PGIM
India Mutual Fund

MEGATRENDS

CRYPTOCURRENCY INVESTING

Powerful Diversifier or Portfolio Kryptonite?

SUMMER 2022

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. For more information, visit www.pgim.com.

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

CHAPTER 1

UNDERSTANDING THE CRYPTOCURRENCY ECOSYSTEM

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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.

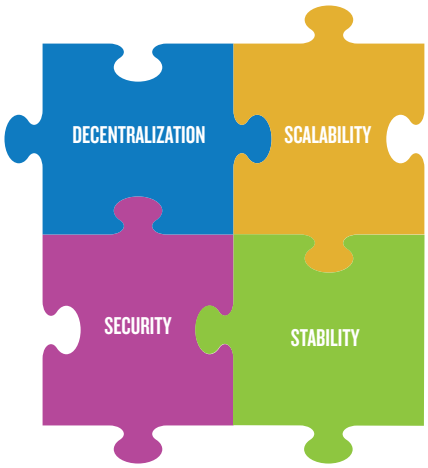
What are cryptocurrencies?

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

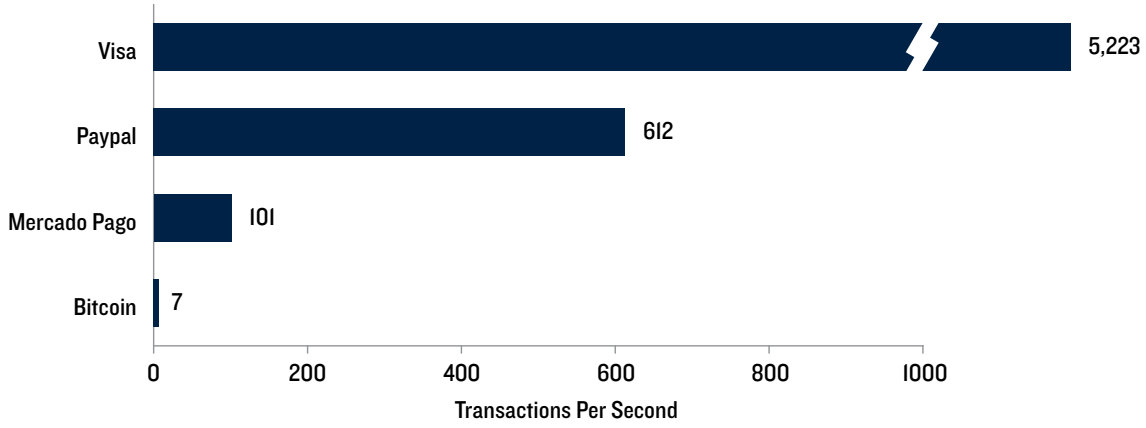
Security refers to the rigor associated with verifying transactions on the blockchain. The degree of rigor determines the ability of the blockchain to function as expected while defending itself from fraud, cyberattacks, hackers, bugs and other malicious ware. With more nodes recording and validating 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, Lighting 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

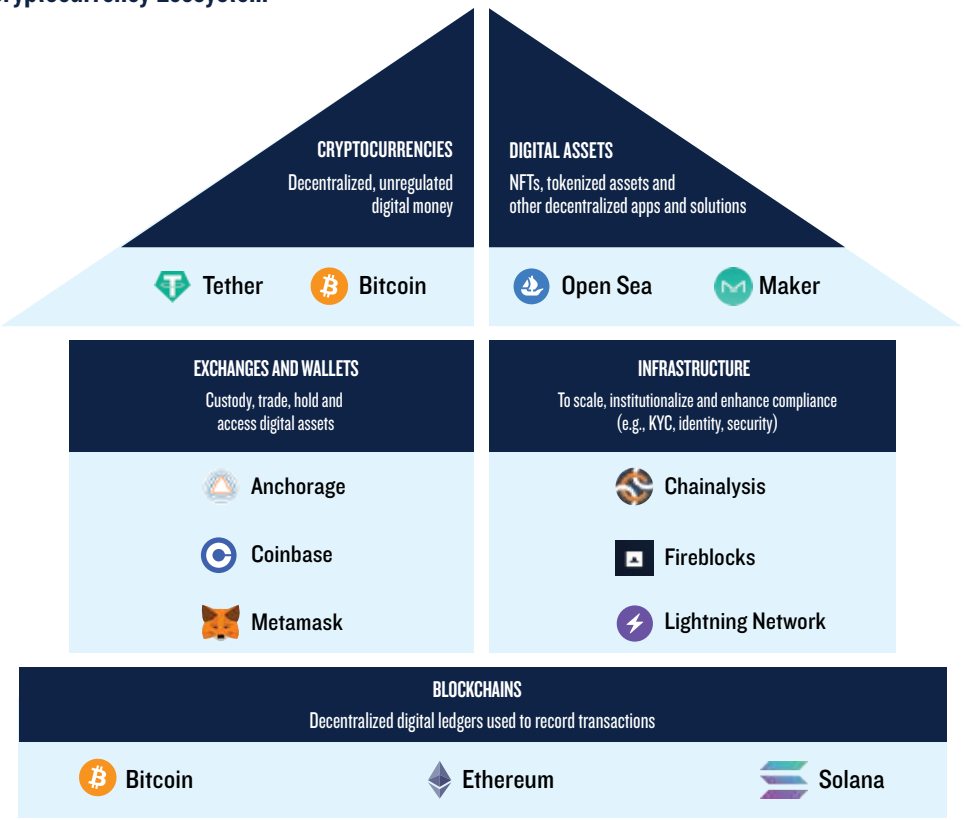
commonplace.[13] Social media hype from tech entrepreneurs and celebrity investors such as Elon Musk and Cathie Wood has furthered the frenzied momentum around cryptocurrencies.[14]

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."

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