens to date!⁷

We identify the key features of this array of cryptocurrencies in this chapter and cut through the industry jargon to understand the underlying innovation behind them as well as the broader and rapidly evolving “crypto ecosystem” – which goes well beyond the digital currencies themselves.

What are cryptocurrencies?

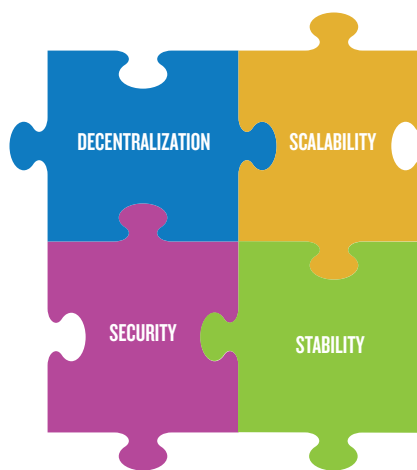
Cryptocurrencies are digital assets maintained and recorded on a blockchain without a trusted intermediary such as a custodian or bank. Every cryptocurrency exists on a blockchain – a decentralized ledger – that records, clears and validates every transaction ever made on that network. Some cryptocurrencies (e.g., bitcoin, ether, Solana) have their own proprietary blockchains; others (e.g., Uniswap, Chainlink, Maker)

use existing blockchains – most commonly the Ethereum blockchain. Cryptocurrencies are inexorably linked to their underlying blockchain; indeed, many of the differences between them can be attributed to the differences in their underlying blockchains.

The four dimensions of every cryptocurrency

The more than 10,000 successors of bitcoin all make design decisions along four dimensions: decentralization, security, scalability and stability. Taken together, these four dimensions allow one to neatly classify the crowded cryptocurrency universe. Every cryptocurrency (and its underlying blockchain) is a unique and different trade-off between these elements (Exhibit 1).

Exhibit 1: Four Dimensions of Cryptocurrencies



Source: PGIM Thematic Research.

* Bitcoin refers both to the digital cryptocurrency as well as the underlying blockchain network.

Decentralization

Decentralization refers to creating an immutable ledger that does not rely on a central entity for validation of participants and transactions. This is in stark contrast to conventional finance where a trusted financial intermediary (often a bank) clears, verifies and records transactions on behalf of customers. On a blockchain, this key function is instead divided among multiple independent “miners” who are financially incentivized – with utility tokens or cryptocurrencies – to act as independent verifiers of the network’s authenticity. Miners record transactions as well as verify other miners’ transactions. On the bitcoin blockchain, these incentive tokens are bitcoin. This ability to make payments anonymously via a “trustless” network is attractive for those seeking a mechanism that is relatively anonymous and independent of financial institutions or governments.

Cryptocurrencies are inexorably linked to their underlying blockchain.

Security

Security refers to the rigor associated with verifying transactions on the blockchain. The degree of rigor determines the ability of the blockchain to function as expected while defending itself from fraud, cyberattacks,

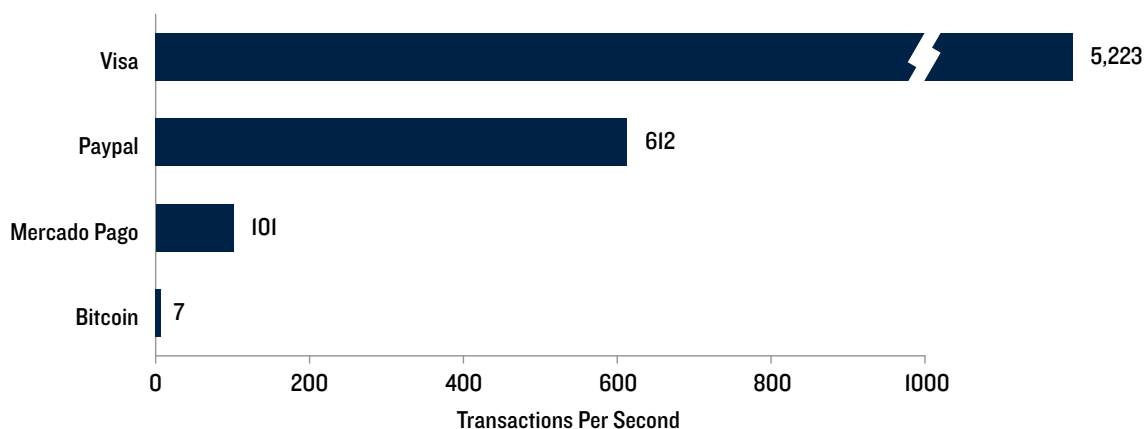
hackers, bugs and other malicious ware. With more nodes recording and validating each transaction, the challenge of corrupting a sufficient portion of the network to hack it or record false transactions becomes more daunting. Blockchains that optimize for security (such as the bitcoin network) are typically highly decentralized. Indeed, though crypto exchanges have been hacked repeatedly, the bitcoin blockchain itself has never been successfully compromised.

Scalability

Scalability refers to the ability of a blockchain to handle an increasing volume of transactions. Efficiency in transaction speed and the cost of recording and validating transactions are paramount for scalability – which in turn is essential for blockchain technology to become a widespread digital payment system. Without some compromise on decentralization and security – what Ethereum co-founder Vitalik Buterin labels the “blockchain trilemma” – it will not be easy for blockchain networks to get to scale efficiently and compete with traditional networks in convenience, speed and capacity (Exhibit 2).⁸

In response to this significant deficit in processing speed, companies are developing a range of scaling solutions. Some aim to create new, faster blockchains (termed Layer 1 solutions) while others are building applications on top of an existing blockchain to boost its efficiency (termed Layer 2 solutions), essentially by bundling multiple user transactions and recording them in aggregate rather than individually.

Exhibit 2: Transaction Speed of Payment Networks



Source: PGIM Thematic Research. Data from 2021 10-K for Paypal, Mercado Pago and Visa; Nasdaq Data for Bitcoin.
Note: Maximum number of transactions for Bitcoin. Average number of transactions for Visa, Paypal, and MercadoPay.

Exhibit 3: Leading Cryptocurrencies and Stablecoins

Cryptocurrency	Market Cap (\$ Billions)	Security	Decentralization	Scalability	Stability
Bitcoin (BTC)	\$585	✓	✓		
Ethereum (ETH)	\$278	✓	✓		
Tether (USDT)	\$83			✓	✓
USD Coin (USDC)	\$48			✓	✓
Ripple (XRP)	\$24	✓	✓		
Sol (SOL)	\$22	✓		✓	

Source: PGIM Thematic Research; CoinMarketCap as of May 9, 2022.

Note: Both Tether and USD Coin are backed by cash and money market instruments (commercial paper, Treasury bills, etc.).

For example, Lightning Network is a scaling solution for the bitcoin blockchain and StarkNet is a scaling solution for the Ethereum blockchain. Many of these scaling solutions may be quite relevant for current and future CBDCs as well.

Stability

All cryptocurrencies face the trade-offs of the blockchain trilemma. But not all cryptocurrencies face tremendous volatility in value. Stablecoins such as Tether, USD Coin and Dai are digital currencies recorded and transacted on a blockchain whose value is explicitly linked to another asset. Many of the most prominent stablecoins are linked to a fiat currency – often, the U.S. dollar (Exhibit 3). Depending on the stablecoin, these reserves can either be “on-chain” (in the form of digital assets) or “off-chain” (in the form of conventional money market assets).⁹ Regardless of whether a stablecoin is backed by fiat or digital assets, the reserve mechanisms are not regulated or required to be audited. In fact, management and reporting of reserves is largely left to the discretion of the coin issuer.

Who are the owners of cryptocurrency?

In understanding the makeup and motivations of cryptocurrency holders, it is probably most instructive to focus on bitcoin, which is by far the largest cryptocurrency by market cap as of March 2022.¹⁰ Roughly a third of bitcoin currently in circulation is held by intermediaries (e.g., exchanges, gambling sites, darknet sites, or brokers) while half are controlled by individual investors.¹¹ Individual ownership is highly concentrated; at the beginning of 2021, the top 0.25% of owners held about 20% of bitcoin.¹²

It is worth considering what draws individual investors to cryptocurrencies. We believe there are five primary reasons:

1. Retail and high-net-worth investors are attracted to the excitement and remarkable speculative returns possible from holding bitcoins or other cryptocurrencies. Anecdotal media and cocktail party accounts of early adopters who became overnight bitcoin millionaires are now

commonplace.¹³ Social media hype from tech entrepreneurs and celebrity investors such as Elon Musk and Cathie Wood has furthered the frenzied momentum around cryptocurrencies.¹⁴

2. There is declining faith in financial institutions and governments – a growing phenomenon since the Global Financial Crisis.¹⁵ For example, the Edelman Trust index for the U.S. has declined by an additional 10 points from an already-low starting point since 2017.¹⁶
3. Retail investors are drawn to bitcoin because of its limited supply and inherent scarcity. In particular, crypto enthusiasts view cryptocurrencies as “digital gold” that protects them from the monetary debasement of fiat currencies – a concern that has been heightened with post-COVID inflationary pressures in many economies.
4. Active traders, especially multi-strategy and quant hedge funds, exploit inefficiencies and arbitrage opportunities arising from the wild gyrations in cryptocurrency prices. By mid-2021, about 20%

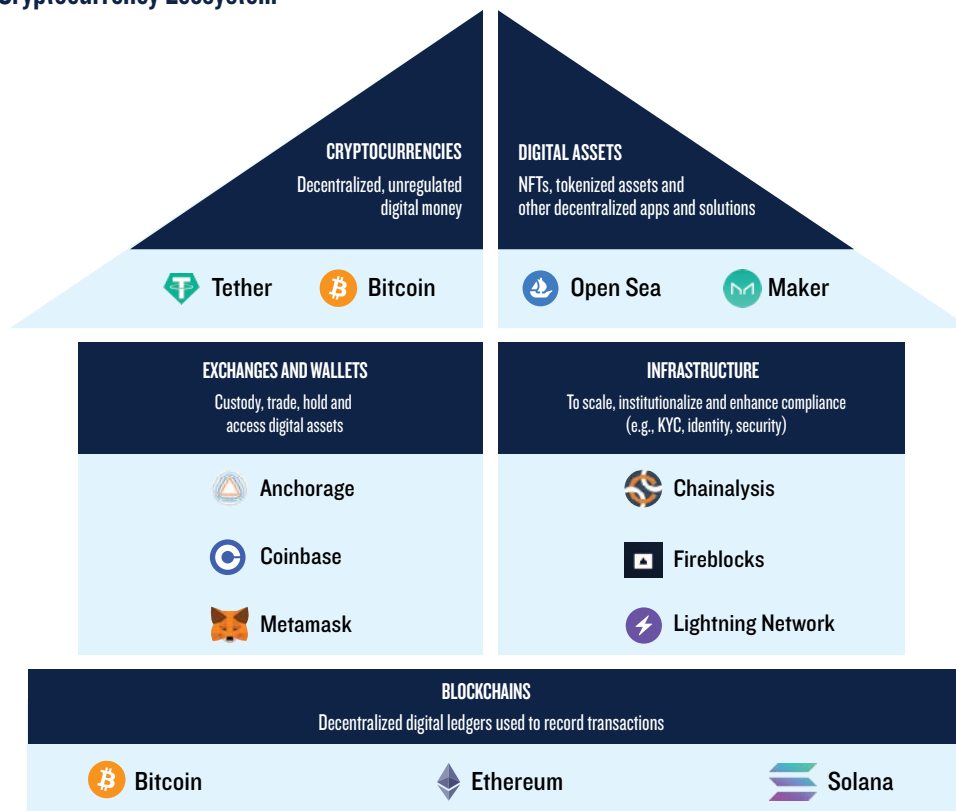
of surveyed hedge funds were actively trading digital assets like bitcoin.¹⁷

5. Crypto natives are active in the metaverse, where cryptocurrencies and digital tokens are established as the primary medium of exchange. For example, V-bucks is the in-game currency used in Epic’s Fortnite multi-user online game, Shards are the digital token in the online, Pokemon-inspired game Axie Infinity, and ether is widely used to purchase NFTs (i.e., digital collectibles).

The broader crypto ecosystem

Cryptocurrencies are part of a broader ecosystem (Exhibit 4) that extends well beyond the digital currencies themselves and include the blockchains they are built on as well as the necessary infrastructure to support mining and storage. It also includes the exchanges where cryptocurrencies trade and the wide array of use cases and applications built on blockchains such as non-fungible tokens and cross-border payment networks. Additionally, it encompasses the

Exhibit 4: The Cryptocurrency Ecosystem



Source: PGIM Thematic Research.

The broader ecosystem has many companies and applications that are likely to endure regardless of the success of the cryptocurrencies that spawned them.

constellation of compliance, risk management and security tools designed to increase comfort levels within the lightly or unregulated crypto marketplace. Finally, the ecosystem also includes the venture capital investors and initial coin offerings that fund so much of this universe.

Critically for investors, this broader ecosystem – and the tremendous innovation it is generating – has many companies, use cases and applications that are likely to endure regardless of the success of the cryptocurrencies that spawned them. Indeed, many of these use cases are not limited to or reliant on cryptocurrencies at all. The best opportunities for institutional investors may lie in this ecosystem rather than in cryptocurrencies themselves.

Smart contracts are an excellent example of this collateral innovation. They are self-executing digital code that holds an agreement between multiple parties and executes as various terms or conditions are met. Smart contracts can be applied to transactions

involving *any* digital asset – including CBDCs and digitized tokens or securities. The Ethereum blockchain, released in 2015, was built as the first blockchain platform to enable smart contracts. It now powers a range of digital applications designed to manage trade finance, escrow services, supply-chains and even insurance claims without costly and lengthy human or institutional intermediation. Some forward-thinking central banks and regulators are closely following innovation in the flourishing crypto ecosystem – for example, around holding, trading, reporting and security of digital currencies – with an eye on future private-public partnerships that may allow these innovations to power CBDCs.¹⁸

We will return to the multiple investment opportunities in the broader crypto ecosystem in Chapter 4. But before we head there, let's dive deeper into cryptocurrencies themselves.

The next chapter explains why our base-case scenario is quite bearish about cryptocurrencies as a currency. This bearishness underpins our ultimate thesis, summarized by the California Gold Rush adage, that “the best way to profit is not to speculate on gold, but to sell picks and shovels.”

CHAPTER 2

NOT QUITE A CURRENCY

“

No cryptocurrency adequately fulfills the three essential functions of money.”

CHAPTERS

1

2

3

4

CHAPTER 2

NOT QUITE A CURRENCY

Money has taken different forms through the ages, from cowry shells to peppercorns and from silver coins to the greenback, but they all share three common characteristics. They act as (1) a store of value, (2) a widely accepted medium of exchange and (3) a unit of account. Unfortunately, no cryptocurrency to date adequately fulfills these three essential functions. Bitcoin, the most prominent cryptocurrency, for example, has a notoriously unstable price, is a poor medium of exchange and is rarely used outside the crypto-native digital realm as a unit of account. These fundamental inadequacies are rarely acknowledged by crypto enthusiasts, who often conflate bitcoin's phenomenal price appreciation with its actual utility as a digital cryptocurrency.¹⁹

Do cryptocurrencies pass any of the three well-defined tests of a currency?

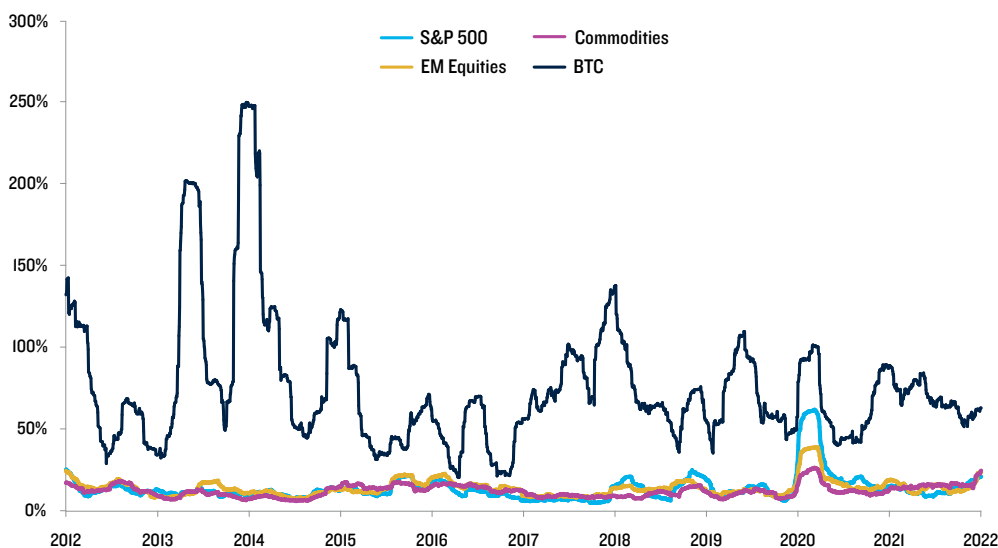
Store of Value

Preserving value, at least over short periods of time, is an important function of currency. Fiat currencies can be eroded over time by price inflation. However, outside of extremely rare hyperinflationary environments they have been an efficient store of

Bitcoin has an unstable price, is a poor medium of exchange and is rarely used outside the crypto-native realm as a unit of account.

short- and medium-term value. In contrast, the wild price gyrations of many cryptocurrencies make them highly unattractive as a store of value – even in the

Exhibit 5: Rolling 3-Month Volatility of Select Asset Classes



Source: PGIM analysis; Refinitiv and Bloomberg.

Note: Volatility of daily returns, annualized. The Bloomberg Commodity and MSCI Emerging Markets Index were used for Commodities and EM Equities respectively.

very short term. Exhibit 5 demonstrates how the price of bitcoin has remained extremely volatile since its inception. Bitcoin clearly falls short on this first test of a workable currency.

Central bank digital currencies are not a distant prospect: China has already launched the e-CNY.

Of course, stablecoins pegged to fiat currencies could function as a more reliable store of value, but they face a potentially existential risk: they would be made redundant once central bank-issued digital currencies (CBDCs) become more commonplace.*

For example, a digital dollar issued by the Federal Reserve and backed by the U.S. Treasury would provide all the functionality of USD Coin – but without any liquidity or credit risk.²⁰ And CBDCs are not a distant prospect: China has already launched the e-CNY. The Fed released a long-awaited study on a digital dollar in January 2022 and the ECB will share its findings on the viability of a digital euro in 2023.

Even beyond the threat from CBDCs, there are material risks around the reserve mechanisms of stablecoins – including a lack of transparency and third-party audits. Stablecoins are essentially unregulated money market funds. Even when regulated, the stable value of these instruments remains vulnerable to large outflows under stressed conditions, as was evident during the financial crisis in 2008.²¹ This lack of transparency and reliable auditing in prominent stablecoins was apparent in the case of Tether – the largest issuer of stablecoin – which was fined for falsifying reserve reporting.²²

Medium of Exchange

Cryptocurrencies are still not close to being widely used as a medium of exchange. It is indeed telling that

even after a dozen years, few commercial enterprises accept them. Using bitcoin as an example, this situation is unlikely to change soon for several reasons.

First, the bitcoin blockchain, optimized for security and decentralization, does not prioritize operational efficiency. Bitcoin's maximum transaction speed of 7 transactions per second (TPS) pales in comparison to the speed of conventional payment networks, which average 1,700 TPS.**

Second, bitcoin transactions are expensive rather than cheap and frictionless. In fact, bitcoin's transaction fees are an intrinsic outcome of the highly secure and decentralized structure of its blockchain and the need to incentivize miners to decipher cryptographic problems. Fees have been as high as \$50 for a single transaction – making bitcoin highly impractical for everyday, small-scale transactions.²³

Bitcoin's high transaction fees are an intrinsic outcome of the highly secure and decentralized structure of its blockchain.

Unit of Account

Currencies are used to denominate the value of products and services. That is, a haircut, a cup of tea, or a diamond ring are typically priced in euros, pesos or yuan. Fiat currencies serve as a common yardstick to measure value across the wide range of daily economic transactions.

Outside of the deep digital realm, however, cryptocurrencies are only rarely used to price products or services. While a growing number of companies accept bitcoin as a payment option (e.g., Burger King, Microsoft, Norwegian Air, and Pizza Hut, to name a few), *none of them* price their products or services in

* A CBDC is the digital form of a country's fiat currency. Instead of issuing paper money, the central bank issues electronic coins or accounts backed by the full faith and credit of the government. However, as they are issued by central banks, they are not truly decentralized and not technically considered cryptocurrencies.

** Blockchains optimized for scalability do offer more attractive transaction speeds. For example, the Solana blockchain theoretically offers up to 65,000 TPS. However, even its cryptocurrency falls short in terms of being a store of value or a unit of account.

Merchants simply accepting bitcoin does not mean it is preferable – or even viable – for wages, prices and assets to all be denominated in bitcoin.

bitcoin. In other words, virtually no business fixes the price of their product in bitcoin and then converts it into fiat currencies.

Importantly, merchants simply accepting bitcoin does not mean it is preferable – or even viable – for wages, prices and assets to all be denominated in bitcoin.²⁴ The lone real-world example of a nation adopting bitcoin as its currency, El Salvador, has not gone well so far. Early experience strongly suggests both consumers and businesses have resisted government-mandated adoption and prefer to price merchandise and transact in U.S. dollars anyway.^{25, 26}

No matter how robust the evidence on the inadequacies of cryptocurrencies as a currency, it is undoubtedly true that some market actors have invested heavily in cryptocurrencies. The soaring speculative rise of many cryptocurrencies has been dramatic, and it is hard to predict how much further momentum can carry cryptocurrency valuations. Some investors now see cryptocurrencies as a new “digital gold.”

Regardless of their multiple shortcomings as currencies, Chapter 3 discusses if cryptocurrencies have a useful or significant role to play in institutional portfolios – and also lays out some alternative scenarios institutional investors would need to believe under which cryptocurrencies would potentially continue to flourish.

CHAPTER 3

CONSIDERING BITCOIN FOR AN INSTITUTIONAL PORTFOLIO

“

The time has come to seriously examine what role bitcoin might play in an institutional multi-asset portfolio.”

CHAPTERS

1

2

3

4

CHAPTER 3

CONSIDERING BITCOIN FOR AN INSTITUTIONAL PORTFOLIO

The spectacular returns, growing scale and market cap of the crypto universe, the search for higher real returns in a yield-starved investment universe as well as their purported role as “digital gold” — a safe haven in volatile times — has led many institutional investors to at least consider allocating a small percentage of their portfolio to cryptocurrencies.

Even for the most hardened skeptics, the time has come to seriously examine what role bitcoin might play in an institutional multi-asset portfolio, particularly in an era of rising geopolitical and inflation risks.

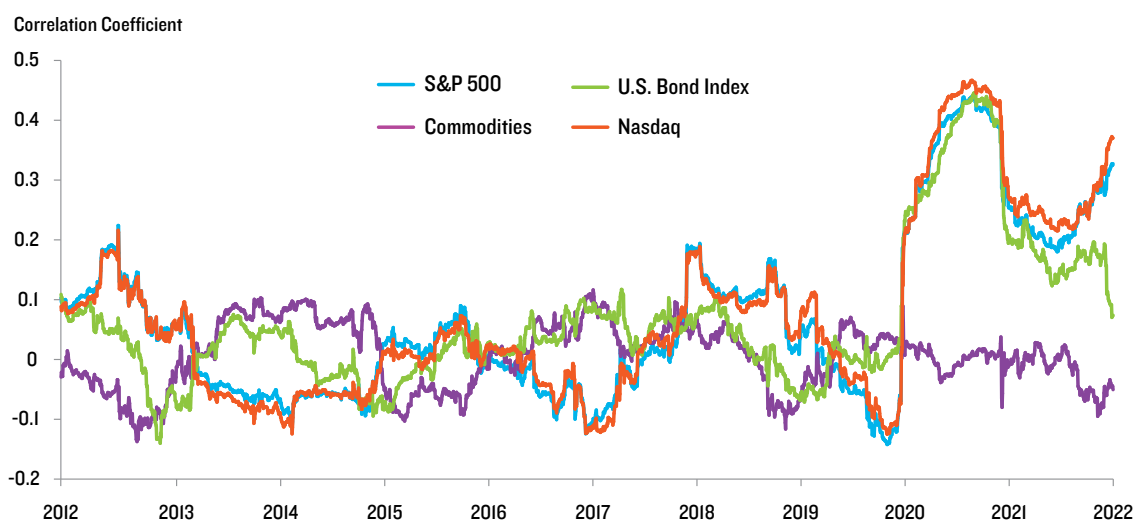
While it would be foolhardy to arrive at a definitive verdict given the brief time period since Bitcoin’s inception and the ongoing evolution of cryptocurrencies, our evaluation of the evidence to date strongly suggests that, despite robust valuations and the conviction of ardent crypto enthusiasts, direct investment in bitcoin or other cryptocurrencies currently offers little benefit to institutional investors and considerable volatility and regulatory risk.

Are cryptocurrencies an effective portfolio diversifier?

Given its deliberate detachment from sovereign states and monetary institutions, bitcoin would appear to be less impacted by classic macroeconomic factors than conventional asset classes such as equities, bonds or commodities.

Unfortunately, for investors looking for diversification, bitcoin’s correlation with equities and commodities has been unstable and trending higher of late. Between 2013 and 2019, bitcoin had a near-zero average correlation with broad U.S. equities and commodities. Starting in 2020, however, its

Exhibit 6: Bitcoin Correlation with Various Assets
(Rolling 1-year)



Source: PGIM analysis; Refinitiv and Bloomberg.

Note: The Bloomberg Commodity Index and Bloomberg Aggregate Bond Index were used for Commodity and Bonds respectively.

correlation with U.S. equities and commodities spiked sharply and has remained consistently positive since (Exhibit 6). Even the International Monetary Fund has noted the “increased and sizable co-movement and spillovers between crypto and equity markets indicate a growing interconnectedness” that is a growing source of systemic risk.²⁷ This suggests cryptocurrencies may not be particularly effective as a portfolio diversifier going forward.

Bitcoin’s correlation with equities and commodities has been unstable and trending higher since 2020.

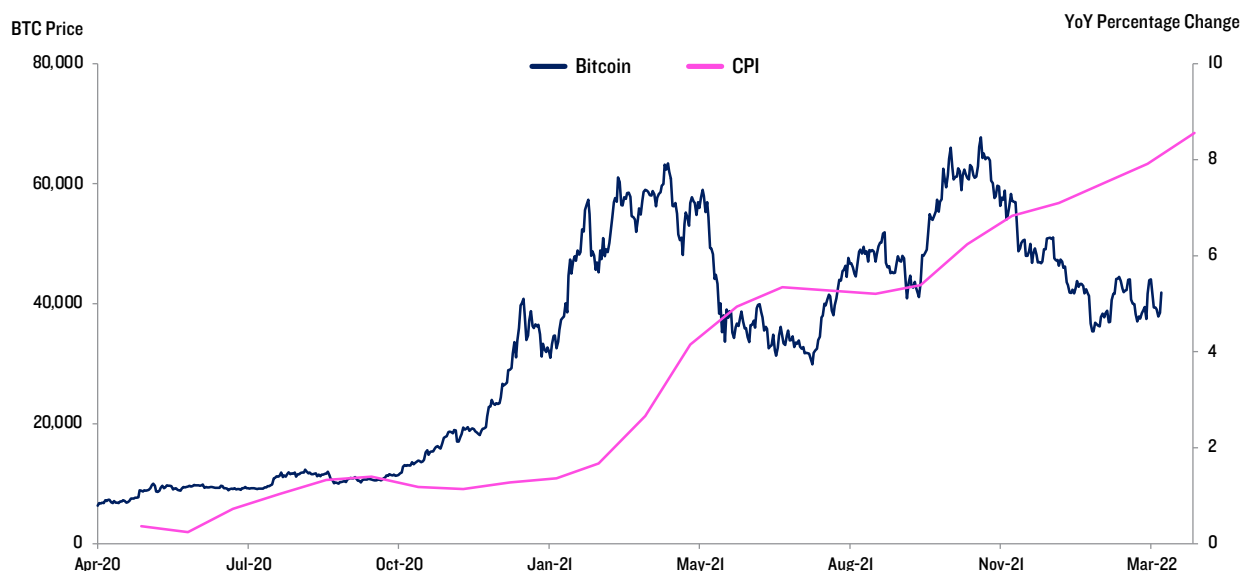
That an emerging asset class has a growing correlation with other assets as it matures is not only theoretically plausible but has historical precedent. Some frontier equity markets have demonstrated a similar tendency in the past. It should therefore come as no surprise that as bitcoin has gone mainstream it has also grown more

sensitive to the broader liquidity and risk sentiment factors that move other assets. In fact, market factor analysis demonstrates that bitcoin has developed a strong “trend following” tendency and more investors view bitcoin as a high-beta, risk-on asset.²⁸

Is bitcoin an effective hedge against inflation?

Bitcoin is scarce. That is, its supply is limited to 21 million coins and this is hard-coded into the bitcoin algorithm. This constraint suggests its value, much like gold, may be resistant to fiat monetary debasement or price inflation. However, there is scant evidence to support this thesis. In the lone episode of elevated U.S. inflation since the introduction of cryptocurrencies, bitcoin provided only limited inflation protection. U.S. prices were whipsawed during the pandemic and inflation began to soar steadily in 2021 and into 2022. The price of bitcoin moved with inflation only for a brief time before falling sharply (Exhibit 7). Gold, on the other hand, has demonstrated since the 1970s that it can be a reasonably effective and reliable long-term inflation hedge.²⁹

Exhibit 7: U.S. Inflation vs. Bitcoin Price



Source: Bloomberg and Federal Reserve Economic Data.

How does bitcoin's volatility and risk-adjusted return compare to other assets?

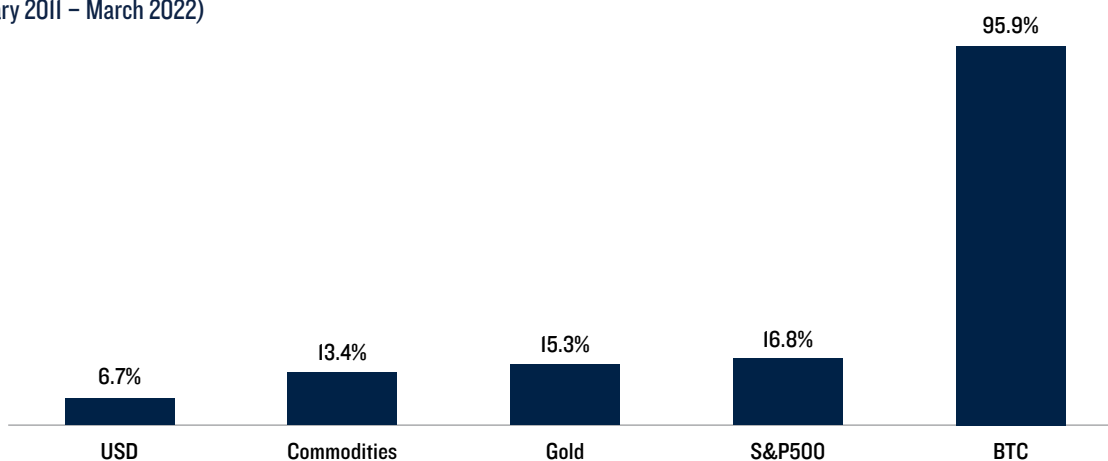
Bitcoin has a justified reputation for being *substantially* more volatile than other asset classes (Exhibit 8).

This extreme volatility manifests itself in far more instances of 10%, 25% and even 50% drawdowns

than either equities or commodities over its brief history. Between June 2010 and March 2022, bitcoin recorded more than 25 episodes of drawdowns of 25% or more. By comparison, equities and commodities recorded just one each (Exhibit 9).

When considering risk-adjusted returns, bitcoin had an extraordinary risk-return profile early on. However, it has not retained this superior performance.

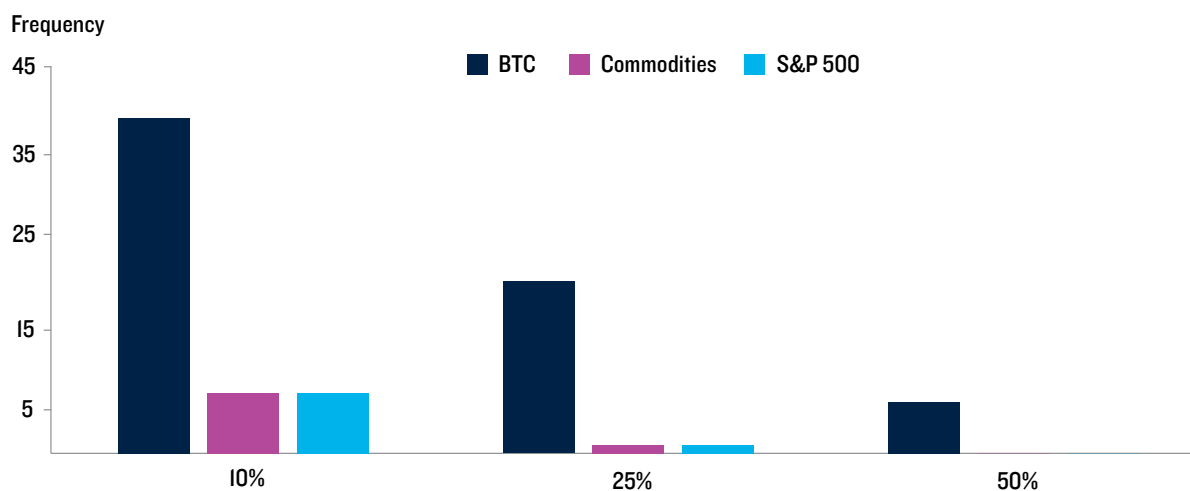
Exhibit 8: Asset Volatility
(January 2011 – March 2022)



Source: PGIM Thematic Research; Refinitiv and Bloomberg.

Note: Volatility of daily returns, annualized. The Bloomberg Commodity Index and London Bullion Market Association Gold Price were used for Commodities and Gold respectively.

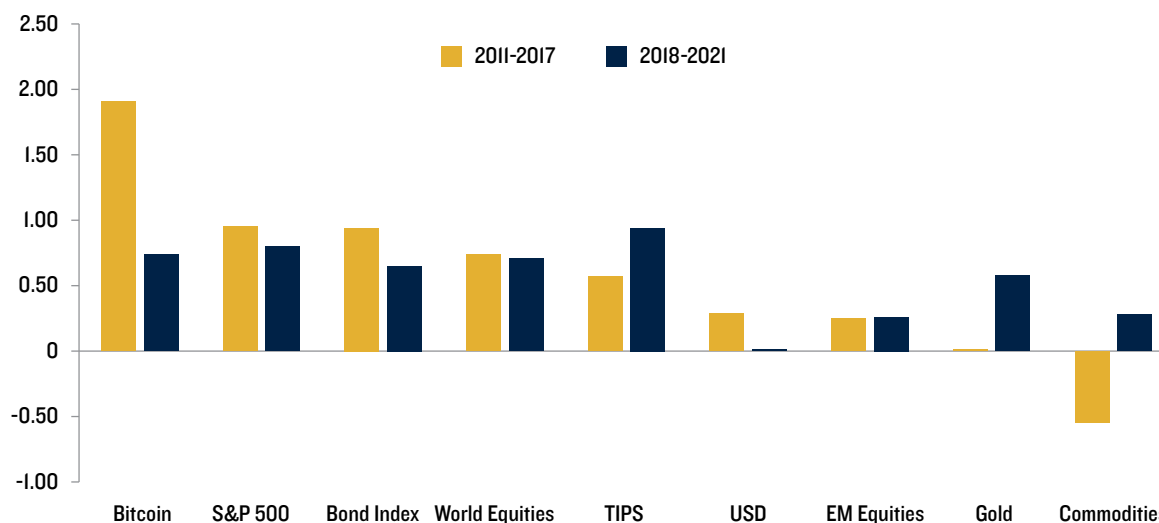
Exhibit 9: Frequency of Drawdowns
(June 2010 – March 2022)



Source: PGIM Thematic Research; Bloomberg and Refinitiv.

Note: Drawdowns calculated over a 3-month rolling window. The Bloomberg Commodity Index was used for Commodities.

Exhibit 10: Sharpe Ratios of Select Asset Classes



Source: PGIM Thematic Research; Refinitiv and Bloomberg.

Note: The MSCI World Index, Bloomberg Aggregate Bond Index, Bloomberg Inflation-Linked Bond Index, U.S. Dollar Index, MSCI Emerging Markets Index, London Bullion Market Association Gold Price, and Bloomberg Commodity Index were used for Global Equities, Bond Index, TIPS, USD, EM Equities, Gold, and Commodities respectively.

Since 2018, its Sharpe ratio has been similar to other assets (Exhibit 10). Given the frequency and severity of drawdowns and its diminished risk-adjusted performance since 2018, it is not clear what role an asset class offering zero yield and dubious diversification qualities should play in a long-term strategic portfolio allocation.³⁰

Bitcoin had an extraordinary risk-return profile early on, but it has not retained this superior performance.

Does bitcoin function as a safe-haven asset? Is it “digital gold”?

Like gold, bitcoin is not issued nor controlled by an institution, central bank, or government. This characteristic has enabled gold to serve as a safe-haven asset during some periods of increased economic or political uncertainty. Does bitcoin share some of those characteristics as well? No, it does not.

For starters, the theoretical foundations of cryptocurrencies as a safe haven are somewhat shaky. A white paper, no matter how elegant, cannot decree a safe haven. In contrast, gold and other precious metals have held some financial status for over 2,000 years.³¹ Furthermore, many precious metals have multiple consumer and industrial uses that – unlike cryptocurrencies – give them a non-zero price floor.³² For example, currently about half of gold production goes to jewelry, one-tenth to industry and a quarter to back central bank reserves.³³

More importantly, the empirical evidence to date does *not* support the hypothesis of bitcoin as a safe haven. Over its short history, bitcoin has not exhibited stability in its value. Between 2015 and 2022, for example, its volatility was consistently *much* higher than other conventional safe-haven assets such as gold, U.S. Treasuries, or the U.S. Dollar (Exhibit 11).

The true test for a safe-haven asset, however, is how it retains its value during a period of extreme and widespread market volatility. Bitcoin was not exactly a steadying force in early 2020 when global asset prices spiraled downward due to worldwide COVID-induced shutdowns. It did *not* exhibit safe-haven characteristics at that time and held *far less* of its value

than conventional safe-haven assets like gold and the U.S. dollar (Exhibit 12).

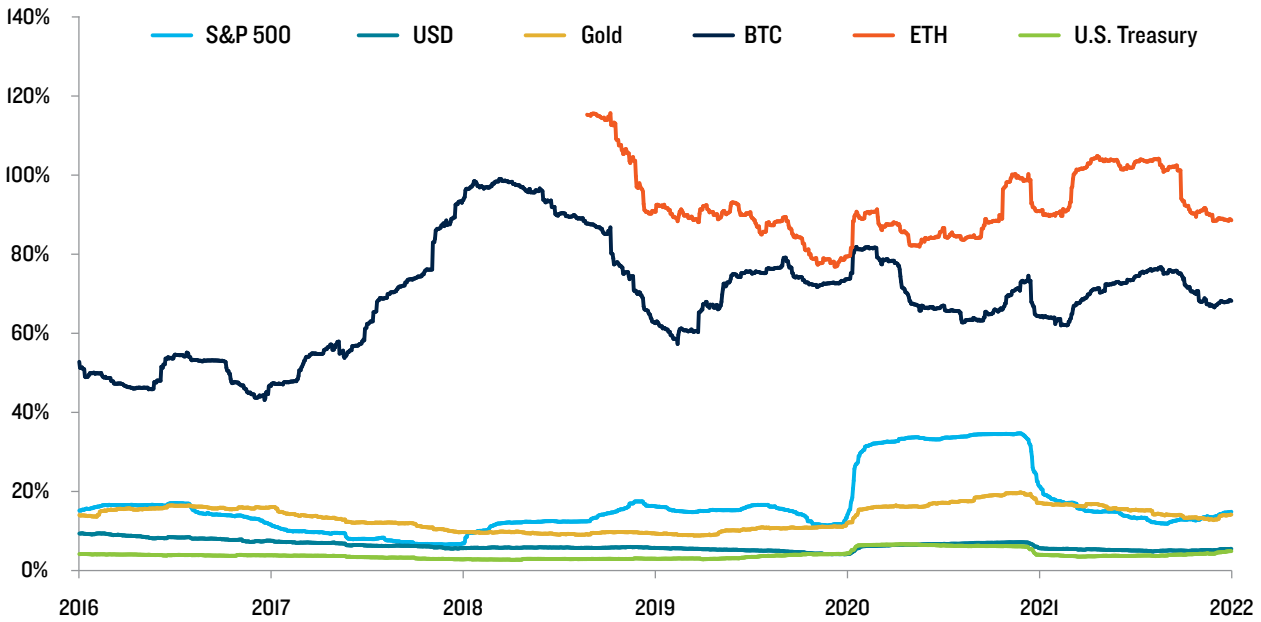
Does bitcoin offer any short-term alpha opportunities?

Some features of cryptocurrency markets, especially the wild price gyrations, provide opportunities for active trading. In particular, hedge fund strategies

can potentially exploit market inefficiencies and dislocations that arise in these immature, retail- and momentum-driven markets.

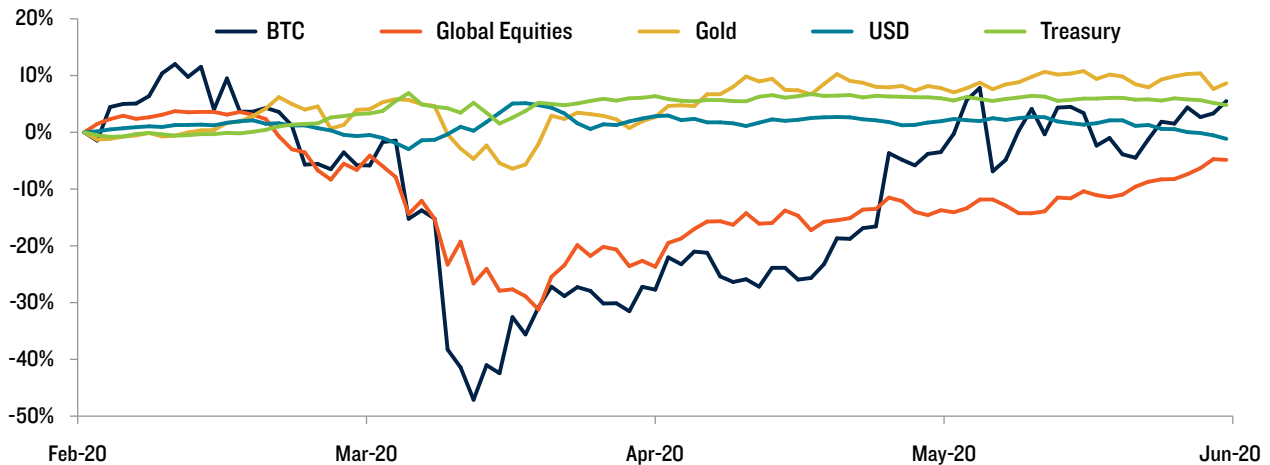
Dislocations in the nascent cryptocurrency market draw comparisons to other less efficient frontier markets. For example, futures contracts for some cryptocurrencies are not standardized and their prices do not always align with spot markets

Exhibit II: Price Volatility of Select Asset Classes



Source: Refinitiv and Bloomberg.
 Note: Annualized rolling 1-year volatility. The London Bullion Market Association Gold Price and Bloomberg Treasury Index were used for Gold and Treasuries respectively.

Exhibit 12: COVID Market Drawdown



Source: Refinitiv and Bloomberg.
 Note: The MSCI World Index, London Bullion Market Association Gold Price, and Bloomberg Treasury Index were used for Global Equities, Gold and Treasuries respectively.

across exchanges, creating arbitrage opportunities that quant hedge funds have been successfully exploiting.³⁴ In addition, the extraordinary volatility of cryptocurrencies presents a wide range to trade in. Also, similar to frontier markets, liquidity and leverage can be unreliable and scarce in cryptocurrency markets.³⁵ Such a backdrop provides return potential for market players who have the capability of providing leverage or liquidity to the market when it is needed most. These alpha opportunities are available to a range of multi-strategy and quantitative hedge funds.³⁶

Cryptocurrencies are problematic along multiple dimensions of ESG.

How do cryptocurrencies align with overall ESG objectives?

For sustainability-minded investors, cryptocurrencies are problematic along multiple dimensions of ESG.

Environmentally, the most worrying aspect of cryptocurrency is its massive energy consumption. Major blockchains – including bitcoin and the original Ethereum – currently utilize a proof-of-work (POW) mechanism to validate transactions that is extremely energy intensive. With a POW validation structure, miners on the blockchain compete for the right to create the next block in the chain by solving complex computational problems. This race typically involves thousands of competitors and is repeated every 10 minutes or so. Each of the competitors utilize computing power and consume electricity, while only one of them wins and is rewarded with newly minted coins.

Because of this highly decentralized validation process, just a single transaction on the bitcoin blockchain, for example, requires enough energy to power the average American home for over two months and has a carbon footprint equivalent to 2 million transactions on the Visa network (Exhibit 13). The total electrical energy use around bitcoin annually is on par with the power consumption of countries like Thailand, South Africa and Ukraine.³⁷ In fact, the soaring demand for

electricity from bitcoin miners has given new life to carbon-intensive energy sources – like fossil fuel power plants – as well as raising concerns over diverting scarce renewable energy from other potential uses.³⁸

The intense energy consumption around bitcoin mining and validation is a major reason several countries – including China – have banned mining altogether.³⁹ Indeed, in the wake of the Chinese ban, mining activity has shifted to alternate locations like Kazakhstan, Canada and Texas and has strained power grids in some of these new locations.^{40, 41}



Subsequent iterations of blockchain such as Cardano and Solana reduce their energy footprint through the use of different, less energy-intensive validation mechanisms. Indeed, even Ethereum is planning a transition to this proof-of-stake validation process in late 2022. However, critics suggest these less energy-intensive validation protocols may be less secure.⁴² Nevertheless, the oversized energy footprint of bitcoin remains a major area of concern for ESG investors.

Socially, cryptocurrencies offer the promise of being more inclusive and accessible, providing a digital platform to underbanked households. However, many mobile phone-based payment services in developing countries (e.g., M-Pesa's domestic money transfers in Kenya and Tanzania or Grameen Bank's international remittance pilots in Bangladesh) have alleviated some of these financial inclusiveness concerns. Mobile phones, of course, are more widely available than high-speed internet service and these payment networks require neither a new currency nor new payment infrastructure.

Furthermore, when it comes to the distribution of wealth, there is no reason to think crypto wealth is less unequal than conventional wealth, and recent empirical research confirms that the distribution of holdings of bitcoin does significantly differ from the distribution of wealth in the U.S. – 0.25% of total global accounts control roughly 20% of the bitcoins in circulation.⁴³

Finally, from a governance perspective, the anonymity and difficulty in identifying cryptocurrency ownership raises significant concerns around anti-money laundering (AML) and sanction evasion. Regulatory scrutiny of these risks is growing.

Exhibit 13: Annualized Bitcoin Power Usage and Carbon Footprint

	ANNUALIZED BITCOIN FOOTPRINTS	SINGLE BITCOIN TRANSACTION
 CARBON FOOTPRINT	Czech Republic The annual carbon footprint of BTC (114 Mt CO ₂) is comparable to the annual carbon emissions of the Czech Republic.	2 Million A single BTC transaction has a carbon footprint (1,180 kg CO ₂) equivalent to two million Visa transactions.
 ELECTRICAL ENERGY	Thailand BTC uses as much electricity annually (204 TWh) as the entire nation of Thailand.	73 Days A single BTC transaction consumes sufficient electrical power (2,200 kWh) to power an average U.S. household for 73 days.

Source: "Bitcoin Energy Consumption Index," Digiconomist, March 2022.

For example, South Korean regulators are auditing commercial banks' ties to cryptocurrency exchanges for AML adequacy and U.K. cryptocurrencies now need to comply with AML requirements by April 2022 as well.^{44, 45}

On sanction evasion, concerns have escalated with the war in Ukraine. Increased trading between ruble and crypto suggest evasion of financial sanctions. Furthermore, links between sanctioned individuals and cryptocurrency wallets, have culminated in the seizure of multiple crypto accounts.^{46, 47, 48}

Will the risk profile of cryptocurrencies improve or worsen going forward?

Our base case is that (1) regulatory uncertainty will decrease as policy frameworks and legal guidelines catch up with the frenzied pace of growth and innovation in the crypto ecosystem, but with that greater clarity will come more rigor; (2) tougher cryptocurrency regulations may act as a significant headwind on the industry; (3) there may be a real threat to the survival of many cryptocurrencies from central bank digital currencies.

First and foremost, a lack of clear and uniform regulations – both across and within countries – has led to tremendous uncertainty for long-term investors evaluating cryptocurrencies for their portfolio.⁴⁹ It remains ambiguous, for example, when a cryptocurrency in the U.S. falls under the regulatory framework of a security – and thus subject to SEC regulations about issuance – and when it is deemed to be an asset like bitcoin and Ethereum have claimed. This lack of clarity around a fundamental question is emblematic of the material policy risks facing crypto investors.

Some regulators are keen to nurture the innovation around cryptocurrencies and blockchain technology. The UK government, for example, is planning to accept stablecoins as a form of payment in a push to become a global hub of crypto innovation.⁵⁰ Meanwhile, other regulators view cryptocurrencies as a major risk to both consumers and to the commercial banking systems they oversee.^{51, 52}

In addition to unclear regulation and rising scrutiny, cryptocurrencies are facing outright prohibition in some countries. China's abrupt banning of all cryptocurrency trading and mining in the fall of 2021 is a prominent example, but by no means the

only one (e.g., Egypt and Bangladesh).⁵³ Even when not explicitly prohibited, some countries are taking measures to rein in crypto trading. India, for example, has decided to tax income from the transfer of cryptocurrencies at 30%.⁵⁴

Market manipulation is another area of concern. With almost no regulations around cryptocurrency insider trading or price manipulation, celebrity crypto

influencers can send market prices soaring or tumbling with impunity. In May 2021, a series of tweets by Elon Musk, mentioning personal and corporate activity in bitcoin, sent the price of bitcoin soaring by as much as 10%.⁵⁵ This was not the only incident, as supportive tweets around dogecoin led to short-lived 30% gains.⁵⁶ This came just two weeks after prior comments sent dogecoin prices into sharp decline.⁵⁷

Box I: What do investors need to believe to justify cryptocurrency valuations?

What do you have to believe?	Why this outcome is not our base case
<p>Spiraling inflation from central banks “printing money” and excessive government debt leads market participants to abandon government-issued fiat currencies for cryptocurrencies across most transactions.</p>	<p>Fighting inflationary pressure remains a key objective for central banks, with a greater risk they overshoot in monetary tightening and rate increases triggering a recession. In any case, persistently high inflation in a few G8 currencies would more likely lead to a shift to other major fiat currencies rather than bitcoin.</p>
<p>Cryptocurrency’s extreme volatility turns out not to be a retail-fueled speculative bubble but the price discovery journey of a new asset class that slowly becomes a stable and truly diversifying addition to investor portfolios. In this scenario, bitcoin matures into “digital gold” and takes a significant share of gold’s market share as an institutional asset.</p>	<p>While multiple bitcoin rallies may imply more staying power than typical bubbles, cryptocurrency pricing is likely based on speculative behavior and a fundamental thesis around its value has yet to emerge. Furthermore, with limited evidence that bitcoin is an inflation hedge or safe-haven asset it is unlikely cryptocurrencies will be widely held by institutional investors.</p>
<p>Major cyberattacks overwhelm traditional financial institutions as well as wholesale and retail payment networks. With plummeting trust in the formal banking system, market participants turn to cryptocurrencies to seek security and reliability.</p>	<p>Cyberattacks that systematically derail the global payment networks for a sustained period would likely also disrupt the global internet infrastructure – making mining, trading and using cryptocurrencies quite problematic.</p>
<p>Major central banks fail to launch CBDCs due to a desire to protect the conventional banking system, technological and operational shortcomings in the public sector, or just general ineptitude. In the absence of major CBDCs, digital stablecoins fill the void.</p>	<p>While some central banks will inevitably lag, nearly all major central banks are exploring how to issue digital currencies. China has already launched a digital renminbi. Active discussions are ongoing in the U.S. and the EU, with our base case that several G8 countries will launch CBDCs over the next five years.</p>
<p>Mistrust in governments and institutions by their citizens grows more widespread, perhaps triggered by a global banking sector meltdown. Cryptocurrencies fill the void.</p>	<p>The 2008 financial crisis and COVID pandemic tangibly demonstrated that governments and central banks remain willing and able to support commercial banks under stress. Furthermore, with more than 100 different fiat currencies and central banks, it remains a remote possibility that confidence is depleted in all major fiat currencies simultaneously, so systemic risk in one country or region is more likely to lead to a flight to other fiat currencies.</p>
<p>Human activity moves from the physical to the digital realm, where cryptocurrencies dominate. With gaming, eSports, the metaverse, and Web 3.0 accounting for a material share of global economic activity in the virtual realm, cryptocurrencies see explosive growth.</p>	<p>Our base case is that while the metaverse will take up a growing share of people’s entertainment budgets, especially younger millennials and Gen Z, the majority of people will prefer to spend their non-entertainment resources and time in the physical rather than virtual world. Furthermore, if CBDCs are successfully established, even e-gaming and metaverse activity is likely to shift from crypto to fiat digital currencies.</p>

These episodes of market manipulation have drawn the attention of regulators in some jurisdictions who cite this as a primary reason for rejecting new crypto investment vehicles like bitcoin ETFs.⁵⁸ In response, a coalition of major cryptocurrency firms – including exchanges, digital asset platforms, and crypto software providers – has launched an initiative to self-regulate the industry. The coalition acknowledges the potential for fraud and manipulation in the cryptocurrency space and is urging digital asset companies to sign a “market integrity” pledge that calls for the industry to protect investors.⁵⁹

Regulators and market participants have also been concerned by the notable and repeated breakdowns in the infrastructure supporting cryptocurrency mining and trading. Centralized cryptocurrency exchanges are one example. These exchanges set prices for various digital assets and take a small fee off every transaction. Only a few countries have appropriate guidelines or regulations in place even though more than 300 exchanges are now operating globally.⁶⁰ With the rapid growth in cryptocurrency trading volumes, many exchanges do not have the capital or technical resources to scale up robustly, becoming popular targets for hackers. High-profile hacks of major cryptocurrency exchanges – like Mt. Gox, BitMart, Coincheck, and Binance – have been occurring since 2012 with more than 46 exchanges suffering thefts. The trend appears to be accelerating – overall cryptocurrency theft rose by more than 75% in 2021, totaling more than \$14 billion in stolen assets.⁶¹

Despite the growing investment mythology surrounding bitcoin, direct investment in it does not currently offer an attractive proposition for institutional investors. Specifically, it has not demonstrated enduring characteristics as a reliable portfolio diversifier, safe-haven asset, or inflation hedge. Its risk-adjusted returns of late are comparable

to other asset classes but come with significantly greater frequency of drawdowns. Furthermore, the unsettled and increasingly harsher regulatory backdrop, the immature operational infrastructure supporting it and its problematic ESG attributes pose significant and material risks for institutional investors.

While this is our base case, it is worth considering the alternative scenarios under which cryptocurrencies continue to rise in valuation and importance. We highlight a few of these potential pathways to crypto-dominance, as well as the counterarguments that lead us to currently consider these scenarios unlikely (see Box 1 on the prior page).

Despite the investment mythology surrounding bitcoin it does not currently offer an attractive proposition for investors.

We therefore believe it's important for institutional investors to focus instead on evaluating the potentially more attractive long-term opportunities in the broader crypto ecosystem, beyond cryptocurrencies themselves. Chapter 4 highlights a range of investment opportunities investors will want to evaluate as they consider the more long-lasting and enduring investment ideas in the broader crypto ecosystem that have emerged alongside the cryptocurrency phenomenon.

CHAPTER 4

INVESTMENT OPPORTUNITIES IN THE BROADER CRYPTO ECOSYSTEM

“

The most powerful applications of blockchain may be unrelated to cryptocurrencies.”

CHAPTERS

1

2

3

4

CHAPTER 4

INVESTMENT OPPORTUNITIES IN THE BROADER CRYPTO ECOSYSTEM

In many ways the cryptocurrency boom resembles the Dutch tulip mania of the 1630s and the internet stock bubble of the late 1990s. But savvy long-term investors willing to look beyond the breathless hype surrounding cryptocurrencies are likely to find enduring investment opportunities around tangible, real-world applications of distributed ledger technology that are likely to generate attractive risk-adjusted returns – even if crypto-mania itself fizzles.

We lay out four longer-term investment themes that CIOs will want to evaluate for their portfolios as they look beyond cryptocurrencies for sources of long-term value creation.

1. Private blockchains and smart contracts

The most powerful use cases for blockchain may be unrelated to the cryptocurrency payment networks. Indeed, blockchains are a highly secure and robust system for verifying and recording transactions. While there is hype around the “blockchain revolution,” investors would be wise to focus on blockchain use cases with well-defined practical applications that address real-world problems today, especially in the financial services sector.

While permissioned private blockchains still require central authorities to authenticate users initially, they can reduce the costs of routine financial transactions as they eliminate the need for counterparty and trade verification as well as transaction and record reconciliation. Because of the centralized authority verifying users, private blockchains can be easily scaled and will likely have the largest near-term impact on financial services firms.⁶²

Permissioned blockchains also offer efficiencies in the origination, servicing and trading of assets, especially those (like real estate) with many different participants across the value chain and incompatible legacy

systems. The complexity of the value chain around mortgage origination, securitization and servicing, for example, has led companies to push for a more efficient and real-time process using blockchains. For example, Figure Technologies is a company which originates home equity loans and mortgages as well as securitizes and services them on the Provenance blockchain. This distributed ledger platform is an early example of the greater transparency and efficiency potential of permissioned blockchains targeting specific challenges.^{63, 64}

When partnered with self-executing smart contracts, distributed ledger technology offers greater efficiency in the clearing and settlement of securities than current systems. Major global financial institutions are already utilizing private blockchains to enable real-time clearing and settlement of transactions today. In fact, private blockchains are already handling trades with almost no need for humans to verify counterparties, confirm trade instructions or settle transactions. In 2021, for example, JP Morgan launched Onyx, an Ethereum-based blockchain that uses smart contracts, to swap digitized Treasury collateral and digitized cash instantaneously and clears, settles and records billions in daily repo trading.⁶⁵

Furthermore, innovations in smart contracts and the rapidly evolving ecosystem of innovative Layer-2 technologies are rapidly expanding the functionality and creating new and important possibilities for applications in the conventional financial realm.

The next step for settlements could be more complex transactions like OTC derivative contracts and other kinds of bespoke, highly customized transactions.⁶⁶

Partnered with self-executing smart contracts, distributed ledger technology offers greater efficiency in the clearing and settlement of securities than current systems.

2. The infrastructure and ecosystem supporting blockchain applications and CBDCs

A range of surrounding technology and services will be required to support permissioned blockchains and smart contracts – and many will also play a pivotal role in supporting the adoption and growth of CBDCs. Specifically, investors should focus on two areas which are likely to be especially attractive: (1) blockchain enablers and (2) fraud prevention and regulatory compliance services.

Key blockchain enablers

The internet didn't really take off and gain widespread adoption until its broad infrastructure had matured and was able to overcome initial challenges. Similarly, the landscape for innovation in blockchain infrastructure is wide open and there is tremendous potential for key enablers to reduce current challenges and barriers.

One such area for blockchain is interoperability. While there already exists a diverse ecosystem of blockchains, these different blockchain networks do not interact with each other in a meaningful way. Their ability to “talk” and transact with each other seamlessly is referred to as interoperability and this innovation will enable a wide range of blockchain-enabled products and services.⁶⁷ This innovation could make interoperable smart contracts possible and open up new possibilities for record and document management in healthcare, law and real estate by

allowing important business information to be securely sent back and forth between private and public networks in a customizable and controlled manner.⁶⁸ VC-funded platforms like Polkadot and Cosmos are major enablers of interoperability.

Another infrastructure area that has drawn VC investment is Layer 2 technologies that enhance performance and scalability on popular platforms like Ethereum. Polygon, for example, is a company which provides software that lowers the cost and friction of transacting on Ethereum.⁶⁹ Another area of innovation in crypto infrastructure is the growth of companies that support the development of decentralized applications, or dApps. For example, Alchemy is software to create cryptocurrency apps that communicate with Ethereum and several other blockchains.⁷⁰

Fraud prevention, security and regulatory compliance

Given the complicated regulatory environment for cryptocurrencies and concerns raised by decentralized and anonymous transactions, there is a growing field of AML risk assessment and management. A whole slew of PE and VC-funded software firms like Fireblocks and Chainalysis in the US, and Coinfirm and Elliptic in the UK, currently provide services to exchanges, payment providers and custodians to help them conduct due diligence on customers, track transactions and manage these risks. Firms like Simplex in Israel utilize AI to provide crypto and fraud prevention solutions to merchants. Meanwhile Merkle Science in Singapore offers businesses, banks and government agencies tools for crypto threat detection and risk management. As the world of digital assets and CBDCs matures and intersects further with conventional finance and other firms, the need for these services will grow.

3. Tokenization: Next-generation securitization of real assets

Tokenization of real assets – essentially fractionalizing ownership into digital tokens on a distributed ledger – represents a potentially game-changing future

application that opens up simpler, more cost-efficient ways to issue, manage, and transact assets and investments.

Tokenization of real assets opens up simpler, more cost effective ways to issue, manage and transact assets.

In theory, any real asset – precious metals, real estate, artwork or infrastructure – could be tokenized and substantially reduce frictional costs from transactions and servicing. This would increase liquidity, simplify transactions, enhance price transparency, and allow more granular portfolio construction. It also allows investors to potentially benefit from increased liquidity, shorter and more flexible lock-up periods, and easier proof of ownership.

It is important to note, however, this application remains at a very early stage and significant challenges need to be resolved. First, the lack of clear regulatory, legal and tax guidelines around tokenized assets leads to compliance uncertainties. Second, while distributed ledger technology is already being employed by banks in their clearing and settling operations, it needs to be further refined to work across private assets and at efficient scale under real-world conditions. Third, market participants need to build trust in the new operational mechanisms and governance frameworks and adapt their internal systems to them.

However, when the legal, governance and regulatory frameworks become more settled, tokenization will lead to a more fractionalized ownership model for real assets. For example, institutional investors who are significant participants in real estate funds are accustomed to influencing the contours of the fund's investment strategy. A more fractionalized ownership model could potentially reduce the influence of anchor investors in the covenants or terms for large real estate transactions that could now be broadly syndicated with smaller institutional, high-net-worth

and even retail investors. Tokenization could also lower the transaction costs of holding a significantly more diversified portfolio of real assets as expensive intermediaries in the securitization marketplace are displaced by cheaper blockchain-powered technologies. Indeed, the prospect of fractionalized ownership and better liquidity under a tokenized real asset regime might allow investors and real estate managers to diversify or fine-tune portfolios with greater ease.

4. Monitor the metaverse as a leading indicator of crypto innovation

Metaverse platforms combine augmented reality (AR), virtual reality (VR), blockchain technology and digital tokens or currencies to create highly immersive digital worlds where people can gather to socialize, play, work, and trade digital goods.⁷¹ While it is unclear whether the metaverse will simply become a part of our entertainment allocation, or become something much more meaningful than that, we believe institutional investors should track new technologies, companies and platforms in the metaverse for three primary reasons.

First, the metaverse is big and will get bigger. Virtual gaming, entertainment (e.g., concerts by major bands) on virtual sites, and advertising in the metaverse generates roughly \$500 billion annually in revenue today – as large as the “real-world” global sports industry – and is growing rapidly.^{72, 73} In 2021, even putting aside NFTs, over \$60 billion was spent on purely cosmetic, nonfunctional virtual goods.⁷⁴ Given the degree of investment going into real-time 3-D rendered virtual universes, investors should observe how these platforms evolve.

Second, we are not quite there yet, but applications in the metaverse may start leading to tangible improvements in real-world industries. Johns Hopkins recently performed its first pair of surgeries on live patients using augmented reality displays.⁷⁵ In the defense sector, the U.S. military has discovered that you can accelerate the learning curve for new recruits looking to fly helicopters with VR goggles, effectively giving them a private helicopter to learn on.⁷⁶ And in industrials, BMW's new all-electric vehicle ran a VR simulation for six months before finalizing the actual

layout for the factory – changing 30% of the design from the original during those virtual experiments.⁷⁷ Perhaps even more importantly, these new uses of metaverse platforms are spawning innovative technologies, in holographic displays and speech recognition, for example. Investors will therefore want to evaluate opportunities both in metaverse applications – especially in education, training, healthcare and e-commerce – as well as the VR/AR hardware field.⁷⁸

Third, cryptocurrencies and digital tokens are *the* currency in the metaverse. This is a world where crypto natives have chosen to adopt digital currencies and tokens as the sole medium of exchange and unit of account to trade NFTs, buy digital assets in a multiplayer game, or attend a virtual concert. Investors looking to understand the future direction of the broad cryptocurrency and digital token landscape will need to monitor the transaction, payment and currency systems being developed for and in the metaverse.

Conclusion

It is clear cryptocurrency is not currently (and may never be) ready for prime time. Given its flip-flopping correlations with other assets, frequent stomach-churning drawdowns, a highly unsettled regulatory landscape, immature infrastructure and problematic ESG impact, investing directly in bitcoin and other cryptocurrencies is currently quite unattractive for institutional investors.

Of course, investors will want to monitor developments in the cryptocurrency space in the unlikely event that conditions arise for the mainstreaming of private cryptocurrencies. But regardless of how cryptocurrencies themselves endure, savvy long-term investors will certainly want to capture the emerging constellation of investment opportunities in the broader ecosystem of innovation surrounding cryptocurrencies – many of which will power new trading platforms, smart contracts, central bank digital currencies and next-generation securitization technologies in the years and decades ahead.

ACKNOWLEDGMENTS

PGIM gratefully acknowledges the contributions by the following individuals:

Victoria Cheng, Partner, PruVen Capital
Ezechiel Copic, Global Head, Public Sector Research & Development, C Labs
Seth Ginns, Managing Partner and Head of Liquid Investments, CoinFund
Ramneek Gupta, Founder and Managing Partner, PruVen Capital
David Lawant, Director of Research, Bitwise Asset Management
Dr. Nathan Sheets, Global Chief Economist, Citibank
Travis Skelly, Partner, PruVen Capital
Pete Townsend, Managing Director, Techstars

PGIM Contributors

Lauren Alpeyrie, PGIM Real Estate
Raimondo Amabile, PGIM Real Estate
Mariusz Banasiak, PGIM Fixed Income
Mark Baribeau, Jennison Associates
Edward Campbell, PGIM Quantitative Solutions
Peter Clark, Jennison Associates
Dr. Guillermo Felices, PGIM Fixed Income
Dr. Ellen Gaske, PGIM Fixed Income
Dr. Lorne Johnson, PGIM Quantitative Solutions
Ed Keon, PGIM Quantitative Solutions
David Klausner, PGIM Fixed Income
Dr. Harshad Lalit, PGIM Quantitative Solutions
Morgan Laughlin, PGIM Real Estate
Dr. Katharine Neiss, PGIM Fixed Income
Dr. Harsh Parikh, PGIM IAS
Gregory Peters, PGIM Fixed Income
Dr. Bruce Phelps, PGIM IAS
Abhinai Pothireddy, PGIM Innovation
Dave Power, PGIM Quantitative Solutions
Raj Shant, Jennison Associates
Dr. Gavin Smith, PGIM Quantitative Solutions
Peter So, PGIM Innovation
Dr. Yesim Tokat-Acikel, PGIM Quantitative Solutions
Robert Tipp, PGIM Fixed Income
Andrew Tucker, Jennison Associates
Eugenia Unanyants-Jackson, PGIM
Peter Vaiciunas, PGIM Quantitative Solutions
Dr. Sushil Wadhwani, PGIM Quantitative Solutions
Lauren Waldman, PGIM
Dr. Noah Weisberger, PGIM IAS

Principal Authors

Shehriyar Antia, PGIM Thematic Research
Dr. Taimur Hyat, PGIM
Jakob Wilhelmus, PGIM Thematic Research

Endnotes

1. Goodwin, Jason, "Greenback: The Almighty Dollar and the Invention of America," MacMillan, Page 195, 2004.
2. Rolnick, Arthur and Weber, Warren, "Free Banking, Wildcat Banking, and Shinplasters," Federal Reserve Bank of Minneapolis, Quarterly Review, Fall 1982.
3. CoinMarketCap, as of May 9, 2022. < www.coinmarketcap.com >
4. Karniol-Tambour, Karen, Tan, Ross, Tsarapkina, Dina, Sondheimer, Joe and Barnes, Will, "The Evolution of Institutional Investors' Exposure to Cryptocurrencies and Blockchain Technologies," Bridgewater, January 14, 2022. < <https://www.bridgewater.com/research-and-insights/the-evolution-of-institutional-investors-exposure-to-cryptocurrencies-and-blockchain-technologies> >
5. Nakamoto, Satoshi, "Bitcoin: A Peer-to-Peer Electronic Cash System," 2008. < <https://bitcoin.org/bitcoin.pdf> >
6. Prasad, Eswar, "The Future of Money," Harvard University Press, Page 106, 2021.
7. CoinMarketCap, as of May 9, 2022. < www.coinmarketcap.com >
8. In the first half of 2022, the Ethereum network is planning on adopting a proof-of-stake validation system that will lower transaction costs and enable better scaling.
9. Catalini, Christian and de Gortari, Alonso, "On the Economic Design of Stablecoins," 2021. < https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3899499 >
10. CoinMarketCap as of May 9, 2022. < www.coinmarketcap.com >
11. Makarov, Igor and Schoar, Antoinette, "Blockchain Analysis of the Bitcoin Market," 2021. < https://www.nber.org/system/files/working_papers/w29396/w29396.pdf >
12. Ibid.
13. Yaffe-Bellany, David, "They Made Millions on Luna, Solana and Polygon: Crypto's Boom Beyond Bitcoin," New York Times, February 7, 2022. < <https://www.nytimes.com/2022/02/07/technology/cryptocurrency-luna-solana-polygon.html> >
14. Otani, Akane, "Elon Musk Has Become Bitcoin's Biggest Influencer, Like It or Not," Wall Street Journal, May 23, 2021. < <https://www.wsj.com/articles/elon-musk-has-become-bitcoins-biggest-influencer-like-it-or-not-11621762202> >
15. Sullivan, Tim, "Transparency, Trust, and Bitcoin," Harvard Business Review, June 2015. < <https://hbr.org/2015/06/transparency-trust-and-bitcoin> >
16. "Edelman Trust Barometer 2022," Edelman, 2022. < https://www.edelman.com/sites/g/files/aatuss191/files/2022-01/2022%20Edelman%20Trust%20Barometer%20FINAL_Jan25.pdf >
17. "3rd Annual Global Crypto Hedge Fund Report 2021," PricewaterhouseCoopers, May 2021. < [https://www.pwc.com/gx/en/financial-services/pdf/3rd-annual-pwc-elwood-aima-crypto-hedge-fund-report-\(may-2021\).pdf](https://www.pwc.com/gx/en/financial-services/pdf/3rd-annual-pwc-elwood-aima-crypto-hedge-fund-report-(may-2021).pdf) >
18. "Bank of Canada and MIT Announce Joint Central Bank Digital Currency Collaboration," Bank of Canada, Press release, March 16, 2022. < <https://www.bankofcanada.ca/2022/03/central-bank-digital-currency-collaboration> >
19. Taleb, Nassim Nicholas "Bitcoin, Currencies, and Fragility," 2021. < <https://arxiv.org/abs/2106.14204> >
20. "Money and Payments: The U.S. Dollar in the Age of Digital Transformation," Board of Governors of the Federal Reserve System, January 2022. < <https://www.federalreserve.gov/publications/files/money-and-payments-20220120.pdf> >
21. "Money Market Fund Reform Options," President's Working Group on Financial Markets, October 2010. < <https://www.sec.gov/rules/other/2010/ic-29497.pdf> >
22. Palma, Stefania and Stafford, Philip, "Tether to Pay \$41M for Claiming Its Stablecoins Were Fully Backed by Dollars," Financial Times, October 15, 2021. < <https://www.ft.com/content/d7db307c-ef43-4af8-8f14-c1d1ba414058> >
23. Harper, Colin, "Bitcoin Transactions Are More Expensive Than Ever," CoinDesk, September 14, 2021. < <https://www.coindesk.com/markets/2021/04/21/bitcoin-transactions-are-more-expensive-than-ever> >
24. Taleb, Nassim Nicholas "Bitcoin, Currencies, and Fragility," 2021. < <https://arxiv.org/abs/2106.14204> >
25. McDonald, Michael, "El Salvador's Companies Barely Bother With Bitcoin," Bloomberg, March 18, 2022. < <https://www.bloomberg.com/news/articles/2022-03-18/el-salvador-s-businesses-barely-bother-with-bitcoin-study-finds> >
26. Gerard, David, "Bitcoin Failed in El Salvador. The President Says the Answer Is More Bitcoin," Foreign Policy, December 6, 2021. < <https://foreignpolicy.com/2021/12/06/bitcoin-city-el-salvador-nayib-bukele> >
27. Adrian, Tobias, Iyer, Tara and Qureshi, Mahvash, "Crypto Prices Move More in Sync With Stocks, Posing New Risks," IMF, January 11, 2022. < <https://blogs.imf.org/2022/01/11/crypto-prices-move-more-in-sync-with-stocks-posing-new-risks> >
28. Botte, Alex and Nigro, Mike, "Risk Analysis of Crypto Assets," TwoSigma, July 2021. < <https://www.twosigma.com/articles/risk-analysis-of-crypto-assets> >

29. Parikh, Harsh, "Institutional Gold!" PGIM Institutional Advisory & Solutions, November 2019.
30. Prasad, Eswar, "The Future of Money," Harvard University Press, Page 143, 2021.
31. "Ancient Gold Coins," Deutsche Bundesbank, December 1980.
32. Prasad, Eswar, "The Future of Money," Harvard University Press, 2021.
33. "Gold and Cryptocurrencies," World Gold Council, February 2, 2021. < <https://www.gold.org/goldhub/research/gold-and-cryptocurrencies> >
34. Greifeld, Katherine and Hajric, Vildana, "Bitcoin's Money-Printing Machine Breaks Down as Futures Fall," June 22, 2021. < <https://www.bloomberg.com/news/articles/2021-06-22/bitcoin-s-money-printing-machine-breaks-down-as-futures-collapse> >
35. Ossinger, Joanna, "Bitcoin Rally Faces Potential Test From Falling Market Liquidity," February 22, 2021. < <https://www.bloomberg.com/news/articles/2021-02-22/bitcoin-rally-faces-potential-test-from-falling-market-liquidity> >
36. "3rd Annual Global Crypto Hedge Fund Report 2021," PricewaterhouseCoopers, May 2021. < [https://www.pwc.com/gx/en/financial-services/pdf/3rd-annual-pwc-elwood-aima-crypto-hedge-fund-report-\(may-2021\).pdf](https://www.pwc.com/gx/en/financial-services/pdf/3rd-annual-pwc-elwood-aima-crypto-hedge-fund-report-(may-2021).pdf) >
37. Digiconomist as of March 29, 2022. < <https://digiconomist.net/bitcoin-energy-consumption> >
38. Spegele, Brian and Ostroff, Caitlin, "Bitcoin Miners Are Giving New Life to Old Fossil-Fuel Power Plants," Wall Street Journal, May 21, 2021. < <https://www.wsj.com/articles/bitcoin-miners-are-giving-new-life-to-old-fossil-fuel-power-plants-11621594803> >
39. "China Widens Ban on Crypto Transactions; Bitcoin Tumbles," Bloomberg, September 24, 2021. < <https://www.bloomberg.com/news/articles/2021-09-24/china-deems-all-crypto-related-transactions-illegal-in-crackdown> >
40. McGregor, Grady, "China Already Banned Crypto Mining. Now It's Cracking Down on Any Holdouts," Fortune, November 17, 2021. < <https://fortune.com/2021/11/17/china-bitcoin-mining-ban-crypto-holdouts-ether-solana-price> >
41. Bitcoin Mining Map, Cambridge Bitcoin Electricity Consumption Index. < https://ccaf.io/cbeci/mining_map >
42. Kharif, Olga, Mathis, Will and Saul, Josh, "Crypto's Energy Guzzling Sparks an Alternative That Merely Sips," Bloomberg, November 17, 2021. < <https://www.bloomberg.com/news/articles/2021-11-17/crypto-s-power-consumption-sparks-an-energy-efficient-alternative> >
43. Taleb, Nassim Nicholas "Bitcoin, Currencies, and Fragility," 2021. < <https://arxiv.org/abs/2106.14204> >
44. Harley-McKeown, Lucy, "Crypto Firms Face Cliff-Edge in UK as Time Ticks Down for AML Approval," The Block, February 10, 2022. < <https://www.theblockcrypto.com/post/133597/crypto-firms-face-cliff-edge-in-uk-as-time-ticks-down-for-aml-approval> >
45. Alper, Tim, "South Korean Crypto Exchanges Face AML Probes as Regulators Test Compliance," Cryptonews, January 17, 2022. < <https://cryptonews.com/news/south-korean-crypto-exchanges-face-aml-probes-as-regulators-test-compliance.htm> >
46. Szalay, Eva, "Hundreds of Thousands of Crypto Accounts Linked to Oligarchs, Data Company Finds," Financial Times, March 15, 2022. < <https://www.ft.com/content/e3d7f22d-d858-44c0-a86e-6909a6eab266#post-7e9c3b04-a6b5-4a52-b7c0-640fc64d748f> >
47. "US and German Law Enforcement Investigation Leads to Shutdown of Largest Online Darknet Marketplace," Internal Revenue Service, April 5, 2022. < <https://www.irs.gov/compliance/criminal-investigation/us-and-german-law-enforcement-investigation-leads-to-shutdown-of-largest-online-darknet-marketplace> >
48. Egkolfopoulou, Misyrlena, "Cryptocurrency Is a Potential New Tool for Billionaires to Avoid Sanctions," Bloomberg, February 24, 2021. < <https://www.bloomberg.com/news/articles/2022-02-24/russia-billionaires-could-use-crypto-to-go-around-severe-us-sanctions> >
49. "Cryptocurrency: A Legal Framework for a Fast-Moving Technology," Vandeventer Black LLP, June 2, 2021. < <https://www.jdsupra.com/legalnews/cryptocurrency-a-legal-framework-for-a-8631830> >
50. Glen, John, Keynote Speech at the Innovate Finance Global Summit, April 4, 2022. < <https://www.gov.uk/government/speeches/keynote-speech-by-john-glen-economic-secretary-to-the-treasury-at-the-innovate-finance-global-summit> >
51. "BIS Annual Economic Report," Bank of International Settlement, Chapter III, June 23, 2021. < <https://www.bis.org/publ/arpdf/ar2021e3.pdf> >
52. Menon, Ravi, "The Future of Money, Finance and the Internet," Speech at the Singapore FinTech Festival, November 9, 2021. < <https://www.mas.gov.sg/news/speeches/2021/the-future-of-money-finance-and-the-internet> >
53. John, Alun, Shen, Samuel and Wilson, Tom, "China's Top Regulators Ban Crypto Trading and Mining, Sending Bitcoin Tumbling," Reuters, September 24, 2021. < <https://www.reuters.com/world/china/china-central-bank-vows-crackdown-cryptocurrency-trading-2021-09-24> >
54. Bhatia, Ruchi and Ghosh, Suvahree, "Crypto Tax in India Spurs Bonanza for Digital-Coin Bourses," Bloomberg, February 17, 2022. < <https://www.bloomberg.com/news/articles/2022-02-17/india-s-30-crypto-tax-spurs-bonanza-for-digital-coin-exchanges> >
55. Molla, Rani, "When Elon Musk Tweets, Crypto Prices Move," Vox, June 14, 2021. < <https://www.vox.com/recode/2021/5/18/22441831/elon-musk-bitcoin-dogecoin-crypto-prices-tesla> >
56. Pound, Jesse, "Dogecoin Jumps After Series of Elon Musk Tweets Fans More Wild Cryptocurrency Trading," CNBC, May 21, 2021. < <https://www.cnbc.com/2021/05/20/dogecoin-jumps-on-elon-musk-tweet-as-wild-cryptocurrency-trading-continues.html> >

57. Bentley, Alden and Chavez-dreyfuss, Gertrude, "Dogecoin Tumbles After Elon Musk Calls It a 'Hustle' on 'SNL' Show," Reuters, May 7, 2021. < <https://www.reuters.com/technology/dogecoin-spotlight-cryptocurrency-backer-musk-makes-snl-appearance-2021-05-07> >
58. Lang, Hannah, "Crypto Firms Launch Coalition to Promote Market Integrity," Reuters, February 7, 2022. < <https://www.reuters.com/technology/crypto-firms-launch-coalition-promote-market-integrity-2022-02-07> >
59. Ibid.
60. CoinMarketCap as of May 9, 2022. < <https://coinmarketcap.com/rankings/exchanges> >
61. Sigalos, MacKenzie, "Crypto Scammers Took a Record \$14B in 2021," CNBC, January 7, 2022. < <https://www.cnbc.com/2022/01/06/crypto-scammers-took-a-record-14-billion-in-2021-chainalysis.html> >
62. Carson, Brant, Romanelli, Giulio, Walsh, Patricia and Zhumaev, Askhat, "Blockchain Beyond the Hype: What Is the Strategic Business Value?" McKinsey Digital, June 19, 2018. < <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value> >
63. "Figure and Apollo Execute Mortgage Transactions Using Blockchain Technology to Transfer Ownership," Figure, Press release, March 17, 2022. < <https://www.prnewswire.com/news-releases/figure-and-apollo-execute-mortgage-transactions-using-blockchain-technology-to-transfer-ownership-301504772.html> >
64. Krebs, Eric and Tempkin, Adam, "Apollo Joins Forces With Blockchain Startup Figure," Bloomberg, July 14, 2021. < <https://www.bloomberg.com/news/articles/2021-07-14/apollo-joins-forces-with-blockchain-startup-figure-in-tech-push> >
65. Leising, Matthew, "JPMorgan Using Blockchain to Move Billions in Repo-Market Trades," December 10, 2020. < <https://www.bloomberg.com/news/articles/2020-12-10/jpmorgan-using-blockchain-to-move-billions-in-repo-market-trades> >
66. Morini, Massimo, "Managing Derivatives on a Blockchain. A Financial Market Professional Implementation," January 9, 2019. < https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3075540 >
67. "Cross-Chain Interoperability: What It Means for Blockchain," Gemini, December 21, 2021. < <https://www.gemini.com/cryptopedia/why-is-interoperability-important-for-blockchain#section-benefits-of-blockchain-interoperability> >
68. Ibid.
69. Kruppa, Miles and Waters, Richard, "Sequoia and Silver Lake Fund Crypto Infrastructure Start-ups," Financial Times, February 8, 2022. < <https://www.ft.com/content/3bdbde8d-64b1-40cf-89ba-21b276c192c5> >
70. Ibid.
71. Bremmer, Ian, "The Technopolar Moment," Foreign Affairs, November/December 2021. < <https://www.foreignaffairs.com/articles/world/2021-10-19/ian-bremmer-big-tech-global-order> >
72. Kanterman, Matthew and Naidu, Nathan, "Metaverse May Be \$800B Market, Next Tech Platform," Bloomberg Intelligence, December 1, 2021. < <https://www.bloomberg.com/professional/blog/metaverse-may-be-800-billion-market-next-tech-platform> >
73. "Global Sports Market Opportunities and Strategies Report 2021," Research and Markets, Press release, July 22, 2021. < <https://www.globenewswire.com/news-release/2021/07/22/2266996/28124/en/Global-Sports-Market-Opportunities-and-Strategies-Report-2021-Sports-Market-Forecast-to-Reach-599-9-billion-by-2025-as-COVID-19-Lockdowns-Ease.html> >
74. "The Premise and the Peril of the Metaverse," McKinsey Podcast, March 29, 2022. < <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-promise-and-peril-of-the-metaverse> >
75. Ibid.
76. Oprihory, Jennifer-Leigh, "Virtual Reality Spreads to USAF Helicopter Training," Air Force Magazine, October 18, 2019. < <https://www.airforcemag.com/Virtual-Reality-Spreads-to-USAF-Helicopter-Training> >
77. "Innovation and Practical Applications of the Metaverse," McKinsey Podcast, March 29, 2022. < <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/innovative-and-practical-applications-of-the-metaverse> >
78. "Metaverse Report – Future Is Here," Deloitte, March 2022. < <https://www2.deloitte.com/cn/en/pages/technology-media-and-telecommunications/articles/metaverse-whitepaper.html> >

Important Information

Professional Investor Use Only. All investments involve risks, including possible loss of principal. Past performance is not indicative of future results.

The information contained herein is provided by PGIM, Inc., the principal asset management business of Prudential Financial, Inc. (PFI), and an investment adviser registered with the U.S. Securities and Exchange Commission (SEC). Registration with the SEC does not imply a certain level of skill or training.

In the United Kingdom, information is issued by PGIM Limited with registered office: Grand Buildings, 1-3 Strand, Trafalgar Square, London, WC2N 5HR. PGIM Limited is authorised and regulated by the Financial Conduct Authority (“FCA”) of the United Kingdom (Firm Reference Number 193418). In the European Economic Area (“EEA”), information is issued by PGIM Netherlands B.V. with registered office: Gustav Mahlerlaan 1212, 1081 LA Amsterdam, The Netherlands. PGIM Netherlands B.V. is authorised by the Autoriteit Financiële Markten (“AFM”) in the Netherlands (Registration number 15003620) and operating on the basis of a European passport. In certain EEA countries, information is, where permitted, presented by PGIM Limited in reliance of provisions, exemptions or licenses available to PGIM Limited under temporary permission arrangements following the exit of the United Kingdom from the European Union. These materials are issued by PGIM Limited and/or PGIM Netherlands B.V. to persons who are professional clients as defined under the rules of the FCA and/or to persons who are professional clients as defined in the relevant local implementation of Directive 2014/65/EU (MiFID II). These materials are issued to persons who are professional clients or eligible counterparties as defined in Directive 2014/65/EU (MiFID II), investing for their own account, for funds of funds or discretionary clients. In Singapore, information is issued by PGIM (Singapore) Pte. Ltd. (PGIM Singapore), a Singapore investment manager that is licensed as a capital markets service license holder by the Monetary Authority of Singapore and an exempt financial adviser (registration number: 199404146N). These materials are issued by PGIM Singapore for the general information of “institutional investors” pursuant to Section 304 of the Securities and Futures Act, Chapter 289 of Singapore (the “SFA”) and “accredited investors” and other relevant persons in accordance with the conditions specified in Section 305 of the SFA. In Hong Kong, information is provided by PGIM (Hong Kong) Limited, a regulated entity with the Securities & Futures Commission in Hong Kong to professional investors as defined in Section 1 of Part 1 of Schedule 1 (paragraph (a) to (i) of the Securities and Futures Ordinance (Cap. 571). PGIM, Inc. is exempt from the requirement to hold an Australian Financial Services License under the Corporations Act 2001 in respect of financial services. PGIM, Inc. is exempt by virtue of its regulation by the Securities and Exchange Commission under the laws of the United States of America, including applicable state laws and the application of ASIC Class Order 03/1100. The laws of the United States of America differ from Australian laws. In Japan, information is presented by PGIM Japan, Co. Ltd. (“PGIM Japan”), a registered Financial Instruments Business Operator with the Financial Services Agency of Japan. In South Korea, information is issued by PGIM, Inc., which is licensed to provide discretionary investment management services directly to South Korean qualified institutional investors on a cross-border basis.

These materials are for informational or educational purposes only. The information is not intended as investment advice and is not a recommendation about managing or investing assets. In providing these materials, PGIM is not acting as your fiduciary. These materials represent the views, opinions and recommendations of the author(s) regarding the economic conditions, asset classes, securities, issuers or financial instruments referenced herein. Distribution of this information to any person other than the person to whom it was originally delivered and to such person’s advisers is unauthorized, and any reproduction of these materials, in whole or in part, or the divulgence of any of the contents hereof, without prior consent of PGIM is prohibited. Certain information contained herein has been obtained from sources that PGIM believes to be reliable as of the date presented; however, PGIM cannot guarantee the accuracy of such information, assure its completeness, or warrant such information will not be changed. The information contained herein is current as of the date of issuance (or such earlier date as referenced herein) and is subject to change without notice. PGIM has no obligation to update any or all of such information; nor do we make any express or implied warranties or representations as to the completeness or accuracy or accept responsibility for errors. These materials are not intended as an offer or solicitation with respect to the purchase or sale of any security or other financial instrument or any investment management services and should not be used as the basis for any investment decision. No risk management technique can guarantee the mitigation or elimination of risk in any market environment. Past performance is not a guarantee or a reliable indicator of future results and an investment could lose value. No liability whatsoever is accepted for any loss (whether direct, indirect, or consequential) that may arise from any use of the information contained in or derived from this report. PGIM and its affiliates may make investment decisions that are inconsistent with the recommendations or views expressed herein, including for proprietary accounts of PGIM or its affiliates. Any projections or forecasts presented herein are as of the date of this presentation and are subject to change without notice. Actual data will vary and may not be reflected here. Projections and forecasts are subject to high levels of uncertainty. Accordingly, any projections or forecasts should be viewed as merely representative of a broad range of possible outcomes. Projections or forecasts are estimated, based on assumptions, and are subject to significant revision and may change materially as economic and market conditions change. PGIM has no obligation to provide updates or changes to any projections or forecasts.

PGIM and its affiliates may develop and publish research that is independent of, and different than, the recommendations contained herein. PGIM’s personnel other than the author(s), such as sales, marketing and trading personnel, may provide oral or written market commentary or ideas to PGIM’s clients or prospects or proprietary investment ideas that differ from the views expressed herein.

© 2022 PFI and its related entities, registered in many jurisdictions worldwide.

PGIM'S MEGATREND SERIES

How today's shifting global landscape will affect the investments of tomorrow



Reshaping Services

Technological disruption has finally reached the shores of the service economy. It's a development that will represent a major shift for investors and the global economy as services represent more than two-thirds of global GDP, three-quarters of the workforce in developed markets, and nearly half of the workforce in advanced emerging markets.

[Learn more at pgim.com/reshaping](https://pgim.com/reshaping)



Weathering Climate Change

Climate change is no longer a hypothetical risk. It is already transforming the global economy, reshaping markets and altering the investment landscape. In this paper, we propose an actionable climate change agenda that addresses both hidden portfolio vulnerabilities and potential opportunities in the transition to a lower-carbon world.

[Learn more at pgim.com/climate](https://pgim.com/climate)



After the Great Lockdown

The pandemic has forced businesses to adapt in ways that will lead to lasting changes in consumer behavior and corporate business models. Now is the time to focus on the massive disruption that lies ahead so we're best positioned for when the Great Lockdown has passed.

[Learn more at pgim.com/lockdown](https://pgim.com/lockdown)



The Future Means Business

Disruptive forces have led to the emergence of three new business models that are radically changing the investment calculus for institutional investors. Here we explore the investment implications of these transformative new corporate models.

[Learn more at pgim.com/futurefirm](https://pgim.com/futurefirm)



The Technology Frontier

We are living in an era of unprecedented technological change. At PGIM, we believe the implications for investors will be profound, radically transforming investment opportunities across asset classes and geographies.

[Learn more at pgim.com/tech](https://pgim.com/tech)



The End of Sovereignty?

Never before in history have people, information and capital moved across borders at the speed, frequency and volume we see today. In this white paper, we take a closer look at the escalating tussle between globalization and nationalism, the implications this could have for global financial markets, and how long-term investors may best position themselves to navigate these uncertain times.



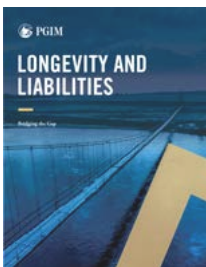
Emerging Markets at the Crossroads

A radical shift in the forces shaping emerging market growth will require investors to take a different investment approach from what may have worked in the past. Increasingly, discovering investment opportunities will be rooted in the ability to capture alpha from the new growth drivers, rather than in chasing the beta of the broad universe.



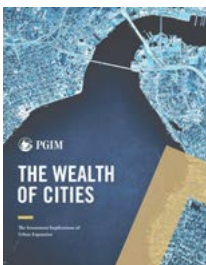
A Silver Lining

The unprecedented aging of the global population creates increased opportunities in senior housing, multifamily condos, biotech, and the emerging silverttech industry. Institutional investors should consider how this megatrend could affect their portfolios, given the trend's evolving impact on consumer spending and far-reaching effects on emerging nations, home to two-thirds of the world's elderly.



Longevity and Liabilities

The rise in global life expectancy has implications for pension plan liabilities that are not fully appreciated. As new mortality tables demonstrate, longevity risk to pension liabilities could increase dramatically over the next two to three decades. This report examines the challenge and the available risk mitigation strategies.



The Wealth of Cities

Never in history has the pace of urbanization been so rapid: 60 to 70 million people moving to cities every year for the next few decades. To help institutional investors benefit from this “prime time” of urbanization, we identified a range of specific investment ideas across the major investable themes of this opportune megatrend.



THE PURSUIT OF OUTPERFORMANCE™

PGIM, Inc. 655 Broad Street, Newark, NJ 07102



Printed on Forest Stewardship Council (FCS) certified paper
containing 30% post-consumer waste and produced carbon neutral.

留意事項

- ※ 本資料は米国 SEC の登録投資顧問会社である PGIM インクが作成したものです。
- ※ 本資料は情報提供を目的としたものであり、特定の金融商品の勧誘又は販売を目的としたものではありません。また、本資料に記載された内容等については今後変更されることもあります。
- ※ 記載されている市場動向等は現時点での見解であり、これらは今後変更することもあります。また、その結果の確実性を表明するものではなく、将来の市場環境の変動等を保証するものでもありません。
- ※ 本資料に記載されている市場関連データ及び情報等は信頼できると判断した各種情報源から入手したものです。その情報の正確性、確実性について当社が保証するものではありません。
- ※ 過去の運用実績は必ずしも将来の運用成果等を保証するものではありません。
- ※ 本資料は法務、会計、税務上のアドバイスあるいは投資推奨等を行うために作成されたものではありません。
- ※ 当社による事前承諾なしに、本資料の一部または全部を複製することは堅くお断り致します。
- ※ 本資料内で取り上げられた資産クラス、個別セクター等はあくまで例示目的であり、推奨ならびにこれらにかかる将来性を明示・暗示的に示唆するものではありません。
- ※ “Prudential”、“PGIM”、それぞれのロゴおよびロック・シンボルは、プルデンシャル・ファイナンシャル・インクおよびその関連会社のサービスマークであり、多数の国・地域で登録されています。
- ※ PGIM ジャパン株式会社は、世界最大級の金融サービス機関プルデンシャル・ファイナンシャルの一員であり、英国プルデンシャル社とはなんら関係がありません。

PGIM ジャパン株式会社
金融商品取引業者 関東財務局長（金商）第 392 号
加入協会 一般社団法人 投資信託協会、一般社団法人 日本投資顧問業協会

PGIMJ90285