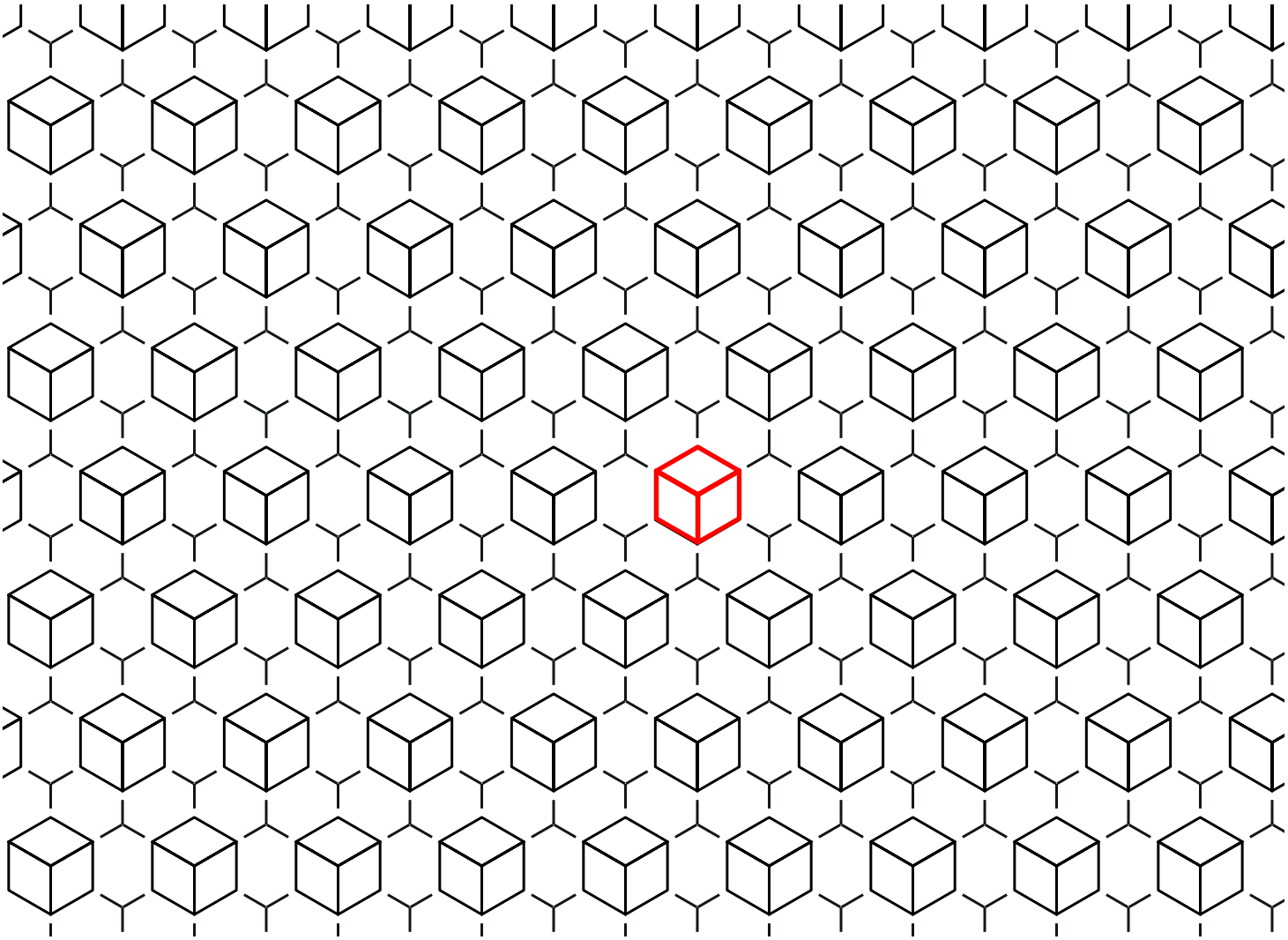
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Chief Investment Office GWM
Investment Research
September 2021

Distributed ledgers and digital assets

A primer



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Distributed ledgers and digital assets: A primer
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Editorial



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Dear readers,

Over the course of the last couple years, crypto has risen from obscurity and novelty to become a household word and a frontier digital industry.

Yet, despite its prominence in the zeitgeist, the rapid pace of change means even market participants must work to keep up with new developments in digital assets and the underlying technologies. As John Oliver from Last Week Tonight put it: crypto combines "everything you don't understand about money with everything you don't understand about computers."

While soaring and plummeting prices of individual crypto coins and tokens tend to draw front page media coverage, this paper addresses a broader range of topics, including distributed ledgers and digital assets—technologies that have the potential to disrupt mainstream business models, create new opportunities, and even support the UN's social development goals.

Our aim is to guide readers through the opportunity set and the risks involved in this nascent industry, so that investors can make more informed decisions that bypass some of the sensationalism and hype that goes hand-in-hand with the sector.

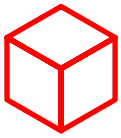
We hope you find this report informative and enjoyable.

Michael and Dominic

What's your experience with digital assets?
We want to know.
Click to tell us.

Key findings

1.



DLT applications have the potential to lower the cost of transactions while increasing speed and transparency. Distributed ledger technology (DLT) offers an alternative solution for facilitating transactions between counterparties. For example, the adoption of DLTs could enhance trade finance services by using smart contracts to automatically trigger contingent payments. This could help lower costs and boost efficiency, particularly for small businesses and in emerging markets where the bulk of transactions are still done on paper. Another example is the use of blockchains to improve the speed and costs of posttrade services such as settlement, custody, stock lending, and collateral management.

2.



Efficiencies could produce sustainability benefits, broadening access to the financial system and lowering inequality. Decentralized finance (DeFi) is already hinting at what that future might look like, suggesting a lower-friction financial system and possibly a more equitable one for society. It can help expand financial services accessibility, for instance, although online accessibility is required, which excludes 40% of the world's population today.

3.



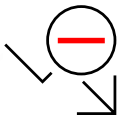
The financial service industry is most prone to disruption—with both threats and opportunity for incumbents. With potential gains in efficiency, transparency, and security, the shared platform technology poses a threat to the business models of today's intermediaries. The financial services industry is among the most prone to DLT-driven disruptions, which may impact areas such as payments, loan syndications, private placements, trade finance, and management of shareholder records. However, incumbents, thanks to their scale and expertise, should be able to integrate the technology and leverage their existing client base.

4.



We see a range of other possible applications—from healthcare to luxury goods—leading to a USD 1 trillion boost to global GDP over this decade. Self-executing programmable agreements, known as smart contracts, also offer incumbents a means for creating innovative products that are economically unviable to operate using traditional infrastructure. Healthcare, public services, and art and luxury goods are a few areas that could benefit. Although estimates vary widely, a study done by PWC forecasts that the adoption of the technology could boost global GDP by more than USD 1 trillion over this decade.

5.



Technological potential does not automatically mean that crypto coins themselves have an attractive risk-reward profile, especially given the challenge of valuing these assets. There is limited understanding and little consensus on how to value crypto coins fundamentally given the lack of meaningful flows and shortage of real-world use cases beyond early-stage adoption. Without time-tested frameworks to value individual coins and tokens, investors face an additional challenge in determining to what extent current prices already reflect the potential business opportunity.

6.



Investors in coins face a range of legal, regulatory, and technology risks. The volume and variability of financial regulations remain an inhibitor to adoption, which, along with nations' own responses to establish digital currencies, raise the costs and risks of switching to a new platform. Attempts to regulate crypto coin mining by China and other countries also illustrates that many of the adoption risks are binary in nature—i.e., they tend to affect the entire industry, not just individual coins, tokens, and networks.

7.



Coins generally are ineffective at providing diversification within portfolios, compared to more traditional hedges against equity drawdowns like government bonds or gold. Coins tend to be highly correlated with each other—making it hard for investors to diversify. In the context of a traditional portfolio, coins still have a relatively low correlation to other assets. However, this has been rising over time. We generally view coins as inferior to traditional hedges against equity drawdowns.

8.



There are substantial ecological costs for coins based on a proof-of-work system. In time, DLTs may be able to provide a positive social impact. But, right now, the majority of investment capital is aligned with activities whose ecological footprints and governance drawbacks outweigh the sporadic evidence of a positive societal impact. So we don't consider proof-of-work based digital assets a sustainable investment at this point.

9.



Given the drawbacks, we view direct exposure in crypto coins and tokens as being only attractive for highly risk tolerant and speculative investors. Such investors could take advantage of the volatility and large price swings of individual crypto coins. They should, however, be prepared for high volatility and the potential for permanent wealth destruction.

10.



Mainstream investors can better gain exposure to these emerging technologies through companies that provide services for DLT-based ecosystems and through enablers and platform operators. Fintech companies, given the breadth of possible applications, are one way to build exposure. We see opportunities in leading payment players, platform companies, and disruptors in emerging technologies like blockchain, cloud, and artificial intelligence. Beyond fintech, we advise taking on exposure through enablers and platform companies.

Part I
Introduction – A brave new world

The digital asset domain is one of the fastest-moving areas in the tech space. Bitcoin, being the world's first and arguably most successful crypto coin[1] at this point, receives the most attention. However, there is much debate about whether Bitcoin, Ethereum, or other coins are a worthwhile investment. Opponents point to their lack of real-world use cases, high volatility, and negative environmental footprint as reasons to avoid exposure. Proponents point to the myriad of potential applications, the independence from centralized authorities, and—in the case of protocols where the coin issuance has been fixed—the inherent scarcity value to justify some exposure.

Predictions aside, Bitcoin and other initiatives inspired by the combination of decentralization, cryptography, and economics have provided a glimpse into the potential for distributed ledger technologies as alternatives to centralized transaction platforms (see Figure 1 for more on how distributed ledgers (DLTs), blockchains, digital assets, and cryptos relate to each other). Importantly, DLTs are being increasingly recognized as operational and scalable and, therefore, that they can be applied to essential real-world applications. This marks an important milestone in the history of this emerging field.

Yet, there are many open questions around this technology. The main ones we are asked relate to the technological aspects as well as the economic and societal relevance. Another important discussion point centers around sustainability, given the high energy use involved in "mining" some coins and tokens, for example those that use the proof of work as a consensus algorithm (for more on these, please refer to Part II).

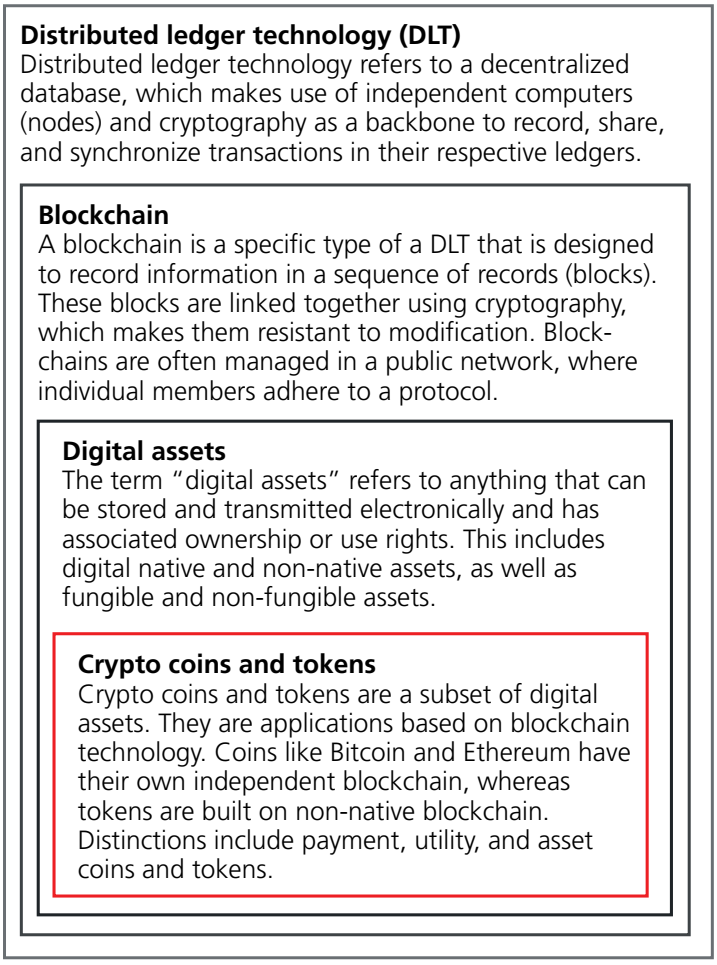
Many people are also uncertain on how to invest. Should they build exposure to public or private companies that might benefit from this nascent technology, gain direct investments in crypto ecosystems, or simply ignore the entire industry as a fad?

There are few examples in history where people were willing to invest substantial amounts on the (quite uncertain) idea that sustainable and profitable business applications will eventually arise, pushing valuations to lofty levels. One such instance was the dot.com period that ended with a severe market correction, which is a good reminder that these endeavors don't always end well for investors. That said, the longer-term value creation of the internet can clearly be seen across today's top tech companies.

We therefore advise looking beyond the hype and instead first establish a better understanding of the underlying technologies as well as their societal and economic relevance. Only then should investors decide on how to gain exposure within the context of the risk capacity of their investment portfolio. Although this approach might be less suited for speculative gains, we believe its longer-term, risk-adjusted merits are far more promising.

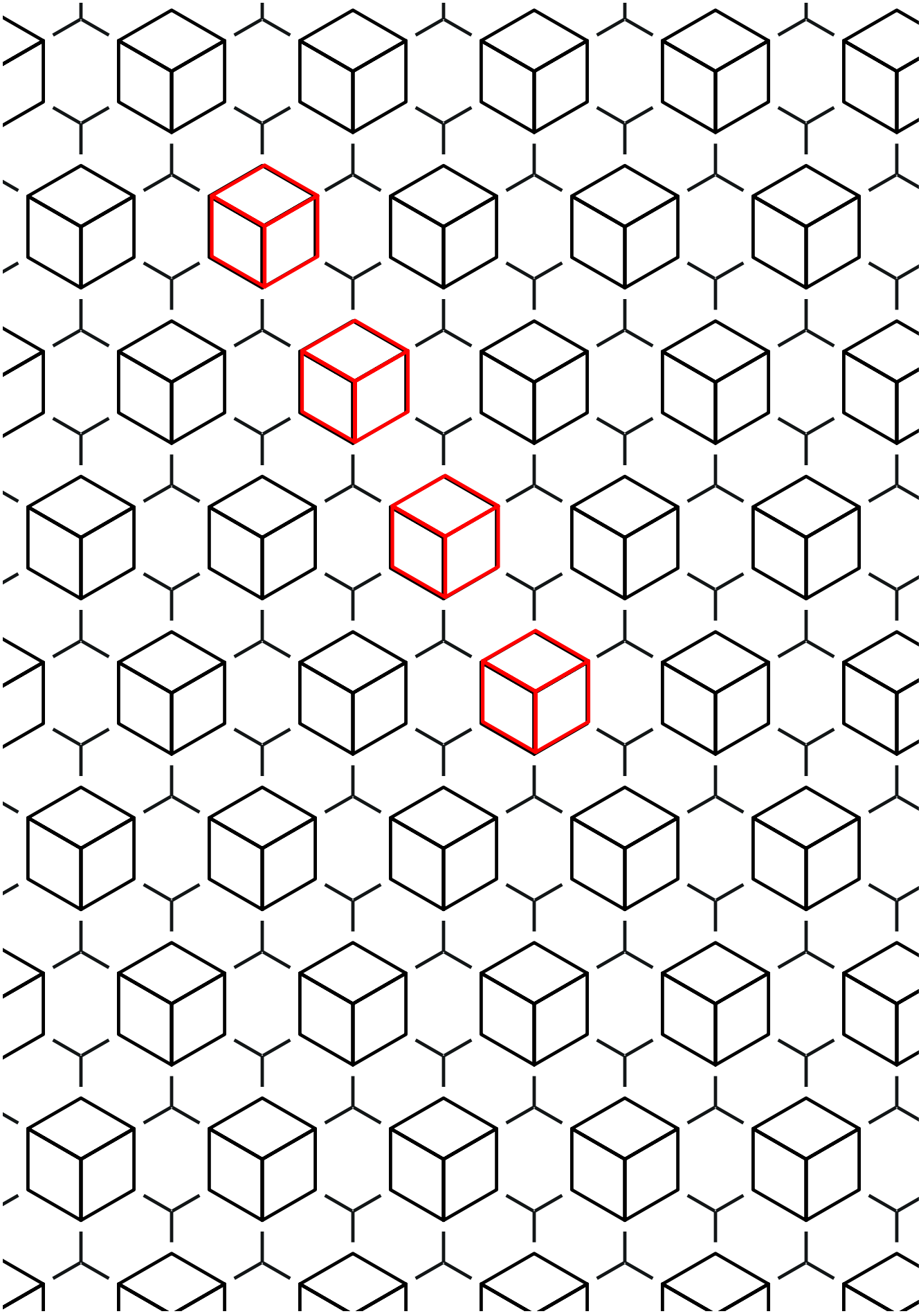
Figure 1

Relationship of DLTs, blockchains, digital assets, and crypto coins and tokens



Source: UBS, CFTC, as of September 2021

1 We do not use the term cryptocurrency in this report, because we think crypto coins and tokens are inherently different from currencies. See page 15 for a more in-depth discussion. Instead, we use the terms crypto coins and tokens or simply cryptos.



Part II
What are digital assets?

The assets recorded on a distributed ledger are commonly referred to as digital assets. So, to understand digital assets, we should first look at how distributed ledgers work.

How does distributed ledger technology work?

A distributed ledger is a special type of database that makes use of various technologies including distributed systems, consensus algorithms and cryptography. While these technologies have been around for many years—the ancient Egyptians used cryptography for royal communications—it is their unique combination that makes distributed ledger applications an interesting nascent technology.

We find it useful to look at the elements individually:

- *Decentralization:* The internet is arguably the best known application of a distributed network. In this form of a network each node can interact with any other node in the network, without relying on a centralized entity. This makes distributed networks scalable, efficient, and reliable. While decentralized and distributed networks have several advantages over centralized solutions, they are currently inferior when it comes to network maintenance and coordination costs. The most prominent example of this challenge is the high energy costs of crypto blockchain networks like Bitcoin (see Part V for more on this topic).

- *Consensus algorithms:* Given the distributed nature of the network, DLTs don't possess a central authority they can rely on to avoid malicious outcomes like conflicts of ownership rights or more generally disagreements about the correct database entry. Instead, consensus algorithms exist to ensure that all nodes in the network agree on the correct state of the ledger. Famous examples of consensus algorithms are proof of work (PoW), which is used by the Bitcoin blockchain, and proof of stake (PoS), which will be used by the upcoming version of Ethereum. However, many more algorithms are used in computer science.

- *Cryptography:* DLTs use cryptography in different forms. Cryptographic hash functions create deterministic and irreversible outputs—i.e., the same input value will always deliver the same output (deterministic), but it is impossible to derive the input value if only the output value is known (irreversible) and the output value is unique to the input value. These attributes contribute to the immutability of blockchains and distribute databases, as they require new blocks that are added to the chain include the "hash" of the previous block. If the previous block is altered, the output of the hash function is altered, which becomes obvious as the references no longer match. Meanwhile, public key (or asymmetric) cryptography enables users to securely propose changes or transactions to the network. Software enables users to present the public key along with a signature that can only be generated by the holder of the associated private key.

What are digital assets and how can we classify them?

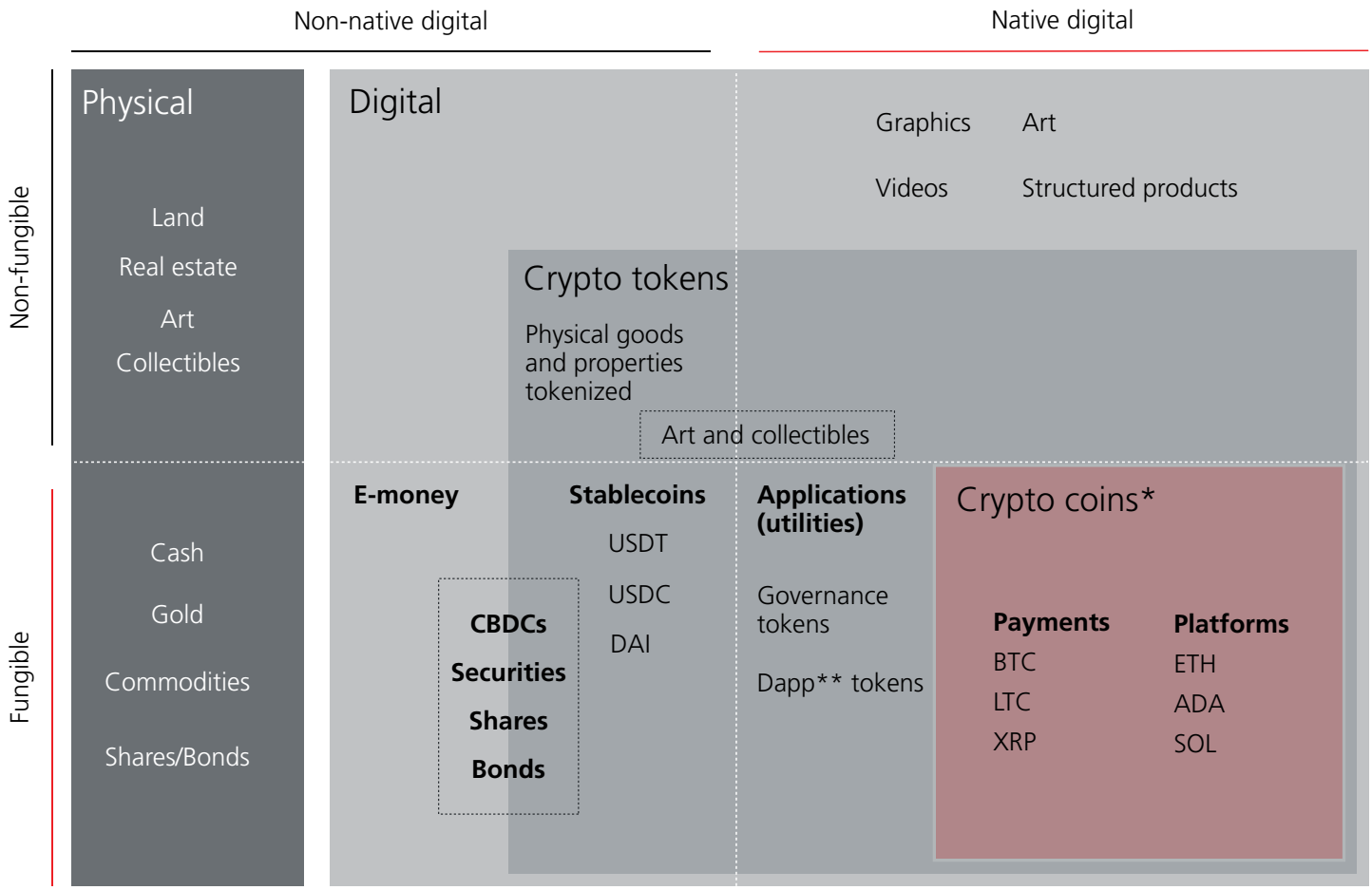
The US Commodity Futures Trading Commission (CFTC) defines digital assets as anything that can be stored and transmitted electronically and has associated ownership or use rights. We find this definition appropriate, because it considers the broad range of digital assets that currently exist.
From an investment standpoint, however, it is useful to look at individual subsegments. We find it useful to distinguish between native versus non-native digital assets and fungible versus non-fungible digital assets (Figure 2). Non-native digital assets are representations of real-world assets like cash, securities, physical goods, and properties. The structure of these assets is defined by their categorization in the real world. Native digital assets don't have a real-world representation.
In the context of cryptography, blockchain, and DLT, we can add another layer of differentiation based on cryptography (using code to protect information and communications). Tokens encompass everything that runs on a blockchain, including non-native and native and non-fungible and fungible assets. Coins are a subsegment of tokens. These are digital assets that have their own native blockchain and can be categorized according to their use cases, namely payments and platform use.

Several other distinctions are regularly used, including centralized versus decentralized digital assets. This is important because many digital assets don't rely on a central party to issue them. Figure 2 visualizes some of the mentioned distinctions and provides examples for each category, including crypto coins and tokens, non-fungible tokens (NFTs), and central bank digital currencies (CBDCs).

Digital assets like art and collectibles and CBDCs can be found in several categories. Art and collectible NFTs, for example, can be digital representations of physical properties or can originate in a purely digital format. Also, CBDCs, which are basically a digital representation of cash, may or may not rely on DLTs.

Figure 2

Overview of the digital asset domain



* Some coins share different characteristics
** Dapp stands for decentralized application
Source: UBS, as of September 2021

Ledger entries determine digital asset ownership

Distributed ledgers and blockchains play a very significant role in the world of digital assets. As we explained above, the fundamental property of a distributed ledger or a blockchain is that its entries cannot be altered or counterfeited. This proposition makes distributed ledgers a valuable tool to record, track, and verify the ownership of digital assets. Think of this as a vast, distributed database, which allows its users to record and transfer ownership of coins, financial transactions, digital assets, and any other digital data. As long as the proposition holds and users have faith in it, the technology allows for the removal of middlemen in many areas. The result should be a more efficient, transparent, and secure transaction (see Part IV for examples of possible applications).

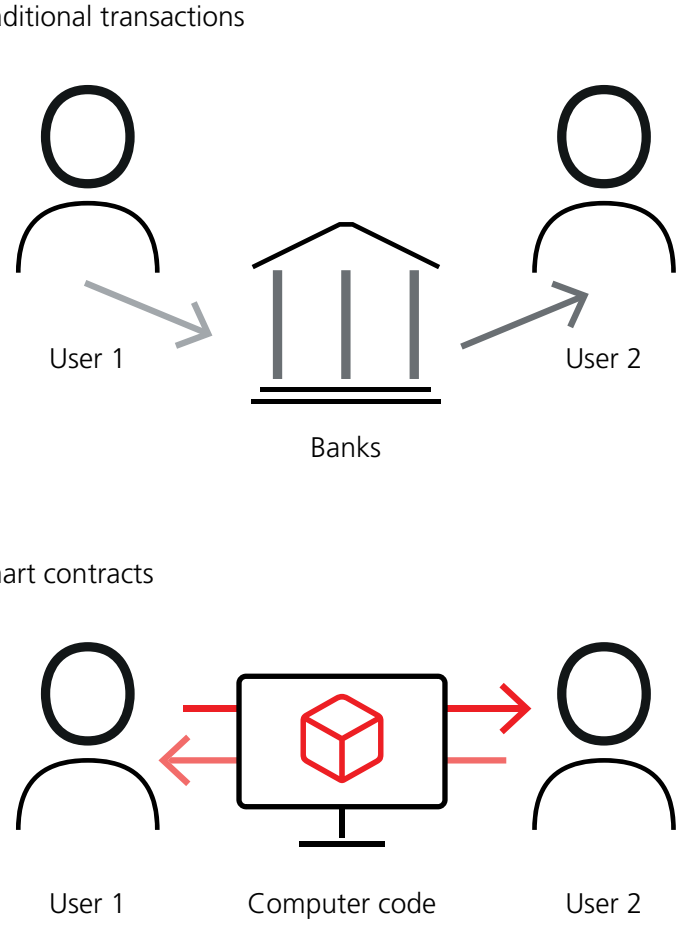
The significance of smart contracts

Smart contracts were first proposed in the 1990s as a computer program that would automatically execute based on the terms of the agreement. Distributed ledger technology has provided a platform for the realization of this concept. As the ledger is immutable, the parties involved in the smart contract know that it is unique—the ledger records the outcome of the smart contract's execution on the ledger, which cannot be tampered with by any of the parties involved.

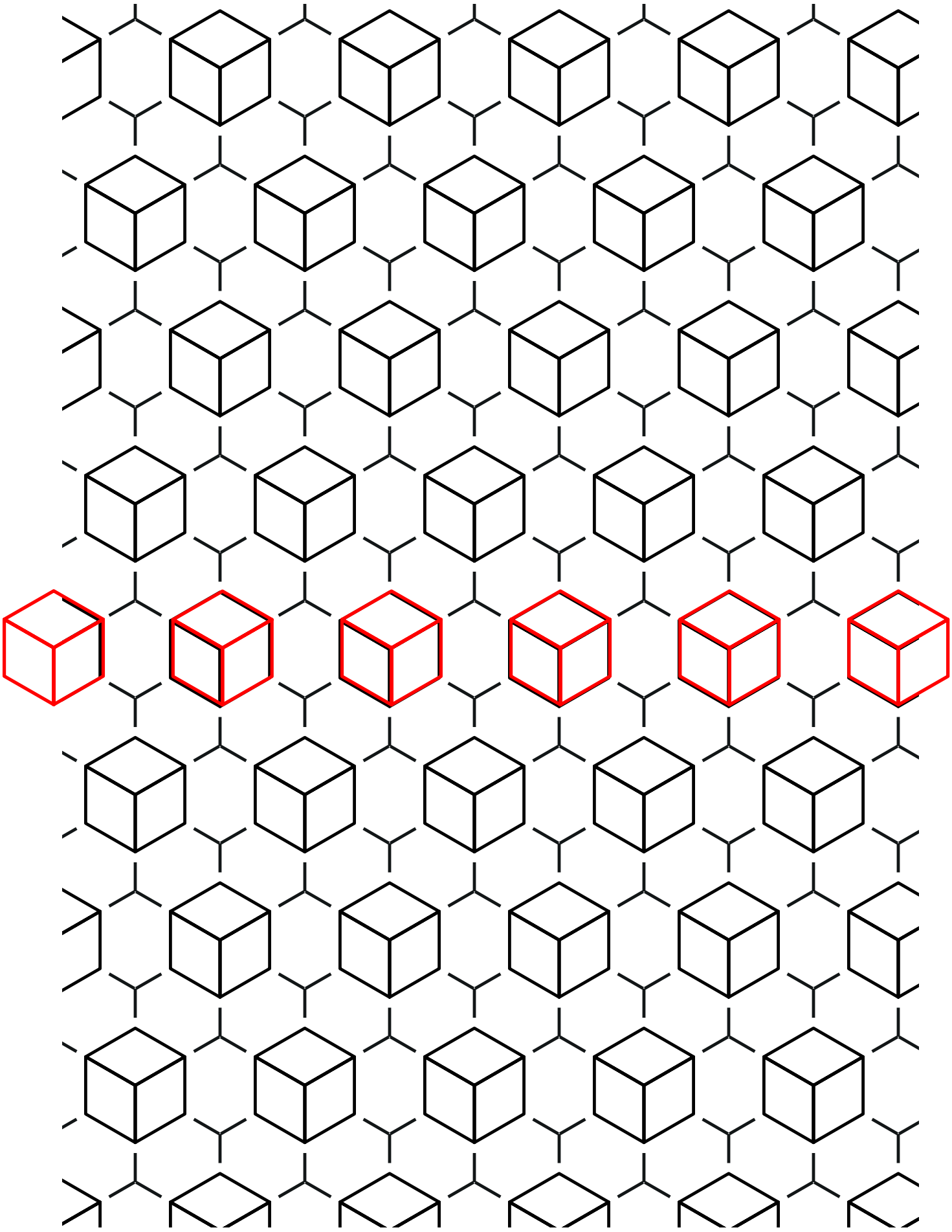
Users can therefore use smart contracts to add conditional logic to a DLT. This includes operational clauses commonly used in computer science that have become part of nearly every aspect of our lives; for example, triggering a payment at a pre-determined point in time. What makes smart contracts significant is that they allow involved parties to agree on automated and self-executing contractual clauses without the need for a middleman.

It is worth noting that not all clauses are equally suitable for automation and self-execution, and that smart contracts may also have undesirable properties. An important challenge is the implicit "code-is-law" assumption. A smart contract is nothing more than a piece of code, so what happens if one of the involved parties misunderstands the logic of the code? Or what happens if there is a glitch or a blackout that leads to an unwanted outcome? Although similar challenges exist with traditional contracts, some aspects of our economic and social interactions are more susceptible to automation and self-execution than others. Still, as smart contracts grow in popularity, the scope and relevance of public and private ledgers should increase.

Figure 3
How smart contracts work



Source: UBS, as of September 2021



Part III
DLT-based ecosystems

The DLT ecosystem explained

Digital assets are at the heart of a well-functioning DLT-based ecosystem, one that various stakeholders (e.g., developers, miners, exchanges, users, service providers) play a crucial role in nurturing.

The participants of such an ecosystem can be categorized into five groups based on their main activities:

- *Developers:* They create and launch crypto coins and tokens and build the applications that allow for workflows associated with achieving use cases.
- *Miners:* Their task lies in verifying and settling the movement of crypto coins and tokens across different protocols on the blockchain. Newly generated units and transaction fees compensate them for the underlying costs to do so.
- *Exchanges:* Centralized exchanges (e.g., Coinbase) and decentralized exchanges (e.g., Uniswap) offer online services, allowing users to trade digital assets. The key difference between centralized and decentralized exchanges is that the latter are non-custodial. Centralized exchanges tend to be custodial exchanges, whereas with decentralized exchanges, users hold their own private keys. Decentralized exchanges are mostly not or only partly regulated.
- *Users:* End users benefit from the applications that are available to ecosystem participants. Such applications extend across a wide variety of use cases specific to the ecosystem. They also enable users to trade the coins and tokens applicable for the different applications. Users include speculators, retail, and institutional investors looking to profit from price changes or arbitrage opportunities, as well as those using the platform as an alternative means of exchanging value such as merchants or criminals.
- *Supporting services:* They assist other participants in the ecosystem. For instance, security and audit service providers help users and developers by improving smart contracts or identifying bugs; merchant services act as intermediaries to provide payment services; and hosted wallet providers offer wallet infrastructure to reduce security inconveniences and improve user experiences.

Challenging existing ecosystems

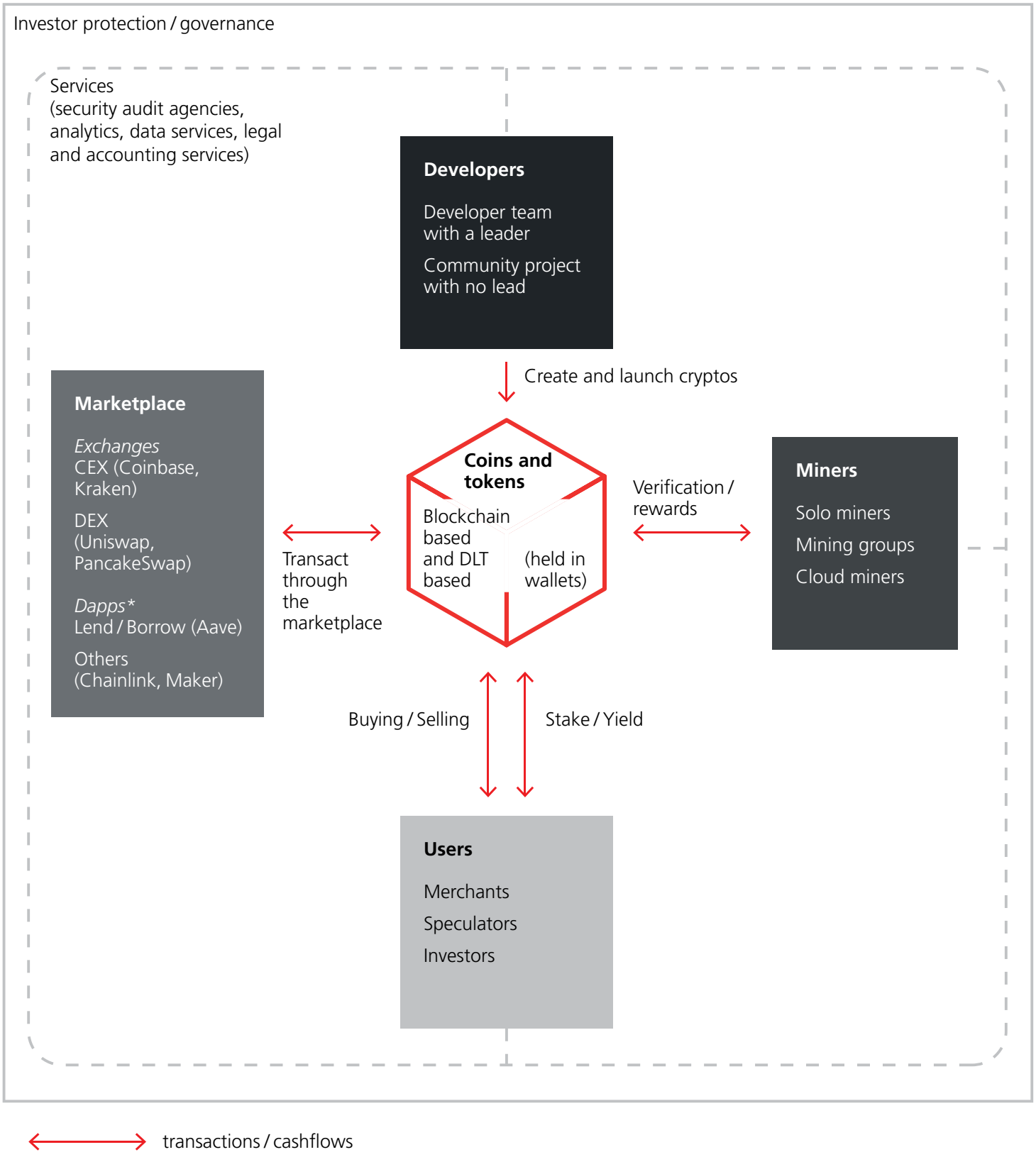
Distributed ecosystems represent a challenge for various ecosystems—for example, the art market, social media, and the financial service industry—because of the changes they may bring about. Specifically, they could make existing processes more efficient, transparent, and secure (see Part IV for more on DLT applications and their benefits).

Incumbent platforms are typically built around a single entity that directly or indirectly controls substantial parts of the overall value chain. By contrast, DLT-based ecosystems utilize a decentralized governance structure, which brings advantages and disadvantages.

Ultimately, consumers—together with external factors such as the legal and regulatory environment—will play a crucial role in determining which ecosystem is going to prevail and whether incumbent industry leaders adequately respond to the competition from DLT-based ecosystems. Similar to the adoption of instant messaging platforms, the decision to migrate will be based on trust and the belief that the new ecosystem will attract a critical mass of counterparties.

Figure 4

Digital asset ecosystem structure and participants



* Dapps stands for decentralized applications

Source: UBS, as of September 2021

Part IV
Application areas

As an immutable shared ledger, DLTs offer a plethora of potential use cases. Many are straightforward and merely a digital representation of existing applications, such as the use of an immutable shared ledger in trade finance or the use of a blockchain to safely record the history of ownership changes of assets.

What makes these applications appealing from an economic and investment point of view is their potential to lead to greater efficiency, security, and transparency. Along with improving existing applications, DLTs offer significant potential for new applications. As existing applications become uneconomical, new ones will be born. We have seen this already with the emergence of decentralized finance applications, non-fungible tokens, and decentralized autonomous organizations.

Also, not all applications will require coins or tokens. Incumbent companies might use immutable shared ledgers to improve existing applications, using only their private networks instead of a public solution. This can help them retain their existing business, while leveraging their existing network could help them defend against new market entrants (see Part VI for more detail on this topic).

Digital asset adoption

For an industry that relies on intermediaries as a source of trust when transacting, distributed ledger systems could be a major disruptor for financial institutions. Disruption could result in significant cost savings for incumbents and consumers alike, as well as in new products and services.

To determine where DLTs might play a crucial role in the foreseeable future, we find it useful to distinguish between the value and the volume of a transaction. Figure 5 breaks down a selection of financial applications by these parameters.

We see the biggest near-term opportunity in private markets, syndicated loans, derivatives, and trade finance—areas with higher inefficiencies, usually because of a comparatively low volume, and high transaction values. This combination should result in sufficient incentives to attract innovation and investments. Reasons to switch to a distributed system include lower costs, shorter settlement periods, the benefits of moving centralized data and services to an independent entity, or simply the lack of a commercially viable offering through current platforms.

Figure 5

Assessing the likelihood of digital asset adoption: Value and volume of transactions



Source: UBS, as of September 2021

Operational efficiencies of existing processes

To illustrate one example in greater detail, let's look at how the adoption of DLTs could enhance trade finance services. In trade finance, the use of smart contracts could automatically trigger contingent payments. This could help lower costs and boost efficiency, particularly for small businesses and in emerging markets where the bulk of transactions are still conducted on paper. Finacle Trade Connect is a blockchain-based solution developed by Infosys, a global IT services vendor, that integrates many trade functions like chain opening account, letters of credit, bank guarantees, bill collections, C2C and B2B transactions, bill discounting, reverse factoring, and invoice financing on a blockchain network. It competes with other bank-initiated ventures such as Komgo and we.trade.

Beyond digital assets, the financial industry might also adopt blockchain technology to improve the speed and the costs of post-trade services such as settlement, custody, stock lending, and collateral management. Blockchain could help improve the current Know Your Customer (KYC) and compliance processes by creating digital identities for clients that are interoperable across platforms and institutions. According to IBM, the company has integrated blockchain technology in the KYC process and has partnered with banks and payment companies to improve their compliance (or regtech) processes.

Payment coins and tokens

Payment coins and tokens are designed to be a digital, decentralized form of money. Bitcoin is arguably the first and most widely known payment coin, but various other payment coins exist, including Litecoin, Dash, and Dogecoin (see the appendix for a list of key cryptos). Many of these coins were designed in a manner to address some of Bitcoin's perceived weaknesses. Payment coins still account for the biggest share of all crypto coins and tokens according to market capitalization[1].

Some payment coins aim to compete with fiat currencies, while others focus more narrowly on payment services. They are all fungible and are not pegged to fiat currencies or other assets. Since payment coins and tokens have no intrinsic value, their value is purely driven by fluctuations in supply and demand.

Payment coins don't have the same properties as cash: they are not legal tender[2], they are not backed by a government, and they are not used to set the prices of goods and services. However, they can be used to settle a transaction for a price in fiat currency terms, despite their very high volatility.

Coin or token?

The terms coins and tokens are often used synonymously. However, there is a difference between the two. Coins are native to their own blockchain, whereas tokens are built on top of another blockchain. For example, Bitcoin has its own blockchain, whereas Dai is built on top of the Ethereum blockchain and is therefore a token.

1 http://coinmarketcap.com as of end-August 2021

2 The Central American country El Salvador recently declared Bitcoin as legal tender. As of this writing, we are not aware of any other country that accepts a decentralized payment coin or token as legal tender.

Stablecoins

Stablecoins have grown rapidly in recent years. Tether, the largest stablecoin emerged in 2014, to help manage volatile coin and token prices, and to reduce exchange transaction frictions incurred when converting crypto back into banking system fiat currency.

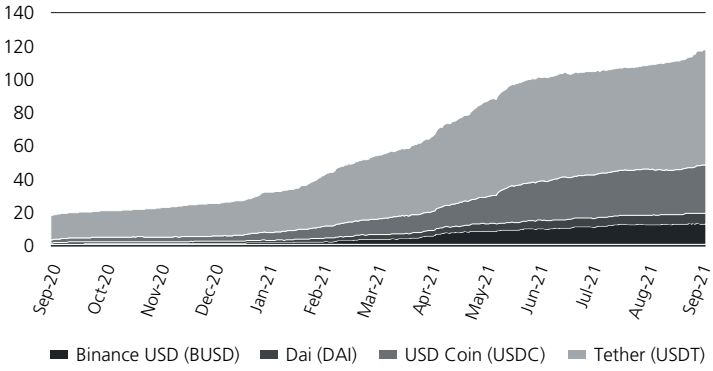
As the name suggests, stablecoins aim to keep their value stable relative to a benchmark, typically the US dollar. The most common approach is to mint and buy back coins at par, with each issued coin backed by the equivalent value in high-quality reserve assets. Auditing standards vary, and there is some controversy over transparency. Crypto traders remain the primary stablecoin holders. Unregulated digital exchanges are also major buyers of stablecoins, which are used to onboard clients and as a vehicle to store parts of their balance sheet in digital assets pegged to fiat currency.

Other applications could prove more lucrative. Stablecoins could be used for payment services or remittances, and at some point could play a key role as gateways between real and digital assets for financial service providers, corporations, or conglomerates. Remittance flows to low- and middle-income countries reached USD 540bn in 2020, according to World Bank data, offering an attractive market for more efficient transfers. The value of the stablecoin market has expanded rapidly over the past year alongside crypto asset appreciation and wider adoption, with the top four nearing USD 120bn in value (Figure 6). That growth has drawn regulatory attention, with the US Treasury reportedly seeking industry input in September on potential regulations and controls. Others, including Fed Vice Chair Randal Quarles, have suggested private sector innovation around stablecoins should be nurtured.

Figure 6

Stablecoins have experienced rapid growth over the past year

Four largest stablecoins by marketcap, in USD billions



Source: CoinGecko, UBS, as of 14 September 2021

At this stage, private sector banks, corporations, and conglomerates are still somewhat behind the curve. These organizations, which are generally less exposed to regulatory hurdles, could leverage their large client networks to accelerate their capabilities on this front. In addition, we think future central bank digital currencies (CBDCs) backed by guarantees will offer direct competition to private issuance. If regulators permit, a few stablecoins could one day reach mass adoption to service the need for international payments and transactions, alongside other solutions. We think it is too early to assess which applications will prevail.

Security tokens (STOs)

Asset tokenization refers to the process of converting assets into security tokens. This process allows real world assets to convert their shares or bonds, or even a piece of artwork, into a digital token represented on a distributed ledger. That token could then be traded in the secondary market, with its legal and ownership rights transferred and recorded on the distributed ledger. The tokenization of assets can be seen as a further evolution of payment and stablecoins.

In many aspects, the tokenization is similar to the traditional securitization of assets. The term "security token offering" (STO) refers to the public offering of a token on an exchange. STOs allow developers to raise capital in a fully decentralized manner.

Another interesting aspect of security tokens is that they are programmable. The use of smart contracts (see Part II) can further enhance the range of possible applications and features of a security token. Companies might process dividend or coupon payments via a security token, without the use of traditional middlemen like a bank or a clearing house.

An interesting example is Pax Gold (PAXG). According to its developers, each token is backed by one ounce of gold and stored in a vault. An investor in PAXG owns the underlying physical gold and the Paxos Trust company acts as a custodian.

Security tokens can offer several advantages over traditional securities, including cost reductions, faster transactions, global market access, and 24/7 trading. But the lack of regulatory oversight is a potential challenge. For example, developers can allege that a security token is backed by an underlying asset, but buyers would have no way to verify the claim. As a result, it is not unusual for some investors to prefer security tokens that are issued by a legal and regulated entity like a bank or an exchange through a permissioned blockchain over those from decentralized organizations.

Central bank digital currencies (CBDCs)

Central bank digital currencies can be seen either as an application of DLTs in a wider sense—although in many cases it is unclear whether central banks are actually going to (fully or partly) rely on DLTs to create CBDCs—or as a government's response to the emergence of payment and stablecoins. (See the next section for more on the external factors that may slow, or stop, the adoption of DLT-based applications.)

It's worth noting that digital currencies are not a new phenomenon and have been a feature of our daily lives for many years. But with the use of private money growing and the share of public money falling, central banks' direct control of money in the economy is shrinking. CBDCs are one way for central banks to keep direct control over money in the economy.

The basic workings
In economic terms, a CBDC would be part of a country's fiat currency system—i.e., it is the same as the existing physical currency. It is a liability of the central bank, just as notes and coins are. It can be held by anyone and used to pay for goods and services. The key difference with existing physical currency is that CBDCs are held digitally such as in electronic wallets.

The simplest way to understand CBDCs is to think of them as a bank account with the central bank. Currency holders would use a digital device or platform to deposit into or withdraw from their CBDC account with the central bank. CBDCs are likely to have the features outlined in Figure 7.

What are the pros and cons of CBDCs?
The main benefit CBDCs offer is a stable store of value, as they are fiat currency, in contrast to cryptos, which are highly volatile. They, in theory, offer an efficient and reliable way to conduct transactions. There are also no credit risks linked to CBDCs, as the holder carries a claim on the central bank—not commercial banks or payment service providers.

For central banks, in addition to keeping some direct control over money in the economy, CBDCs could, in time, lead to more efficient and direct transmission (implementation) of monetary policy relative to the current system. For example, a central bank could provide stimulus to a specific region of a country or sector of the economy, although this would assume that all residents were able to hold CBDCs and that money is spent in the area or sector (i.e., no leakage of CBDCs spent outside of the targeted sector).

The primary concern that could stem from the introduction of CBDCs is the impact on commercial banks. If people can hold CBDCs with no risk, they would be less inclined to hold commercial bank deposits. This would limit the ability of commercial banks to provide lending into the economy, with potentially negative consequences for economic growth. But so long as CBDC deposits don't offer an interest rate markup over private sector deposits, deposit flight (drain) from commercial banks due to the introduction of CBDCs may not be as big a risk as feared. In a world with extremely low (and even negative) interest rates, central banks will have to manage this aspect carefully.

Other concerns are primarily related to privacy—the central bank's capacity for CBDC monitoring would mean that no transactions are anonymous or beyond government control. Distributed ledger technology accounting systems would mean that authorities could monitor transactions to a much greater extent than before, which comes with costs and benefits alike. Inequality is another topic, as not all groups in society will be willing or able to use CBDCs. And then there is the potential for fraud and the impact that system failures (perhaps due to hacking or technical glitches) could have on the day-to-day functioning of the economy, although similar risks already exist today with existing private sector digital currencies.

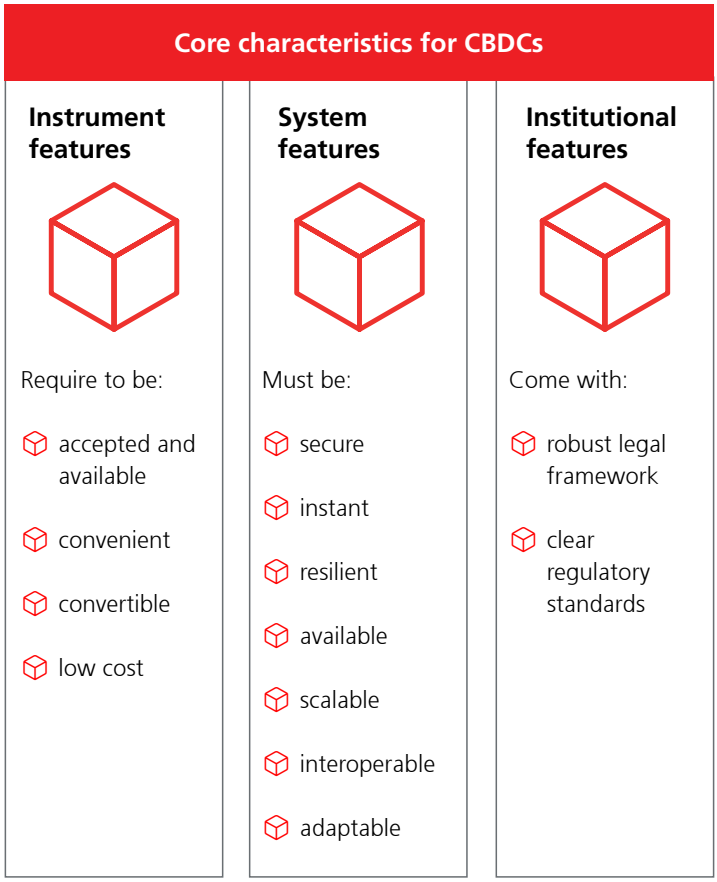
What is the path ahead for CBDCs?
Regardless of the motivation and approach central banks have for creating CBDCs, moving beyond pilot projects is likely to happen in steps. But if implemented successfully, the benefits could include greater diversity in payment options, improved liquidity, and the advantage of having a digital representation of money for an increasingly digital economy.

CBDCs that include digital identification could also successfully facilitate faster and cheaper cross-border transfers and payments while limiting the risk of currency substitution. All CBDCs will have unique national characteristics. Attempts to find multi-CBDC arrangements could help to achieve some degree of standardization across different jurisdictions, which could help speed up CBDC adoption.

China is far advanced in its testing phase in this endeavor. It is working together with the Bank for International Settlements, the Hong Kong Monetary Authority, and other central banks to explore joint CBDC cross-border payments called mCBDC. Moreover, it intends to use its digital currency (DCEP) at the 2022 winter Olympics in Beijing.

Figure 7

Core CBDC features suggested by the Bank for International Settlements (BIS)



Source: BIS, UBS, as of September 2021

CBDCs vs. crypto coins

CBDCs and crypto coins are different for several reasons:

1. Use case

In our view, the focus of CBDCs is predominately to facilitate digital payments and transactions. Many crypto coins, by contrast, are designed for other applications such as the digitalization of assets or the use of smart contracts. Other important considerations are volatility and the ability to act as a store of value. CBDCs are fiat currencies, while some cryptos can experience wild swings in value against fiat currencies.

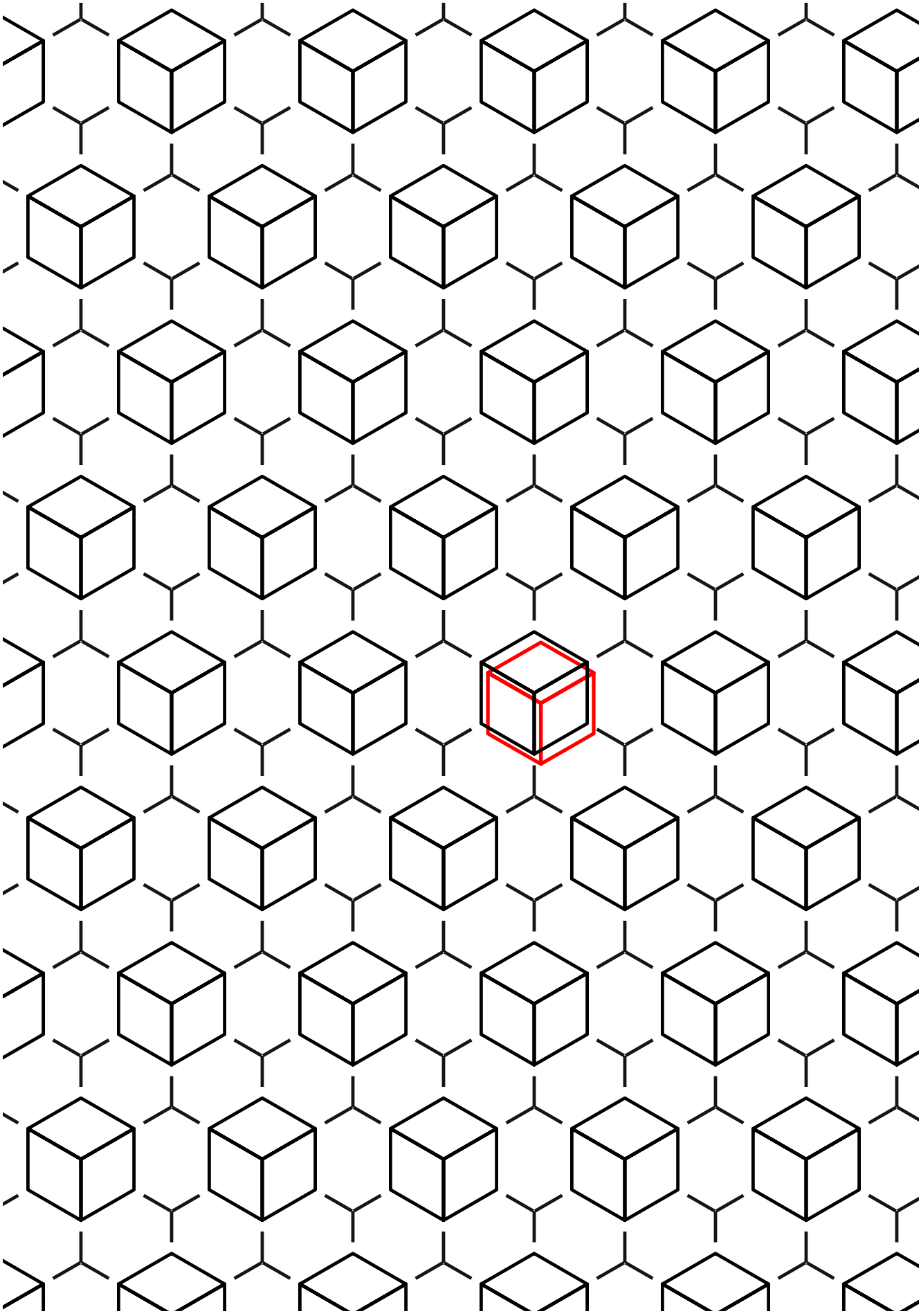
2. Design

A key difference between CBDCs and crypto coins is the centralized infrastructure of the former versus the often decentralized design of the latter. Various design options are under consideration, but it is becoming generally accepted that the location and administration of consumer CBDC accounts would likely take place in banks and other licensed and supervised payment service providers, which would carry out the regulatory compliance. Critically, the central bank would approve CBDC accounts and record transactions.

The centralized nature of CBDCs stands in contrast to the philosophy applied to most crypto ecosystems. CBDCs will ultimately be governed by the issuing central bank, which makes policy decisions in the interest of broad national objectives. Another factor to consider is that the supply of CBDCs can be actively managed by the issuing central bank (as and when they deem it necessary, usually to meet their policy objectives). Many coins don't possess such a flexible supply adjustment.

3. Privacy

When it comes to KYC, Anti-Money Laundering (AML), and other regulatory compliance, this is likely to be administered by the private sector. As a result, the identities of CBDC users will be linked to the existing banking relationship—unlike physical cash and crypto coins. It remains to be seen how much electronic anonymity is to be built in across various countries. CBDCs with greater built-in privacy may see greater adoption and non-resident popularity, although the relevance of privacy concerns will likely vary greatly across user groups, societies, and countries.



Decentralized finance (DeFi)

Decentralized finance is the new frontier in the financial industry and addresses both basic and more complex customer needs. Agreements are reached through smart contracts, which are executed automatically when predetermined conditions are met. This allows for the removal of middlemen, which can lower costs and improve efficiency.

Growing DeFi ecosystem of working apps and protocols
DeFi has grown in popularity over the last two years, with assets deposited as collateral on Ethereum-based platforms growing to more than USD 80bn in 2021 from about USD 4bn in 2020. If we adjust for the price effect, total locked value in Ethereum (ETH) terms has grown to more than 27mn this year, compared to about 11mn a year ago (Figure 8).

DeFi – ecosystem overview
DeFi ecosystems are built on several layers. The foundation is the underlying settlement layer—the blockchain. Currently, the most prominent blockchain network for running DeFi applications is the Ethereum network. Some use cases include verifying transactions on decentralized exchanges, powering stablecoins that are predominantly used for crypto trading, providing liquidity, and enabling activity that can reward participants with a form of yield. In addition to the Ethereum network, other frequently used networks for DeFi applications are Binance Smart Chain, Polkadot, Cardano, and Solana.

Based on this foundation comes the asset layer, which includes coins and tokens, and the application layer. The application layer makes use of smart contracts that run on top of the blockchain and use crypto assets to interact with the applications. Use cases of such applications include trading cryptos, decentralized insurance, and lending, which is typically used for yield generation.

The decentralized exchange and lending and borrowing markets have attracted the most user interest of late; these two markets combined account for around 80% share of all value locked on DeFi protocols[1].

Centralized versus decentralized exchanges
Similar to the role exchanges play for traditional securities, centralized exchanges (CEX) provide a marketplace for buyers and sellers to exchange digital assets. Examples include Coinbase, FTX, and Kraken, as well as various established exchanges in different countries that offer trading capabilities and other services for digital assets. Decentralized exchanges (DEX), on the other hand, allow users to exchange digital assets in a completely decentralized and permissionless way. In a DEX, trade execution occurs automatically through a smart contract—both sides of the trade are conducted automatically in one inseparable transaction on the blockchain. Liquidity-pool-based decentralized exchanges function through an automated market maker (AMM). The AMM determines prices using an algorithm based on the supply of tokens in the pools.

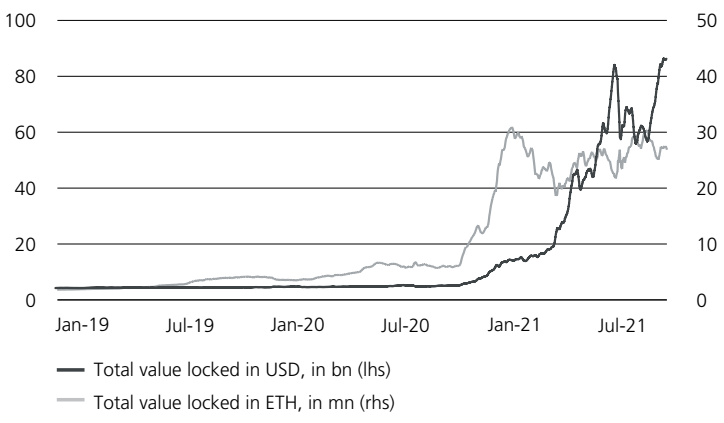
Decentralized lending and borrowing explained
With decentralized lending and borrowing, no direct intermediary is needed. Investors only need to connect their digital asset wallets to the lending and borrowing application. These applications allow users to borrow and lend while maintaining full custody over their digital assets. Lending digital assets typically allows investors to earn a yield, something that crypto coins and tokens normally don't offer to investors. Risks involved include smart contract code risks and the quickly changing variable interest rate charged to borrowers.

To safeguard the lender from the borrower, loans in DeFi are generally over-collateralized. To take a loan from a DeFi application, collateral needs to be locked on the application's smart contract and the collateral will only be released once the loan is paid in full. Loans taken from the pool mainly use a variable interest rate system that is a function of the pool's utilization rate. The utilization rate is defined as the total funds borrowed divided by total liquidity available in the pool, and it monitors what share of the reserve's total capital is borrowed at a specific time. When liquidity is easily available in the liquidity pool, loans will be cheap; and when liquidity is in great demand, loans will become more expensive.

Figure 8

Total value in DeFi applications linked to the Ethereum network

Values in USD billion and ETH million, 5-day average

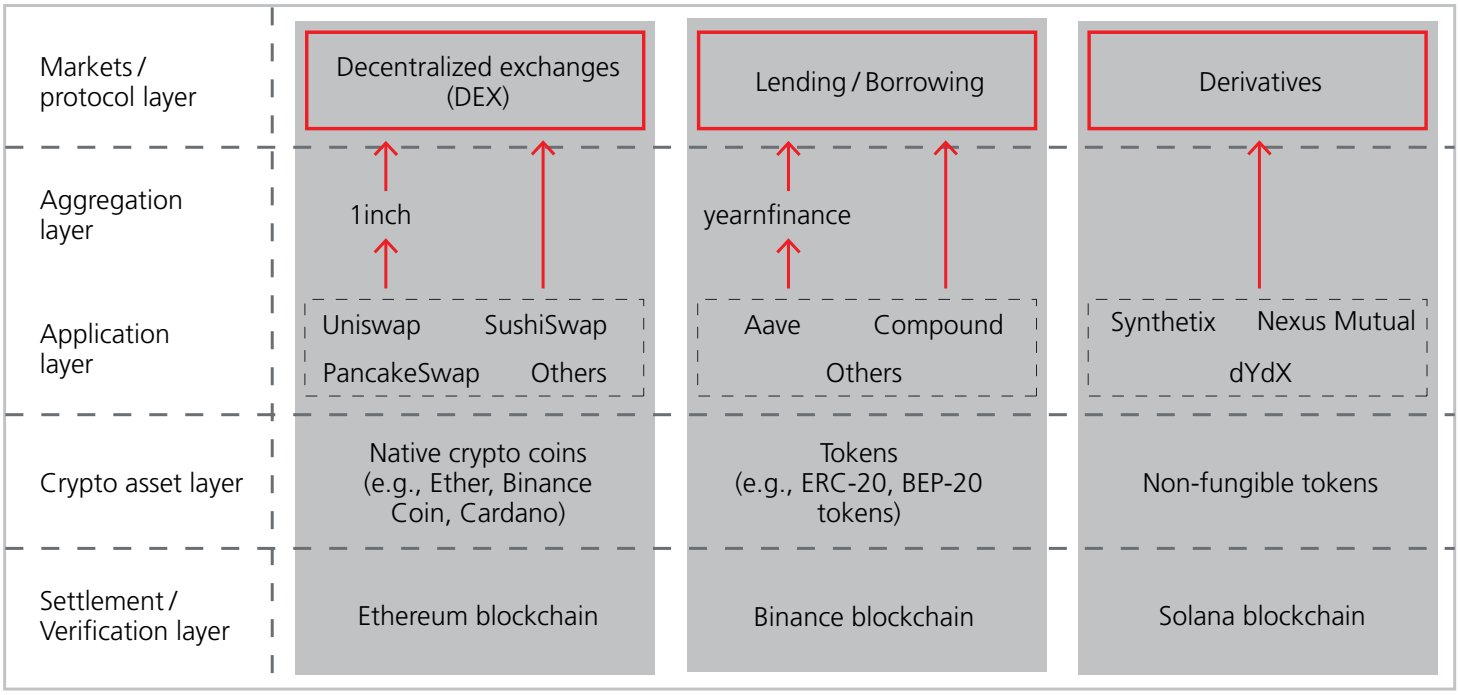


Source: DeFi Pulse, UBS, as of 1 September 2021

1 Source: http://defipulse.com, as of 1 September 2021

Figure 9

Main DeFi layers and how they are interconnected



Source, UBS, as of September 2021

Aave and Compound are two leading DeFi lending and borrowing applications for coins like ETH, stablecoins like USDC, and tokens like UNI.

The next stage for DeFi

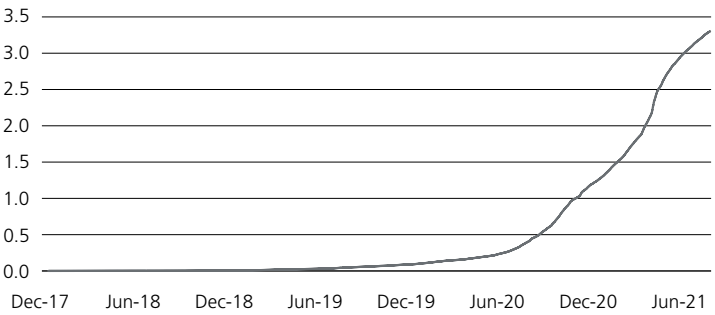
DeFi's most significant innovation lies in the shared settlement layer, which allows seamless interconnection between financial applications. As only about 1.75% of all unique ETH addresses have ever interacted with DeFi protocols, the industry is clearly in its infancy. So far, the biggest use cases—lending and borrowing and decentralized exchanges—are concentrated in the digital asset world. Current DeFi applications are not yet trickling down to generate much real-world utility. The tokenization of real-world assets, such as real estate or gold, could result in greater use of DeFi protocols. For instance, users that tokenize equities or illiquid private market investments could use them as collateral on DeFi lending and borrowing protocols.

But with DeFi's potential comes significant risks. While we cover risks in more detail in Part V, one particular risk that stands out for DeFi is the smart contract risk. Coding errors could allow hackers to drain the funds locked on a smart contract, rendering a promising DeFi application unusable, or force its value to zero. Ultimately, DeFi applications are only as secure as the underlying smart contracts that run them. Audit and insurance services are partial solutions to the smart contract risks. But with no centralized arbiter, DeFi involves a high degree of risks.

Figure 10

Unique addresses interacting with DeFi protocol on Ethereum netwok

Values in million unique addresses



Source: Dune Analytics, UBS, 1 September 2021

Non-fungible tokens

The concept of NFTs has been around since 2012. NFTs have gained greater public awareness over the last few years, particularly in the art and collectible market. So what are non-fungible tokens?

Simply put, NFTs are certificates of ownership of unique physical or digital assets. These assets can take many forms—a picture, music, a video, a piece of code, a domain name, etc., as well as a real estate property, a watch, or a precious metal like gold. The NFT records and tracks the ownership of an asset on a blockchain. This allows others to easily gain access to the information through the internet, without having to rely on a third party.

Until now, NFT issuance has been confined largely to providing a token of ownership for digital works. This proof is typically generated by the creator of the digital content and is usually minted on the Ethereum blockchain; a common alternative is the Binance Smart Chain. The process to mint a token is relatively straightforward thanks to the emergence of NFT marketplaces, where tokens can be created and traded.

The market for NFTs has become quite diverse:

- The 2017 CryptoKitties NFT revolved around a game that involved collecting and breeding virtual cats, with ownership defined by NFTs running on the Ethereum blockchain. In December 2017, these NFTs accounted for more than 10% of Ethereum network traffic. The most expensive CryptoKitties NFT ever sold, named Dragon, found a buyer willing to spend USD 172,000 for it.

- Everydays: The digital artwork "The First 5,000 Days" was sold in a Christie's auction in 2021 for USD 69mn, making it the most expensive NFT ever sold at the time of writing. This digital artwork merges 5,000 pictures that Beeple, the artist, created and uploaded online between 2007 and 2020.

- An NFT representing the original code behind the World Wide Web was issued by English scientist Tim Berners-Lee in 2021 and sold at auction for USD 5.4mn.

What are NFTs worth?

Determining the value of NFTs that represent physical, real world assets is relatively straightforward, as their value should be closely related to the value of the underlying assets. There are several advantages of producing NFTs for physical assets, including divisibility and tradability. The use of an NFT allows for a fast and cheap transaction of a physical asset, like a Fifth Avenue apartment home in New York, to be transacted at very low costs.

It's harder to derive real value estimates for digital-native assets because there is no pre-determined value. But the same argument can apply to physical collectibles too (value is ultimately determined by how much a buyer wants to pay). Also, we think price ranges would start to establish automatically in markets like digital art and collectibles if they start to gain in value.

NFTs can also allow owners of digital content to transact their intellectual property rights. Although Tim Berners could have simply sold a hard copy of his WWW Python code on eBay, producing an NFT with the code attached was straightforward and didn't involve the costly involvement of a third party.

NFTs that represent digital assets do not always include the respective intellectual ownership rights. If you buy, for example, an NFT portrait or an NBA Top Shot, you cannot reissue copies or print t-shirts with the underlying image without the originator's consent. However, the industry has begun to include terms of sale and smart contract codes to clarify copyright and reproduction rights granted alongside the NFT ownership. Some NFT smart contracts also include a royalty function for originators, paying them a percentage of the profit from secondary transactions—similar to Artists' resale rights on physical artworks. The buyer-beware risk matters in the NFT market, as elsewhere too.

Investors should also be mindful that the liquidity of some NFTs might be low, which is often the case for unique assets. Also, NFTs' blockchain-designated ownership structure has yet to be tested in court. There is practically no case law or legislation on smart contracts on general NFTs. Legal complications may challenge the assumption that ownership belongs to the network on which an NFT operates, or may lead to unexpected property rights issues as the laws governing digital assets develop.

The road ahead for NFTs

While the focus today is on speculative assets, NFTs have potential real-world use cases. For instance, they may be used to license intellectual property rights by linking to a smart contract that triggers a transaction every time it is used. Since the contracts are already programmed into the blockchain, the terms are permanent and cannot be changed.

NFTs can also play a role in supply chain management and the sale of physical goods. The Aura Blockchain Consortium—founded by luxury good makers LVMH, Prada Group, and Richemont—uses NFTs to allow "customers to access product history from sourcing to sales, all the way to second-hand markets." A digital ID in each product gives an owner access to the record of each stage of production and distribution.

Decentralized autonomous organizations (DAOs)

Decentralized systems are also empowering the creation of decentralized autonomous organizations (DAOs), a new form of collective governance and organizational structures. Consider an organization that has no central leadership—i.e., no management or hierarchy—autonomously operates on computer codes, and is governed bottom-up by its members (often anonymously). In other words, a DAO is an organizational model whereby people come together with a common cause to interact under a predefined set of rules by using a blockchain application. In this context, some view Bitcoin as the first DAO.

Unlike in a firm, the rules of operational and organizational logic in a DAO are embedded in the source code via smart contracts. There is no need to interpret these programs, and execution happens when predefined conditions are met. So a central oversight like a board of directors or executive committee is not needed. To participate in a DAO decision-making process, members are usually required to own "governance" tokens. Such tokens allow members to vote on and influence how the organization evolves as new governance proposals are being brought forward. Other DAO models make use of share-based memberships, which represents direct voting power and ownership.



Dancing through the verse, 2021. Jon Gordon. 1/1 NFT on Refinable/BSC

DAOs also come with their fair share of criticism and risks. Due to the decentralized nature of DAOs, rules cannot be edited or changed easily, even if apparent flows or weaknesses are spotted. Programing flaws can only be corrected if the majority votes on it. In the meantime, malicious actors can take advantage of them. A good example of an unsuccessful DAO is "The DAO," a revolutionary and successful crowdfunding project until funds were siphoned away by cybercriminals (although they were later recovered). But security issues are not the only concerns. Unclear legal aspects often result in open questions about members' liabilities.

The Nature of the Firm

In 1937, Ronald Coase, a British economist and winner of the Nobel Memorial Prize in Economic Sciences, argued the standard economic model for the allocation of resources through a price mechanism or organized market didn't always fit or wasn't always handled in the most efficient way with what was happening in firms at the time. In his paper, "The Nature of the Firm," he claimed some tasks and functions can be performed more cheaply in-house by hiring someone and thereby reducing, or even eliminating, all the costs of dealing in the marketplace. He believed firms (organizations) exist either to reduce or eliminate transaction costs.

There are now several platforms that help facilitate the creation of DAOs, such as Aragon, OpenLaw, and MarkerDAO. And with decentralized finance protocols gaining in popularity, DAOs have found renewed interest. In fact, some of the most well-known DeFi protocols, such as Uniswap, Compound, and yearn.finance, are governed by DAOs.

To what degree these organizational forms will complement traditional organizations has yet to be seen. But as this form of interaction, collaboration, and revenue/risk sharing matures, we would not be surprised to see other organizations—from financial companies to charitable organizations—adopt DAOs to help them govern part of their business activities.

Beyond finance – applications in other industries

There are countless other applications where distributed ledgers can help to improve efficiencies, security, and transparency (Figure 11). Below, we provide a few examples.

Manufacturing
While the use of blockchain might seem most applicable to services-driven industries, the potential cost savings for manufacturers is significant. We see two areas where blockchain can have the biggest impact: the supply chain and the Internet of Things.

Supply chain: Although global manufacturing supply chains are expected to shrink, the current system remains opaque and suffers from inefficiencies. The use of DLT-based applications can help to improve transparency through identification management, enhance inventory management through transparent entry of activities, manage product quality through verifiable transactions, and make payments faster through smart contracts. Tracr, an initiative led by diamond giant De Beers, integrates blockchain technology to provide provenance data for diamonds and to track the gems from the mine to the store.

Internet of Things (IoT): The distributive nature of blockchain technology can empower IoT units, like smart sensors in industrial equipment, by making networks quicker and more resilient. For example, blockchain could allow a sensor in a manufacturing line to communicate directly with one at the point-of-sale, bypassing the traditional hub. This would save both time and money. Xage Security integrates blockchain in its IoT offerings by storing credentials separately across a decentralized network, which allows for the efficient detection of cyberattacks. Blockchain can also act as an open ledger for IoT devices to record sensor data, allowing users to verify that the sensor data has not been manipulated along the way.

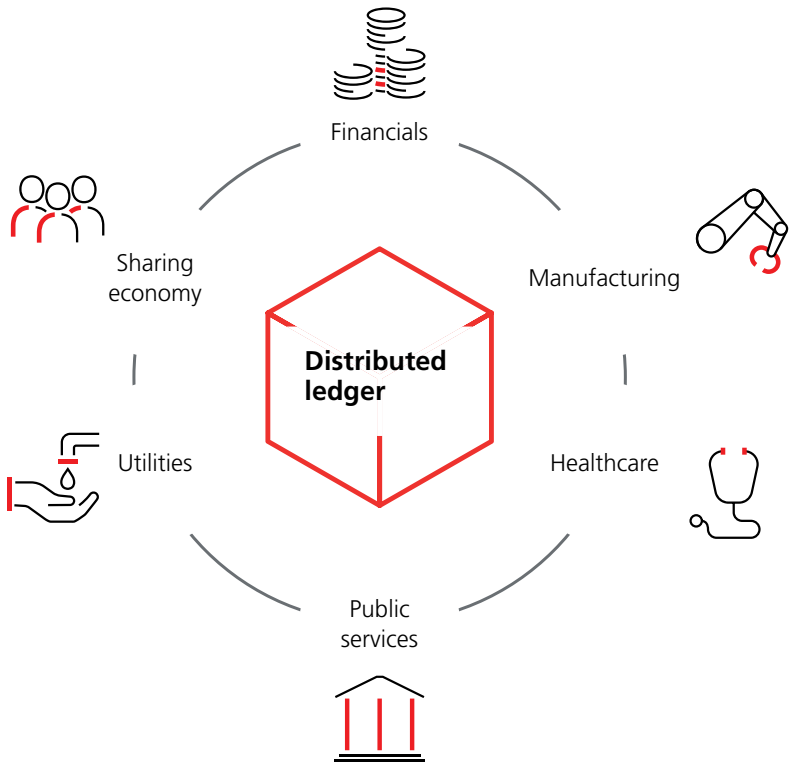
Healthcare
Healthcare companies generate around 5% of all the data generated globally, according to Bloomberg Intelligence, but data is not widely shared currently. This is mostly because patients are often uncomfortable sharing their highly personal medical history. Blockchain can solve this problem by providing anonymized clinical data as part of a distributed ledger, allowing inspection agencies or research institutes to access only the relevant information while maintaining patient confidentiality. Still, the industry might move to solutions that rely on centralized networks offered by the public sector or by private-public partnerships (see Part V for more on this topic). The challenge in this space is the conflict with regulations such as the EU's General Data Protection Regulation (GDPR), similar regulations in other countries, and the right to be forgotten. This ability for an individual to request the deletion of private data is not possible if the database is immutable. So particular attention needs to be paid as to what data is stored and how the data is represented so that it generates value but does not jeopardize the privacy of individuals.

Public services
While government agencies maintain trusted records like the registration of births, marriages, property transfers, and new companies, many records are still made on paper. And even where records are stored electronically, databases often work independently. Blockchain can help integrate databases and maintain the integrity and security of records. A good example here is real estate registration at the time of purchase/sale on a distributed ledger. However, as with healthcare services, it remains unclear whether DLTs will find mass adoption for public services.

Arts and luxury goods
Blockchain has the potential to help solve a long-standing problem in the luxury market: counterfeit products. International trade in counterfeit and pirated products has grown to more than USD 500bn, or about 3% of world trade, based on OECD and EUIPO estimates. A private blockchain based on NFT standards could address this issue. NFTs are not fungible, which means each token is unique and therefore not interchangeable. The private blockchain increases customers' confidence in the authenticity of their products, which are assigned unique digital identities. A secure and immutable database can also allow brand owners to share information on the origins of the luxury goods they sell, down to the materials used, which is critical information for jewelry buyers. Prada, LVMH, and Richemont have formed Aura, a blockchain consortium that aims to tackle these issues. This standard has helped ignite the digital art market, which saw an explosion in transactions in early 2021.

Figure 11

DLT-based applications may span multiple sectors and industries



Source, UBS, as of September 2021

Part V
Factors influencing likelihood of successful adoption

While the use cases for DLTs are vast, there are also many factors that could slow or even stop the successful adoption of distributed ledgers.

To start, it is important to note that significant parts of the digital asset industry operate outside of traditional and regulated financial markets and information systems. For instance, those interested in cryptos have often relied on alternative or informal information sources provided directly by proponents of the crypto industry. This helps explain market watchers' narrative of crypto's inevitable rise and continued price rally around nearly every example of broader adoption—no matter how minor the economic relevance.

As with past hype cycles in financial markets, risk considerations often take a backseat. The growth in crypto coins and tokens largely reflects speculation at this point, in our view, though this could change in the future. The latest volatility in crypto prices—intensified by China's system-wide crackdown—offers a reminder that investors should not treat risk management as an afterthought when it comes to building exposure to this nascent market.

Table 1

Key elements of our four risk layers

Key risk layers

Legal and regulatory	Technology and operational	Market	Reputational
Legality	Cyber security	Valuation	ESG
KYC/AML/CTF	Custody	Volatility	Big losses
Oversight	Irreversibility	Illiquidity	Criminal activities
Jurisdiction	Blockchain/ programming	Ownership concentration	Inequality
Taxation		New entrance (incl. CBDCs)	

Source: UBS, as of 1 September 2021

China's and other countries' attempts to regulate the mining and use of crypto coins also illustrate that many of the risks the crypto industry currently face are binary in nature—i.e., they affect the entire industry, not just individual coins, tokens, and networks. This limits investors' ability to diversify exposure within the crypto space, calling for careful assessment when considering an investment (see Part VI for investment guidance).

We believe the unique nature and rapid rise of cryptos expose investors to far more technological and regulatory risks than traditional assets. They also entail greater market risks, as there is limited understanding and no consensus on how to value cryptos fundamentally given the lack of cash flows and real-world use cases. We find it useful to distinguish between four layers of risks (Table 1).

Sustainability considerations are another important dimension that may affect adoption. While digital assets don't form part of our asset allocation models or investment frameworks, we have assessed them in the same way that we would for any other asset class and have evaluated their sustainability characteristics.

Overall, we consider the environmental case against Bitcoin well-supported given its proof-of-work protocol: as the number of miners grows, so does Bitcoin's environmental footprint. However, this is a design choice, and the Bitcoin community could vote for a future enhancement to include a conversion to an alternative approach. This option has been pursued by the Ethereum community, which has chosen to adopt the less environmentally damaging proof-of-stake configuration, which several other smaller protocols are already using.

We see a variety of possible ESG (environmental, social, corporate governance) benefits from DeFi that are showing early promise. But the current generation of cryptos might not be the most effective or efficient in implementing such applications. At present, the main usage of crypto coins is financial speculation, in our view, which we believe does not justify the increasingly negative environmental impact of the asset class overall, notwithstanding the positive impact some applications may have on societies.

Legal and regulatory risks

A regulatory consensus or global framework has yet to emerge, though there is a general agreement among regulators that tighter scrutiny and oversight is needed. Concerns over the role of crypto coins in illicit activities (like crypto ransomware) and sanctions avoidance have driven the development of a patchwork of rules for the digital asset industry across the world in recent years. Meanwhile, the crypto indus-

try itself has begun to address its practices by implementing KYC/AML checks.

The prospect of greater financial institution participation in the crypto and digital asset domain has heightened regulatory concerns as well. If the interconnectedness between the crypto industry and financial institutions grows, so does the exposure of the real economy to crypto asset markets and their volatility. Potential regulatory actions could include enhancing existing restrictions and requirements for decentralized exchanges and token distribution, improving investor protection, and limiting risky practices such as allowing excessive leverage. More rules are likely to follow to regulate the capital requirements for financial institutions that hold exposure to crypto coins and tokens.

China has shown how authorities can crack down on the digital asset industry by targeting pressure points around payment, trading, mining, and banking. The US has taken a less invasive approach, balancing a desire for private sector experimentation and innovation while eyeing consumer protection. The EU, too, is establishing regulation under its Markets in Crypto-Assets Regulation (MiCAR). Investors are therefore well advised to track and understand the various regulatory changes and the implications for crypto asset prices.

Different jurisdictions have varying stances on the legality or official classification of cryptos, and they can change over time. For example, in 2021, Turkey's central bank banned the use of cryptos for purchases and closed exchanges, and India restricted the banking access of crypto exchanges after some faced money laundering charges. More countries may also restrict the right to own, buy, and sell crypto assets or at least tighten the rules for the respective exchanges.

Equally important for regulators is the focus on investor protection in case these digital assets become more mainstream. If authorities deem cryptos as securities instead of property, the resulting rules could transform the crypto ecosystem by shrinking the liquidity in these markets, at least initially, due to tighter capital rules. How investors hold their crypto assets matters, too—a simple crypto wallet enjoys less legal protection than a simple bank account or traditional assets held with a bank or broker. While insurance for digital asset custodians exists, not all custody providers are insured. Stablecoins, for instance, may give the impression of being equal to bank deposits, but they use higher-risk assets in their backing reserves and do not have the government-backed insurance that most countries' bank deposits enjoy.

The taxation of cryptos also varies greatly across jurisdictions. Getting proper advice on tax implications is essential to prevent a potentially unpleasant surprise at a later date.

Contract enforcement and legal liability are worth highlighting too. This applies especially to smart contracts. Encoding arrangements, which allow for fully automated processing, expose investors to the possibility of erroneous or malicious handling of smart contracts. Legal protection or precedent appears thin, but this could improve with wider adoption. And as the formulation of smart contracts becomes more transparent, best practices should improve and circulate, and the pace of innovation could outstrip that seen in traditional finance.

While regulatory changes can trigger adverse market reactions, we think they will ultimately be positive for the industry. Drawing in different stakeholders under a single legal umbrella and working toward a global consensus on key topics like contract enforcement, KYC/ALM standards, capital requirements, etc. could reduce or remove binary risks and help reduce the uncertainty in crypto coins and tokens.

Technological and operational risks

Engaging in crypto coins and tokens also exposes investors to technological risks, which range from the blockchain technology itself to simple endpoint vulnerabilities when making use of a blockchain.

First, as with all software, blockchain solutions are vulnerable to programing bugs and design flaws. Any vulnerabilities or mistakes of the underlying code could invite hackers to exploit the network. With billions of dollars' worth of crypto routinely staked on new experimental DeFi coins, unanticipated participant behavior in the face of programing flaws can lead to a total loss of value, as demonstrated by the run on the Titan coin this year[1].

Bitcoin has proven resilient so far, but for more complex blockchains, most notably those involving smart contracts, bugs can lead to unintended consequences or unruly market behavior. Many of the issues in a smart contract or platform cannot be fully understood until execution. For instance, the planned shift to Ethereum 2.0—a series of improvements that include moving to the environmentally friendly proof-of-stake consensus protocol—could introduce unanticipated security risks.

1 Titan is a DeFi token that is classified as an algorithmic stablecoin. On 17 June 2021, the value of Titan dropped from more than USD 50 to several thousandths of a cent within a day as investors pulled out of the token and the algorithm started to print more coins.

More intrinsically, the relevance of the underlying blockchain technology supporting a crypto coin or token inevitably shapes its value. Faulty or obsolete blockchain technology can harm an asset's value if more competitive solutions arise (e.g., one with faster transaction speeds, a better ESG footprint, enhanced efficiency, or lower costs). While this argument also applies to companies that don't adapt to technological changes, the impact on crypto assets and their values will likely be more direct and quicker. As a result, investors may face a complete loss of investment.

Cyberattacks and fraud are also an issue, as is the case for all assets. But what elevates cyber risk for crypto assets is the blockchain characteristics. Once a trade is executed on a public blockchain, reversing the trade is nearly impossible (irreversibility). In most cases, there is no help desk to call or superuser or central authority that can overwrite a transaction, thus exposing it to human error.

This makes operational risks a concern. Depending on how investors hold their coins or tokens, losing or destruction of a private key may cause the owners to lose access to their assets—forever. This contrasts with a bank or brokerage account, where one needs to just reset their password. Holding cryptos via a reputable exchange can reduce these risks. But leaving the safety of crypto assets to IT security alone does not offer sufficient protection, in our view.

In this context, wallet technology has come a long way; it's much more secure and sophisticated than in the past. But the private keys for these tools are still a frequent targets of hackers. Phishing techniques can target everything. Trading platforms and crypto wallet providers are also vulnerable to hacking, as history has shown. Crypto exchanges, asset managers, and custodians are therefore beefing up their security by, for instance, improving password recovery and access protection. But in the absence of proper regulatory oversight and common standards, investors need to be aware of a crypto service provider's security management (e.g., hot and cold storage) and whether it's robust enough. For custodial and non-custodial service providers, an insurance plan (against cybercrime, professional error, loss or theft of private keys, etc.) that provides additional investor protection is essential and should be considered.

While hypothetical, a "51% attack" is possible, although highly unlikely and should be understood. A 51% attack can happen if a group of miners or authorizers collectively control more than 50% of the network's mining hash rate (51% for the Bitcoin network), allowing them to make non-validated transactions in the blockchain. This could include modifying the transaction history or double spending to their own benefit. This risk for Bitcoin or Ethereum seems very remote given their expansive market sizes and the investment necessary to achieve the computation needed. However, it's much more of a concern for less-established blockchain networks.

Engaging in crypto is easier today than ever. The emergence of more professional crypto service providers has reduced endpoint risks for investors. But that has not changed the underlying risks in the blockchain technology itself, given the decentralized nature and lack of control. Hence, when engaging in crypto, people need to be more cognizant of the technology risks than when investing in traditional asset classes.

Market risks

Valuing crypto remains a highly controversial topic (see Part VII of this report). There are unresolved debates surrounding the real business utility, the value of cryptos, and even what type of traditional asset they best compare with. In our view, investors are advised to think first of cryptos—and more broadly distributed ledger technologies—as a new technology and focus on the ability of this technology to ultimately produce revenues, instead of trying to compare them with currencies, commodities, or other existing assets.

It's also essential to note that crypto coins have different designs and serve different purposes. Some have a clear claim on utility within a crypto network—such as the adoption of Ethereum as a top-layer coin—while others have less clear use cases.

Many crypto coins—excluding most stablecoins—have experienced enormous price volatility to a much greater extent than equities and other traditional assets. Annualized volatility ranges from 50–100% for coins like Bitcoin and Ether and can easily exceed 100% for lesser-known cryptos. A loss of investor confidence in a particular coin or token can quickly lead to an abrupt decline in its value and liquidity.

Owners should therefore be aware of concentration risks. For many cryptos, a relatively small number of holders account for a sizable market share. An unwinding of such positions could quickly magnify price swings. While this is nothing new for equity-oriented investors, it does represent an additional risk given the lack of transparency and unregulated nature of the crypto market. The concentration of ownership and network participation (e.g., miners and developers) also raises issues around governance standards and the changes thereof that apply to crypto ecosystems. Further, this can intensify limited liquidity conditions. It remains to be seen whether concentration risks will improve as usage grows and what regulation can do to improve liquidity (i.e., the ability to easily and transparently exchange rights).

Compared to traditional financial markets, which have strong intermediaries and defined market makers that are bound to clear rules, crypto transactions are more susceptible to market manipulation. Larger market players or strong influencers can make use of poor liquidity to artificially inflate prices, particularly of smaller coins, through pump-and-dump schemes, wash trades, runs, etc. With no standards or regulation on stake disclosure or financial interests, the network effect driven by statements from celebrities on social media can easily exacerbate volatility.

We believe these risks undermine the integrity of the price discovery path of crypto assets and add additional risks that require greater vigilance. Investors willing to expose their capital to such market risks must be prepared to lose large parts of their investment—and in the worst case, everything.

Reputational risks

Investors should also be mindful of reputational risks. Here, the focus ranges from engaging in a network that has lax standards and being victim to cybercrime, inadvertently participating in money laundering or other illicit activities, or being linked to environmental considerations (see sustainability section).

Evaluating digital assets from a sustainability angle

We think the current sustainability profile of cryptos that have selected security models based on electricity consumption might be a major hurdle for their adoption. Bitcoin in particular has been criticized for the growing energy usage involved in mining, which is currently equivalent to that of countries such as Sweden, Greece, and Malaysia. We seek to evaluate whether this is as bad as it looks, whether it can be improved, and whether other cryptos with a greener profile look more suitable from a sustainable investing point of view. We will also look at other dimensions of sustainability, such as cryptos' potential to facilitate the activities of cybercriminals, terrorist financing, and tax evasion. These considerations need to be weighed against the potential social utility of cryptos; for example, the positive impact from numerous DeFi applications on societies and their ability to further the UN Social Development Goals (SDGs).

Can cryptos go green?

Much has been made of the environmental damage caused by Bitcoin and the potential for this to increase. As the price of Bitcoin rises and more miners enter the mining pool, the computing power required to mine new coins increases because it becomes more difficult to do so by design. At present, Bitcoin is responsible for carbon dioxide emissions of around 60 million tons a year, roughly the same as Greece, based on a calculation by Bank of America. As a result, Bitcoin mining energy consumption has gone up 200% over the past two years alongside the price rally. Ethereum, the second biggest crypto by market capitalization, has a carbon footprint equivalent to that of Mongolia. Some estimates suggest that every USD 1bn inflow into Bitcoin causes an increase in carbon emissions that is equivalent to adding around 1.2 million internal combustion engine cars to the road.

On the other hand, Bitcoin's proponents argue that while creating an additional unit is very energy intensive, transacting it from one wallet to another consumes much less energy. More efficient mining hardware and so-called "layer 2" protocols—e.g., the Lightning Network, which aims to increase the scalability of the underlying blockchain technology—should help reduce the energy usage per transaction in the future.

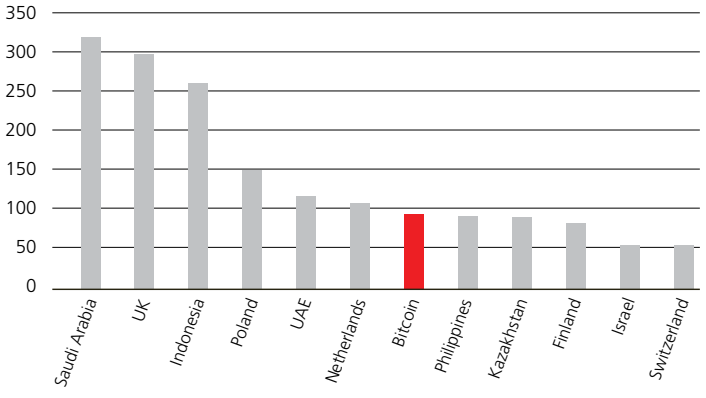
The controversies around such statistics raise several questions, above all what is fact and what is fiction. We think investors can make an informed view by thinking about three questions: First, how accurate are these numbers? Second, are the economic or social benefits worth the environmental harm? Third, can energy-intensive crypto coins become less harmful for the environment over time?

Whether you feel cryptos have a valid claim on society's resources boils down to how much value you think they (may)

Figure 12

Bitcoin's ecological footprint is greater than that of many countries

Annual energy consumption of the Bitcoin ecosystems and select countries, in TWh



Source: CBECI, BP Statistical Review, UBS, as of September 2021

create for society. In our view, the leading cryptos are creating a growing negative environmental impact that is not justified by their economic or social utility. This, however, may change in time.

Is Bitcoin really so environmentally harmful?

Supporters have made several arguments that the ecological damage is less than reported. We are not convinced and believe that Bitcoin is a large and growing source of carbon emissions. But it makes sense to explore the arguments individually.

Bitcoin advocates have argued that the activity is far less emissions-intensive than has been claimed. They believe Bitcoin mining is predominantly based on green or stranded energy, so much is already carbon neutral. Many point to a report from December 2019[2] that estimated 73% of Bitcoin's energy consumption was carbon neutral, largely due to the abundance of hydro power in major mining hubs such as southwest China and Scandinavia.

However, we see compelling evidence that a substantial part of Bitcoin's energy consumption has come from non-renewable sources. Cheap electricity costs make China an appealing location for miners, and a very substantial part of mining takes place in the heavily coal-reliant provinces. While some of China's hydropower is used in the summer months, at present it does seem like Bitcoin has become joined at the hip to coal. On the other hand, countries, including Scandinavia, with a high share of renewables in their energy mix, only play a minor role in crypto mining (Figure 13).

China's share of Bitcoin mining dropped from over 75% to 46% between September 2019 and April 2021, according to data from the Cambridge Centre for Alternative Finance. That follows a regulatory crackdown by the Chinese authorities, who have reportedly been concerned by the high emissions from the activity and from the waste of electricity from cleaner sources such as hydro. While that shift might have the potential to make Bitcoin greener, it is revealing that the main beneficiary to date has been Kazakhstan, which sources around 90% of its energy from fossil fuels. The nation has increased its share of mining sixfold to become the third largest mining location (Figure 13). It seems that miners will seek the cheapest electricity available, regardless of environmental cost, which currently means fossil fuels. This also serves as a reminder that any breakdown of the geographical distribution or energy consumption of miners can become swiftly outdated.

Will crypto mining provide an incentive for renewable energy growth?

Nic Carter, a general partner at Castle Island Ventures, a firm investing in public blockchain startups, recently argued that "as renewable options such as solar grow more efficient and thus more viable for mining, Bitcoin could end up serving as a serious incentive for electricity producers to build out these technologies." We are not convinced. Bitcoin miners invest heavily in machinery to remain competitive in their bid to mine new blocks and to keep their operating expenses, mainly electricity, at the lowest possible level. The equipment swiftly becomes obsolete, which gives miners an incentive to run their machines 24 hours a day, seven days a week, all year round. As a result, they are best served by the cheapest possible form of baseload power—currently coal in most places. The intermittency of solar and wind energy—which might only be available for half the day or less—will generally be unappealing for such operations. Or, as Peter Wall[3] from mining company Argo puts it "If you're a miner, the thing that keeps you up at night, the thing that gives you nightmares, is having machines sitting in storage not mining."

A less discussed environmental drag: hardware waste

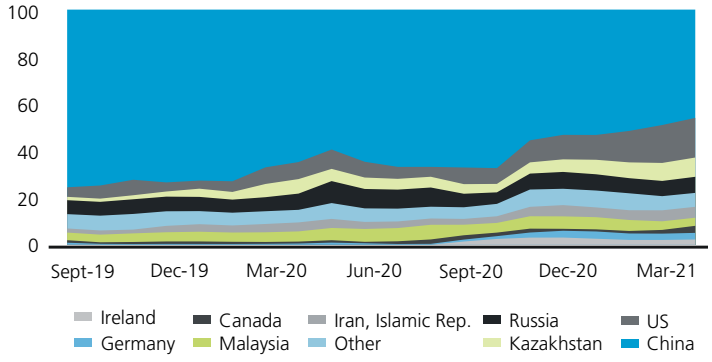
The mining of Bitcoin and many other cryptos is carried out on dedicated equipment that can only be used for this purpose. This mining equipment becomes obsolete roughly every 1.5

2 The Bitcoin Mining Network, Christopher Bendiksen and Samuel Gibbons, CoinShares Research, December 2019

Figure 13

China's share of Bitcoin mining is declining

Global breakdown of Bitcoin mining activity, by country, in %



Source: BECI, UBS, as of 1 September 2021

3 Source: https://www.newscientist.com/article/2284222-coal-powered-bitcoin-mining-soars-in-kazakhstan-following-chinese-ban/

years, since older hardware is pushed out of the market. As a result, Bitcoin appears to be responsible for a level of e-waste that is approaching that of a small country—with 8.2 annualized kilotons of waste, versus 12kt for Luxembourg and 17kt for Jamaica. Meanwhile, a single Bitcoin transaction leads to around 89 grams of waste, versus 45 grams for 10,000 Visa transactions, according to DIGICONOMIST[4]. As a result, solving Bitcoin's energy problem alone won't address its broader impact on sustainability. It is also worth noting that producing the technology for this equipment requires energy, which may further increase the carbon footprint of producing a Bitcoin, as well as other environmentally scarce resources like water.

Protocols can be designed to use more energy efficient systems

Ethereum founder, Vitalik Buterin, has recently added to such enthusiasm by reiterating that he sees Ethereum moving to a proof-of-stake model and away from a proof-of-work, potentially cutting energy use by 99.95%. The Ethereum Foundation has said this switch could be completed by the end of 2021, but it also highlighted the risk of delay. Other protocols such as Cardano, the fourth largest crypto by capitalization at USD 50 billion, Polygon, Tezos, Polkadot, and EOS already use either proof-of-stake or delegated proof-of-stake systems. We think this development is encouraging from an environmental point of view—although delegated proof-of-stake raises alternative questions around security—because it tilts the ratio between environmental costs and economic/social benefits strongly in favor of proof-of-stake crypto ecosystems. This would be a welcome development, although we see little indication that such a move could be made for Bitcoin. So, for the time being, the crypto industry overall does not seem to be on track to curb its adverse impact on emissions.

CBDCs vs. crypto coins from an ESG angle

One way in which CBDCs differ from proof-of-work based crypto coins is the ESG part. CBDCs are not expected to have these power-intensive challenges. While the design of CBDCs will vary from country to country, central banks generally view running a proper currency that uses distributed ledger technology as impractical. While CBDCs may not qualify as sustainable (in the sense that they do not improve the environment over the medium term), they are unlikely to be environmentally destructive.

On the other hand, CBDCs present more challenges in the social and governance spheres. Any form of digital currency, public or private, raises the threat of a digital divide. Digital currencies can only be used by people with regular, reliable access to the internet. This also applies to crypto ecosystems. The digital divide concern has been heard in the Nordic region and in the UK in recent years. Certain groups in society (such as the elderly or lower-income groups) are less likely to have such access and are therefore at a disadvantage in using any form of digital money.

A common concern with CBDCs (versus fiat cash) in more open societies is the degree of control the central bank or government could have over private sector spending. There is no guarantee that CBDC holders will be able to spend as they wish. Even today, owners of private sector electronic money may find themselves unable to spend their money; for instance, if their bank puts a block on their account (often "for security"). But without independent safeguards, there is nothing to stop a government from preventing citizens from purchasing certain goods or spending money with a certain company. This could become politicized: an individual opposed to the government could be prevented from buying a plane ticket, or a company that criticized a government policy could see its sales fall to zero overnight.

Social and governance drawbacks to crypto coins

Certain characteristics of cryptos that make them attractive to proponents present broader social and governance challenges for policymakers. This starts with the anonymity of transactions, which goes against the flow of decades of regulation aimed at combating everything from possible tax evasion to money laundering and terrorist financing. It is notable that cryptos have become a popular method of payment for cyber criminals in recent years.

The most recent "Cryptocurrency Crime and Anti-Money Laundering Report" by CipherTrace indicated that in 2020, major crypto thefts, hacks, and fraud incidents amounted to USD 1.9bn. This pattern was echoed by research from the University of Sydney in 2019 that roughly USD 76bn of illegal activity was linked to Bitcoin, equivalent to roughly the size of the illegal drug market in Europe and the US combined.

At the same time, regulatory efforts to reduce AML activities and to tighten KYC and Know Your Transaction (KYT) standards are on the rise. The growing relevance of virtual asset service providers (VASPs) as the gatekeepers between the digital and the real world is one area where authorities are trying to add regulatory levers. The industry largely seems to welcome improved KYC regimes and the emergence of international standards and collaboration. Ultimately, this should help build a stronger foundation in which digital assets are similarly compliant with their non-digital peers. And this would help improve their ESG footprint.

4 Source: https://digiconomist.net/bitcoin-electronic-waste-monitor/

The challenges around crypto governance go beyond KYC and AML activities. Companies have clearly defined stakeholder structures with governance systems that protect stakeholder interests. There are various examples in the short history of crypto where the lack of similar mechanisms resulted in debate, criticism, and financial losses.

Bitcoin and Ethereum have tools in place to manage and implement change through improvement proposals. But critics of these systems say that this governance is centralized among miners and developers, and they give no voice to ordinary users and investors. In addition, the voting power is typically asymmetrical: stakeholders with greater mining power or holdings will have a greater say than those with lesser holdings. The voting systems should therefore best be described as plutocratic, in our view, instead of the frequent assertion that the governance of crypto ecosystems is democratic.

What about the benefits to society and economic efficiency gains?

Although the ecological footprint of many crypto coins and their governance standards remain a concern, it is worth exploring whether the potential social and economic benefits could justify the environmental costs incurred, and whether crypto coins or digital assets more generally can replace current techniques with approaches that are less costly from an environmental perspective.

First, not all coins are equal. Decentralized finance applications, for example, are built on blockchain and offer the potential to address some of the challenges within the existing financial system. The ability to program logic into transactions expands the possibilities for DeFi beyond what cryptos like Bitcoin can do, enabling these DeFi applications to facilitate more complex transactions like borrowing or lending, conditional payments, and transfers. Doing so with increased transparency, greater speed, and lower frictional costs has the potential to contribute to positive outcomes from a sustainable development and investment perspective.

For example, DeFi applications can help build a more frictionless financial system that may not only have a better ecological footprint than the current one but can also benefit society. DeFi applications might also help to broaden access to the financial system, by lowering the wealth thresholds and costs.

Tokenization of assets could allow retail investors to invest small amounts in lumpy physical assets like real estate or gold, reducing counterparty risks, minimum investments, and fees. Lower payment fees would be supportive of small- and medium-sized enterprise profitability, which is likely to be particularly interesting for developing countries. Moreover, it can help reduce the costs on remittances, benefitting disadvantaged communities. This should support several of the UN's SDGs. Tellingly, the IFC, the financial arm of the World Bank, runs several projects that aim to develop and promote the use of decentralized finance and digital asset frameworks.

Despite the potential for DeFi applications and other DLT use cases to have a positive impact on societies, it needs to be noted that such applications will not be accessible for the 40% of the world's population who do not, as of 2021, have access to the internet[5]. And while internet access ratios are typically above 90% in developed countries, developing nations have lower access ratios. Internet access ranges from 25–40% in East and West Africa and slightly above 40% in South Asia, according to data collected by Kepios. And there are often important differences within countries. For example, there is a substantial gender gap in developing countries: women are 20% less likely than men to have access to mobile internet and 8% less likely to own a mobile phone[6]. Similarly, we think access ratios are likely to be much higher for the wealthiest than the poorest sections of society. All of this puts poorer countries and the poorest parts of society, where accessibility is most needed, at a relative disadvantage to benefit from these innovations. Internet access is rising rapidly, however. At the current rate of expansion, it would take another 10 years to connect the estimated 3 billion people that don't have internet access today, although we will probably never reach a 100% adoption rate. Similar trends can be seen when it comes to the gender gap: although women are 20% less likely than men to use mobile internet in 2021, this represents a reduction from 27% in 2017.

Distributed ledger technologies can also contribute to improved social sustainability in other areas. The traceability of supply chains or the introduction of digital identities are two examples of applications that may lead to positive social impact in many countries. In remains to be seen, however, whether cryptos will play an essential role in such applications.

5 https://datareportal.com/reports/6-in-10-people-around-the-world-now-use-the-internet

6 GSMA, The Mobile Gender Gap Report 2020

GIVETH

One example of a DeFi application that could contribute positively from a societal perspective is GIVETH[7], a community-based Dapp that relies on the Ethereum ecosystem to facilitate social impact through decentralized aid projects. GIVETH allows donors to connect and contribute to projects on an open-source platform. GIVETH's donation application is part of the Commons Stack project that aims to decentralize governance and distribution of donation resources by creating communities around causes that anyone can support. GIVETH is supported by the European Commission and coordinated by the Joint Research Center[8] Donations can be made in either cryptos or fiat currencies free of extra fees.

SARDEX

Decentralized applications can also be applied to B2B cases, which can be seen in the Horizon-2020-backed project SARDEX, a mutual credit system created in Sardinia that relies on the Ethereum blockchain as its ledger[9].

The platform offers a tokenized mutual credit system to enable B2B trade of goods and services between local SMEs, which often have limited access to capital through the traditional banking sector. Surplus credit is made available to cover costs of smaller entities on the platform to strengthen the territory and create an atmosphere of trust while participants get to know each other. SARDEX is an example of how DeFi applications have the potential to create impact and direct trade for local businesses.

7 https://giveth.io/about

8 European Commission (2020). Scanning the European ecosystem of distributed ledger technologies for social and public good. doi:10.2760/802653

9 https://cordis.europa.eu/project/id/754494

Part VI
Investment considerations

Investing in digital assets and the underlying technologies shouldn't be treated any differently to conventional investing. Investors should have a robust and disciplined approach with thought-through premises and clear entry and exit strategies. In this chapter, we outline what investors should focus on when evaluating digital assets, how we would approach the opportunity set from a risk-reward angle, and how these digital assets behave in a broader portfolio context. Lastly, we provide a detailed comparison of Bitcoin and gold to understand their similarities and differences.

Investing in the potential of a nascent technology

Investors should view the broader DLT segment for its ability to disrupt industries and eke out efficiencies, rather than as a currency or commodity. Indeed, as discussed in Part IV, we see many potential use cases and believe the technology will one day earn a place on the mantle of disruptive innovations.

But it is important to note that while the promise is clear, whether decentralized and distributed systems are truly superior to the vastly centralized networks of today is not. In our view, each system offers unique advantages and disadvantages when considering their stability, scalability, flexibility, or customer friendliness.

All roads lead to Rome, but some are much longer than others

From an investment point of view, we find it useful to look at the three ways to gain exposure to DLT-related businesses:

Enablers and platform operators of DLT-based applications
Enablers of DLT-based applications primarily include semiconductor producers as well as hardware and software companies. In an increasingly decentralized world, more people are going to use DLT-based applications. All else equal, this requires more hardware to validate these activities on the network. This includes application-specific integrated circuits (ASIC), applications processors, and graphics processing units (GPUs). Other enablers include software makers and data-center-related companies that help build the overall infrastructure.

The bigger opportunity, in our view, sits with the platform companies that can embrace DLT-based applications. As the technology is increasingly used over the next 5–10 years, we see opportunities from the introduction of new product services and categories, possible savings from the use of technology, potentially lower prices, and an overall improvement in business efficiency. These companies span different industries like internet, fintech, software, IT services, consumer services, and insurance, and can wield digital asset technology to offer a breadth of services like payments, trade finance, custodianship, supply chain management, automation, and consulting.



Private market opportunities

With the blockchain/DLT ecosystem evolving, VC firms' earlier focus on miners and digital coin exchanges has broadened to include investments across the crypto value chain and beyond. These include crypto wallet software and hardware providers, blockchain compliance businesses, clearing and settlement startups, and blockchain infrastructure suppliers. Decentralized finance projects and applications are also gaining a strong following, especially in areas such as digital asset lending, digital asset derivatives, and yield generation solutions.

Capital raises are breaking new records. Earlier in the year, stablecoin payment firm Circle closed a USD 440mn funding round. Digital asset lending provider Blockfi and Ethereum blockchain challenger Solana Labs each successfully secured over USD 300mn of fresh capital in equity and private token sales, respectively.

Ecosystem participants: Fintech, DeFi, and other early adopters
Although crypto coins have been around for a few years, we think it is still fairly challenging to identify pure DLT-based companies. However, we see many opportunities through fintech and DeFi companies given their first-mover advantage with DLT-based applications and their ability to integrate DLT technology in key offerings.

To us, investing in DLT-based businesses now is akin to investing in tech platforms a decade ago when they were just starting to launch subsection services or in digital subscriptions before they reshaped the business models of the entire tech sector. And with COVID-19 accelerating the broader digitalization of the world, fintech companies could spur a similar wave of disruption.

The industry has also demonstrated its agility and ability to partner with traditional financial companies and new market entrants to reshape customer experiences, setting the bar higher for the entire sector. This should allow fintech companies to overcome consumers' stickiness to incumbent financial service providers.

With fintech penetration set to reach low- to mid-teen percentages from low- to mid-single digits today, we expect fintech revenues to grow by double-digit percentages in the coming years. In absolute terms, we forecast revenues to expand from USD 225bn in 2020 to USD 750bn in 2030 (Figure 14). This provides investors with an attractive long-term investment opportunity set when engaging in fintech investments, in our view. We prefer leading payment players, platform companies, and disruptors in emerging technologies.

Also, DLT-based applications might see increased usage in other areas, as we discussed in Part IV of this report, such as in social media or in retail. For firms that are using the technology, DLT-based applications currently only affect a small part of their profits and revenues. But we believe these companies still deserve a place in a diversified selection of stocks, as their businesses at some point might benefit substantially as early movers. The management of food supply chains is a good example in this regard. In recent years, customers have become increasingly wary about the origins and transport of food supplies, but the tracking of the highly complex supply chain is generally impossible for a single entity. The use of DLT-based applications can provide a highly efficient and effective way to address this challenge, in addition to possibly allowing retailers to improve their supply chain management.

Coins and tokens to position for community growth and adoption

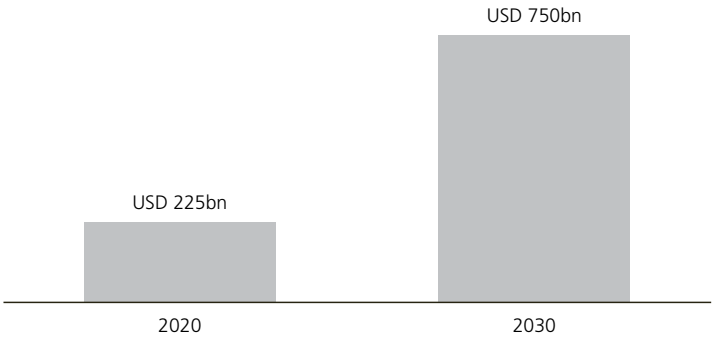
Investors could also buy individual coins and tokens to gain direct exposure to the adoption of the DLT-based ecosystems. This is arguably the most direct way to gain exposure to the growth of the entire ecosystem and its user base. These assets could see substantial upside if the applications eventually achieve broader adoption for primary use cases that serve an essential economic need and hence allows for sustainable creation of revenues and profits—in fiat currencies.

Risk-reward considerations of the three investment approaches

What the three approaches have in common is that they provide investors exposure to DLT-based applications. But their risk-reward propositions are very different, in our view: enablers and platform operators currently have the highest expected risk-adjusted returns, while coins and tokens have the lowest (Figure 15).

Figure 14

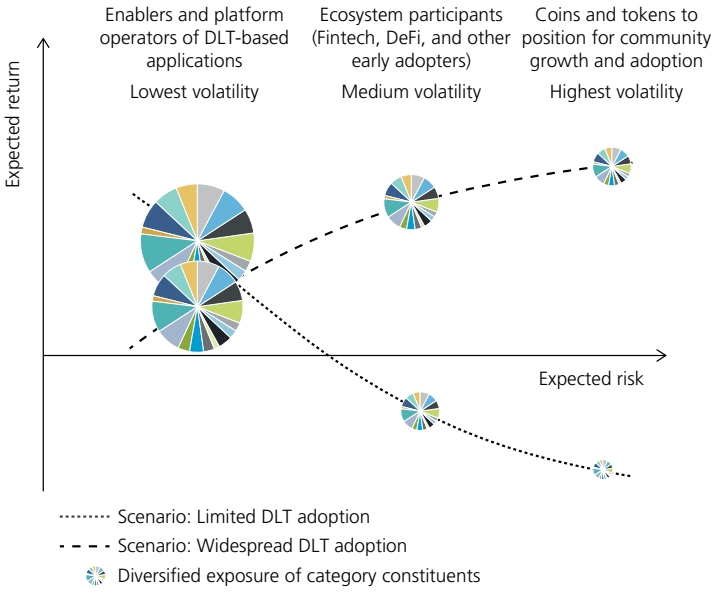
More than 3.5x growth expected for global fintech revenues during 2020–2030



Source: UBS estimates, as of September 2021

Figure 15

Choose wisely: Risk-reward varies greatly by exposure level to DLTs and crypto ecosystems



Source: UBS, as of September 2021

Our view is based on a qualitative assessment of various risk factors (Part V). We highlight the following aspects:

- *Concentrated business models:* From the three investment options discussed above, DLT-based ecosystems exhibit the highest concentration risks, while platform companies and enablers appear most diversified at this stage. In addition, most of the external risks outlined in Part V of this report affect DLT-based ecosystems in a very similar manner. Regulatory changes or adjustments to the legal environment, for example, often represent binary risks or opportunities to the entire crypto market, which explains the high correlations among crypto coins and tokens. In comparison, enablers, platform companies, and ecosystem participants tend to be much less correlated to one another (Figure 16).

- *Low entry barriers:* Many distributed ledger systems are public, allowing new entrants to replicate the technology relatively easily. There is also the threat of new, public blockchain solutions competing with existing networks. Incumbent industry leaders will also increasingly use the technology in their favor, in our view. For example, payment and stablecoins will likely face competition from incumbent tech and financial companies. Quite a few of these firms are already promoting their own digital tokens to promote digital payment services through permissioned or private blockchains. They will likely also integrate third-party tokens or coins, like CBDCs or stablecoins, while trying to offer a superior client experience through better applications, aggregation layers, or costumer services. And to promote their own digital settlement units, leading tech firms and large financial institutions could leverage their vast client networks, technological expertise, and ability to attract talent and investors.

- *Marginal costs of production:* The successful adoption of an ecosystem may not necessarily result in sharp price appreciation of its native coin or token. If the Ethereum network is more widely used in real-world applications, the demand for Ether (ETH), the native coin of the blockchain, should increase as well. However, this may not necessarily translate into a higher ETH price. First, additional ETH supply might exceed demand growth, possibly resulting in greater revenues for various ecosystem participants but a lower ETH price. Also, the services offered via the Ethereum blockchain—mainly DeFi applications—might be more commercially viable if the ETH price declines over time. Second, a higher ETH price might attract more competitors, which can weigh on margins and market share. Again, this might result in a declining price.

- *Consumer inertia:* Most digital services today rely on centralized or decentralized networks, including all major search functions, social media platforms, and online banking applications. The success of these applications suggests that most consumers appreciate their advantages more than their disadvantages. This doesn't imply that DLT-based applications cannot contribute to increased efficiency, but it may suggest that consumers prefer to engage with a centralized entity like a platform company or with a company participating in a DLT ecosystem.

- *Lack of reliable valuation frameworks:* The valuation of assets is always challenging. But compared to traditional financial assets, valuing individual coins and tokens is even more tricky due to various limitations (see Part VII).

Portfolio considerations

Notwithstanding our positive view on DLT-based applications, we think they should play only a minor role in the context of a well-diversified portfolio. The number of attractive companies is limited, in our view, and as discussed above, there are various risks weighing on expected risk-adjusted returns. So, for interested investors with the right risk appetite, such an exposure—for example, via select public and private market companies—should not exceed 2% of an investor's financial assets, in our view. Our separately published Equity Preference List includes a list of companies we think would benefit from the possible rise of DLTs.

Regarding the positioning of cryptos in a portfolio context, we currently see them first and foremost as a speculative investment and believe investors should not build strategic exposure to them. We derived this view from our fundamental assessment discussed in this report and from various statistical metrics that we find useful for portfolio construction.

Specifically, we looked at crypto proponents' frequently made argument that coins or tokens deserve a 2–5% portfolio allocation. They base this view on their perception of crypto coins' declining volatility, diversification benefits, expanding market capitalization and liquidity, and inflation hedge potential.

High volatility weighs on expected risk-adjusted returns
While Bitcoin and several other cryptos have seen periods of skyrocketing performance, we would not extrapolate such high returns into the future. We have also found that after analyzing their historical profiles, the volatility of Bitcoin and other crypto coins has been trending sideways at a high level for many years (Figure 17).

Figure 16

Correlation of TSMC, Intel, Samsung, Coinbase, etc. to BTC, ETH, etc.

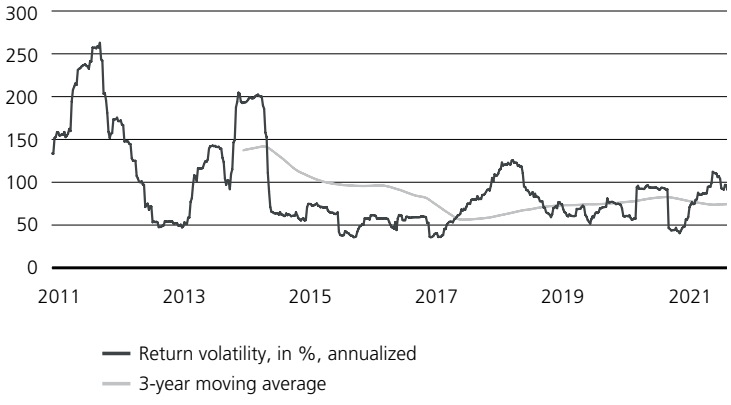
	BTC	ETH	XRP	LTC	BNB	ADA	DOGE	Top 10	GBTC	BLOK	Micro Strat-egy	Riot Block-chain	Mara-thon Digital	Hut 8 Mining	Square	PayPal	ICE	CME	Nvidia	Intel	TSMC	Sam-sung
BTC																						
ETH	0.78																					
XRP	0.47	0.56																				
LTC	0.79	0.81	0.56																			
BNB	0.58	0.59	0.48	0.61																		
ADA	0.64	0.71	0.59	0.70	0.58																	
DOGE	0.28	0.28	0.21	0.30	0.18	0.29																
Top 10	0.82	0.87	0.71	0.88	0.74	0.83	0.31															
GBTC	0.80	0.63	0.38	0.64	0.47	0.49	0.21	0.65														
BLOK	0.51	0.44	0.33	0.44	0.42	0.34	0.16	0.48	0.56													
MicroStrategy	0.45	0.37	0.24	0.36	0.31	0.26	0.18	0.38	0.47	0.67												
Riot Blockchain	0.55	0.44	0.31	0.47	0.38	0.35	0.14	0.48	0.65	0.66	0.50											
Marathon Digital	0.49	0.43	0.36	0.43	0.32	0.35	0.15	0.44	0.60	0.58	0.43	0.76										
Hut 8 Mining	0.53	0.41	0.30	0.41	0.33	0.35	0.16	0.44	0.60	0.52	0.40	0.56	0.55									
Square	0.24	0.24	0.22	0.23	0.21	0.24	0.14	0.26	0.28	0.62	0.32	0.37	0.33	0.25								
PayPal	0.26	0.23	0.23	0.23	0.21	0.23	0.12	0.27	0.29	0.61	0.32	0.36	0.35	0.26	0.71							
ICE	0.22	0.20	0.15	0.18	0.19	0.19	0.10	0.22	0.21	0.44	0.22	0.21	0.20	0.19	0.46	0.55						
CME	0.17	0.17	0.12	0.15	0.15	0.16	0.06	0.18	0.17	0.35	0.21	0.18	0.17	0.17	0.33	0.37	0.77					
Nvidia	0.19	0.20	0.16	0.18	0.19	0.20	0.07	0.22	0.24	0.56	0.26	0.29	0.28	0.16	0.63	0.67	0.49	0.31				
Intel	0.20	0.19	0.14	0.18	0.18	0.19	0.10	0.23	0.23	0.47	0.23	0.26	0.22	0.14	0.44	0.54	0.42	0.37	0.61			
TSMC	0.16	0.18	0.16	0.16	0.15	0.16	0.09	0.20	0.19	0.54	0.27	0.26	0.25	0.18	0.49	0.53	0.38	0.33	0.63	0.53		
Samsung	0.01	0.01	0.05	0.04	0.03	0.03	–0.04	0.05	0.03	0.24	0.06	0.08	0.08	0.13	0.18	0.15	0.20	0.19	0.18	0.14	0.33	

Note: Equally weighted basket of top ten coins by market cap
Source: Bloomberg, CoinGecko UBS, as of 1 September 2021

Figure 17

Not on a declining trend

Annualized volatility of weekly USDBTC log returns and 3-year moving average

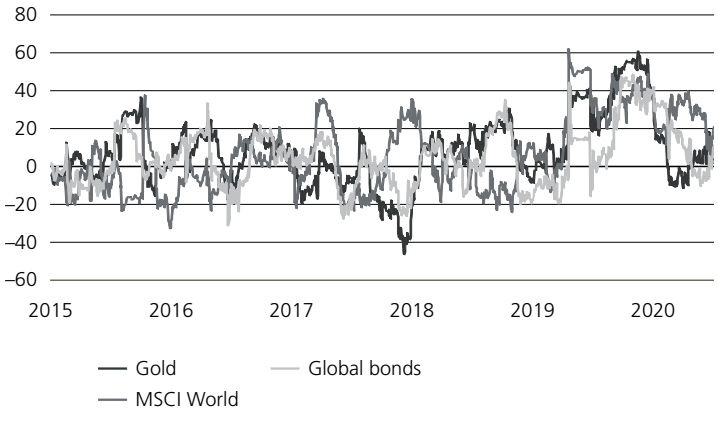


Source: Bloomberg, UBS, as of 1 September 2021

Figure 18

Often, but not always, on its own

Correlation between Bitcoin and select other assets, based on 3-month rolling log returns, in %



Source: UBS, Bloomberg, as of 1 September 2021

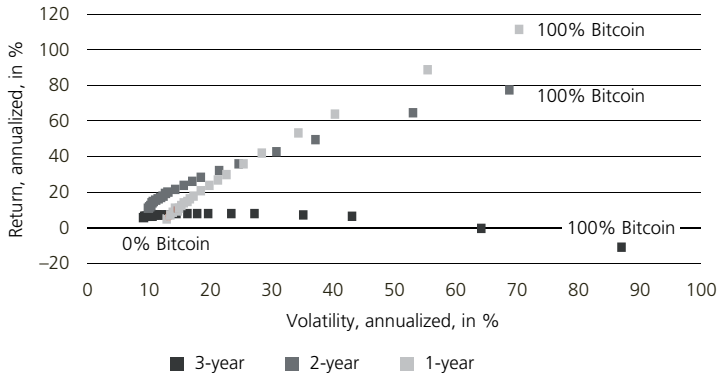
While volatility might decline in the future, we are not aware of a compelling argument why this should happen anytime soon. Some observers proclaim that if cryptos see wider adoption, volatility will start to decline. While we have some conceptual sympathy for this thought, it may not apply to all cryptos equally. In the case of Bitcoin, for example, its limited and highly inelastic supply makes the coin prone to elevated volatility levels and extreme volatility spikes. As long as demand fluctuates—either because of shifts in sentiment that affect speculative demand or from business cycle fluctuations that affect demand for potential digital payment services, programable money, or stores of wealth—its volatility is likely to remain highly elevated when compared to most legal tenders, traditional stores of wealth, and risk assets in general, in our view. This may also explain why Bitcoin, as well as other crypto coins, has yet to exhibit declining volatility despite rising interest from a broader audience.

High volatility limits diversification benefits

The low correlation of various cryptos to traditional asset classes has become an important argument for investors to add cryptos to their portfolios. Looking at the historical data, we find that Bitcoin has had an overall low correlation to a wide range of asset classes (Figure 18, previous page), including bonds, stocks, and gold. Correlations spiked in 2020 with the outbreak of the pandemic, providing a first test to see how cryptos behave during larger crises and whether their diversification benefits hold up. Despite some normalization since then, we note that the correlations didn't decline to the previous lows, potentially because of Bitcoin's wider use as a speculative investment, among other factors.

Figure 19

Crypto coins/tokens only useful for portfolio diversification if prices rise fast enough



Note: Annualized return and volatility of a portfolio with exposure to Bitcoin.
We use monthly log returns for three sample periods: January 2018 to December 2020 (3-year), January 2019 to December 2020 (2-year), and January 2019 to December 2020 (1-year).
The portfolios are rebalanced monthly.
Source: UBS, Bloomberg, as of 1 September 2021

Should this low correlation be maintained, it can indeed help to diversify a financial portfolio. However, in our view, a low correlation to the asset classes is not reason enough alone to add Bitcoin or other cryptos to a portfolio. As highlighted at the beginning of this section, investors also need to factor in volatility and expected risk-adjusted returns to determine whether they are sufficiently compensated for the risk taken.

The historical evidence on this is mixed: Had you held Bitcoin during a period of sharply rising prices, the overall risk-reward of the portfolio would indeed have increased strongly. But during periods of less extreme increases—and of course stagnating or declining prices—this hasn't been the case (Figure 19).

Ultimately, deciding whether to add Bitcoin or other cryptos to a portfolio comes down to potential price appreciation. And as discussed above, without the ability to form credible fair value estimates, we find it hard to derive a fundamentally sound and defensible number with a sufficiently high conviction at this point.

Market capitalization, structure, and liquidity

While the size of the crypto market has soared in recent years, its total market capitalization is still small when compared to established public and private markets globally. As of early September 2021, the total market capitalization of the nearly 6,000 coins listed under CoinMarketCap.com stood at USD 2.3tr. This compares to global equity markets worth USD 109tr for 50,000 listed companies, according to the World Federation of Exchanges, and global bond markets worth USD 119tr, according to numbers provided by the Securities Industry and Financial Markets Association. The pool of alternative assets, including public and private commercial real estate (USD 32.2tr, according to data provided by European Public Real Estate Association), hedge funds (USD 4tr, per Hedge Fund Research data), private equity (USD 4.7tr, per Pitchbook data), and private debt (USD 1tr, per Pitchbook), all offer much better diversification than Bitcoin, in our view.

In addition, a substantial part of global equity and bond markets is relatively liquid. Liquidity tends to be much lower in crypto coins. A developer could create 1 billion units of a new coin and sell one coin to a friend at the price of one dollar. Within seconds, the market capitalization of the crypto market would have increased by one billion dollars. But this argument also holds for the largest coins. A recent study by Bank of America showed that the Bitcoin price is highly inelastic—an inflow of USD 1bn can increase the price by as much as 15%.

On the other hand, anecdotal evidence suggests that many investors intend to build strategic exposure to their favorite crypto coins and tokens. As long as these investors don't

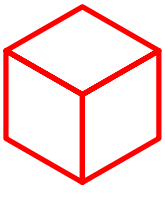
change their strategic stance toward these digital assets, the comparatively low liquidity might be not that problematic.

Although investors shouldn't construct a portfolio purely on the back of relative market capitalization, we think the relative size of these asset classes is one of the parameters investors should consider when they think about portfolio construction. This is particularly important for those asset classes that have a proven track record in delivering attractive risk-adjusted returns and contributing to portfolio diversification over the past decades and that are often missing in portfolios, like private markets, hedge funds, or other alternative assets.

The crypto universe is also highly concentrated and many of the individual coins and tokens are highly correlated (hovering round 0.65 for the 25 most traded crypto coins over the last one year, which makes it difficult to achieve good diversification within a crypto portfolio. Bitcoin accounts for roughly half of the crypto market's capitalization (42% according to data from coinmarketcap.com in early September). Together with Ether, the two biggest cryptos account for roughly two-thirds of the crypto universe's market capitalization.

This underscores the high exposure to binary risks that affect most coins and tokens, in our view, such as the regulatory and legal environment, technological risks, the overall challenges to replace centralized ecosystems, and the low entry barriers for market entrants. As a result, the outlook for economic success and ESG footprint is very uncertain at this point.

Moreover, Bitcoin and other cryptos have experienced several hyperinflation or near hyperinflation episodes. Fiat currency maintains spending power not by limiting liquidity supply, but by making sure liquidity supply and liquidity demand are in balance. This is why "printing" money never creates inflation if it simply matches liquidity demand. This means that, periodically, liquidity supply must be reduced in order to match falling liquidity demand. Central banks do this all the time—scaling back quantitative policy to reduce liquidity in the system. However, a crypto like Bitcoin has no mechanism to reduce its supply. So if demand for crypto liquidity is falling, there will be a sudden and significant loss of spending power.



Bitcoin ain't gold

Gold and Bitcoin are functionally distinct and don't serve the same investment purpose. They also behave differently in a portfolio context—i.e., they have different volatility profiles and are broadly uncorrelated. Between 2016 and 2021, adding Bitcoin to a portfolio provided higher returns but much greater volatility, which does not suit all investors. Moreover, our calculations show that adding Bitcoin to a portfolio doesn't provide any diversification benefits. Adding gold, by contrast, lowered volatility and improved risk-adjusted returns for a balanced and equity portfolio (Figure 20).

For Bitcoin to be a proper store of value, we believe it first needs to meet three characteristics: liquidity, universal acceptance, and essential real-world application. Currently, Bitcoin doesn't fully possess any of these attributes. Whether it meets this criteria will require further observation—and Bitcoin may succeed or fail in the end, something we consider is very unlikely when it comes to gold. See the appendix for a more detailed comparison between Bitcoin and gold.

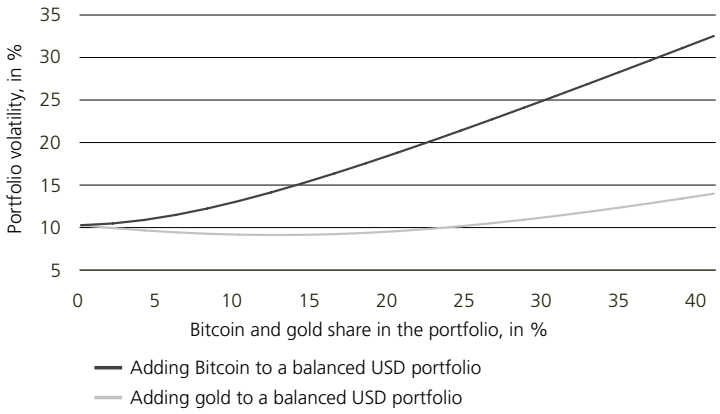
Figure 20: Volatility trajectory of a balanced portfolio when incrementally adding Bitcoin and gold (USD-based currency, % refers to weight of Bitcoin and gold in the portfolio)

Some believe Bitcoin acts an inflation hedge because, unlike fiat currencies, it has a limited supply. So far, the empirical evidence contradicts this argument. While the supply of an individual crypto like Bitcoin may be limited, the overall number of different cryptos is not. So we do not think the "no debasement" argument applies for the overall asset class. Proponents also argue that Bitcoin is unique, given its supreme status in the community, and hence cannot be replaced. But we find it difficult to appreciate the underlying logic of this statement. Bitcoin's historical volatility and drawdown levels are also so high that the crypto cannot be considered a viable hedging vehicle and an alternative to gold (Figures 20 and 21) without building exposure to other sources of risks not linked to inflation. Last but not least, Bitcoin's correlation with inflation measures is weak, as demonstrated in Figure 22.

Figure 20

Volatility dynamics when adding bitcoin and gold to a balanced portfolio

Observation window from 2016, based on weekly data

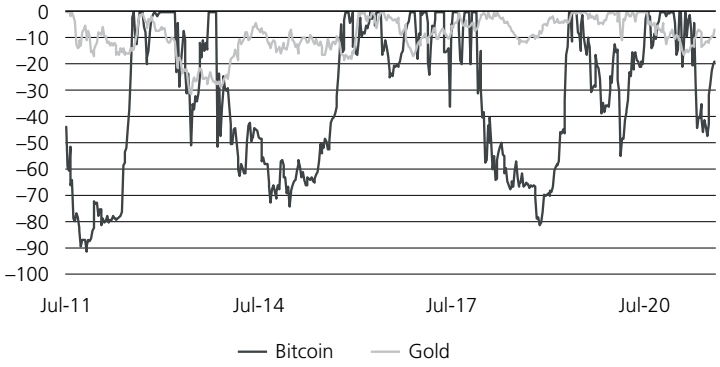


Source: Bloomberg, UBS, as of 1 September 2021

Figure 21

Price drawdowns in Bitcoin and gold

12-month rolling window, in %

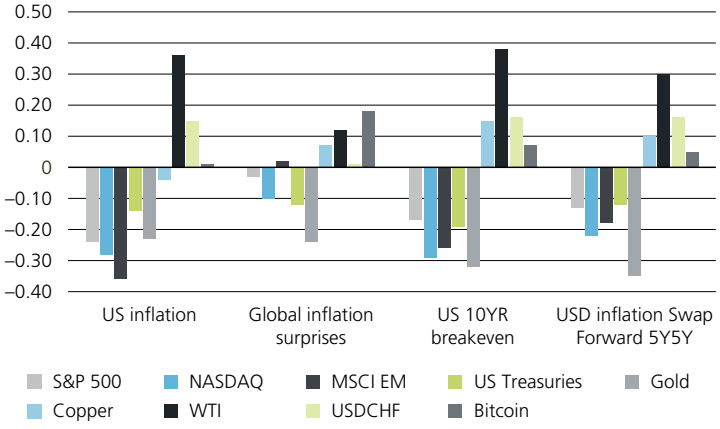


Source: Bloomberg, UBS, as of 1 September

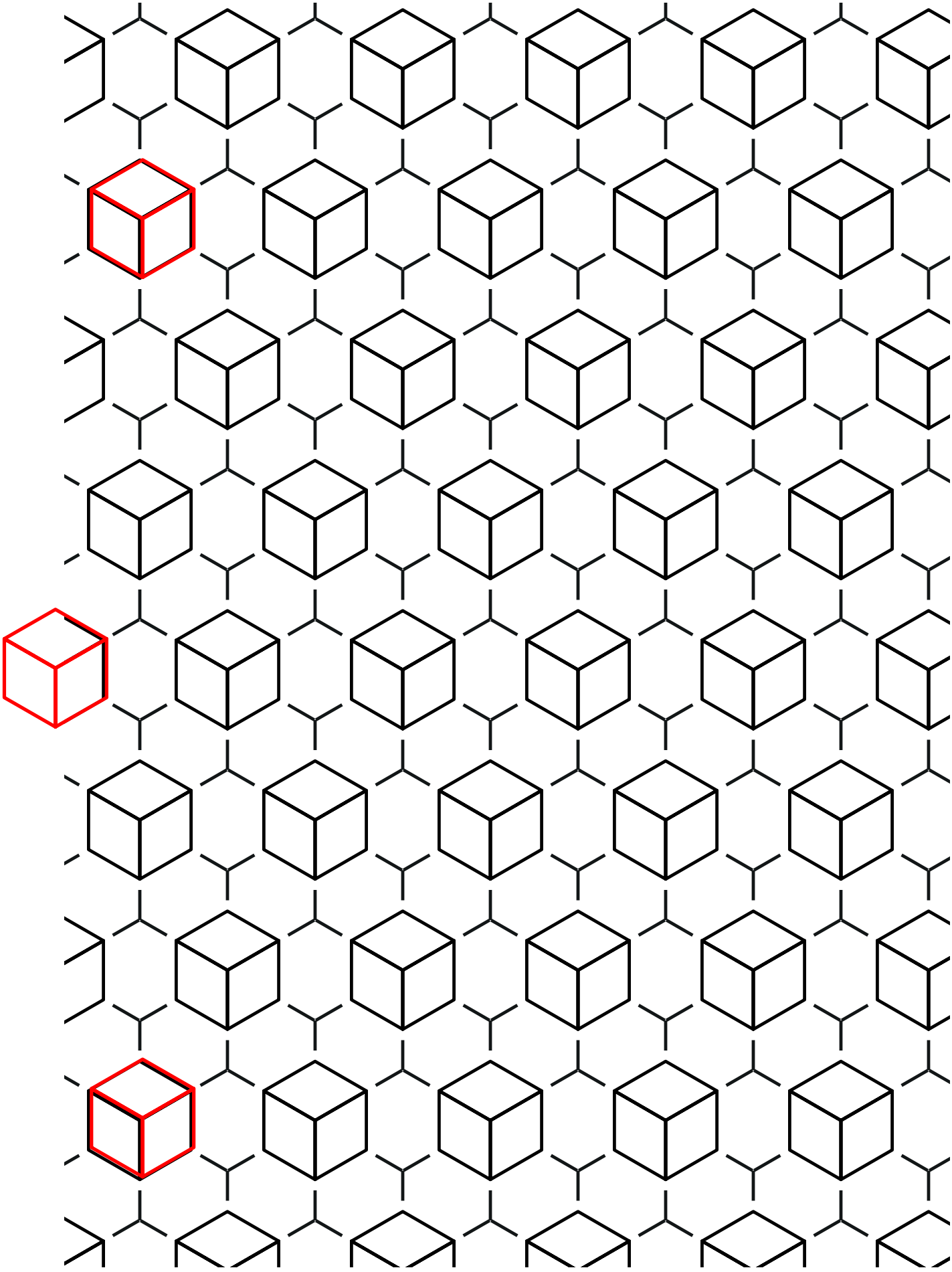
Figure 22

Neither gold nor cryptos are good inflation hedges

Correlation of different assets with inflation measures



Source: Bloomberg, UBS, as of June 2021



Part VII
Ecosystem valuation approaches

Valuation methods are a challenge investors generally face with nascent technologies. Numerous new applications—some of which we may not fully understand or even be aware of today—promise a high potential for growth and profits for individual companies and entire industries. On the other hand, external factors such as regulatory and legal risks or ESG concerns may hinder adoption. Also, incumbent industry players will almost certainly respond to new market entrants by adjusting and improving their business models. Incumbents possess a competitive advantage from their ability to leverage existing client networks, although history is full of examples where dominant companies failed to adequately respond to a changing business landscape.

Naturally, this is a big challenge for companies with a concentrated exposure to DLTs or crypto ecosystems and even more so for pure crypto ecosystems. It is a lesser one for companies with some exposure to the evolution of DLTs, given their more diversified business model. Semiconductor companies are a good example: they benefit from increased demand for hardware equipment to run devices used to mine crypto coins and tokens, but they make the bulk of their profit from supplying manufacturing, IT, and other industries.

Price regression models

In our experience, investors often focus on purely descriptive price regression models—an approach whereby the price of a coin or token is regressed on another variable, often time or a function thereof. Such models enjoy popularity among investors because of their high accuracy to explain historical price patterns (in statistical jargon, this is called "in-sample fit"). A good in-sample fit, however, doesn't imply that the model can accurately be used for out-of-sample forecasts—i.e., to predict future prices and therefore returns.

The stock-to-flow model, introduced in 2019 by an anonymous Twitter user PlanB, is one of the most widely cited price regression models for Bitcoin. Bitcoin has become the benchmark for digital coin scarcity, which is quantified by the stock-to-flow ratio in this framework. The stock-to-flow ratio reflects the ratio between the size of existing stockpiles and reserves (all the coins already minted) and the flow of the (yearly) production of newly minted coins.

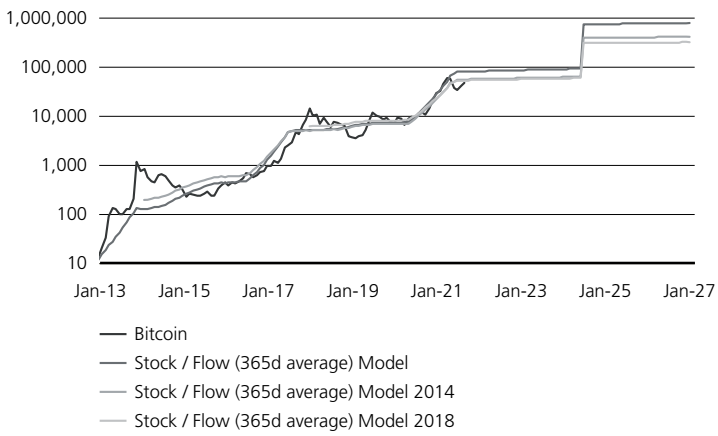
One of the reasons this approach enjoys a high popularity among crypto investors is that it allows them to directly compare the scarcity of physical assets like gold and silver to the scarcity of cryptos like Bitcoin. Although precious metals are also quite scarce, Bitcoin's scarcity is already very close to that of gold and will increase further as the supply of additional coins halves every couple of years.

Another reason why this framework is so popular among investors is its ability to explain the history of Bitcoin prices (Figure 23). This doesn't mean that the framework has a good ability for out-of-sample predictions, however. The stock-to-flow metric used is ultimately a simple function of time (combined with the deterministic Bitcoin supply schedule). While the model now "predicts" that Bitcoin prices will increase further, in contango with its historical trend, the prediction would point in the opposite direction had prices declined over the same period. By construction, the model is therefore only able to "predict" that Bitcoin prices will continue to evolve in parallel to its growing scarcity. This assumption could be right, of course, but we wouldn't rely on it because it lacks a fundamental explanation.

Figure 23

Bitcoin stock-to-flow: A great track record to explain historical price patterns, but not necessarily future returns

Base on monthly data, in USD



Source: Bloomberg, UBS, as of 1 September

Platform valuations and other approaches

One widely recognized approach to value platform or network companies is Metcalfe's law. It states that the value of a telecommunication network increases proportionally to the square of the number of users in the network. Extending this approach to crypto ecosystems seems intuitive given their decentralized nature. Applying this approach to derive a price estimate for Ether again shows a relatively good in-sample fit, but also a very high sensitivity to the parametrization of the underlying regression function. In plain English, this means that these models provide a rather wide range of fair-value estimates and often don't provide sufficient guidance for investors.

To complicate matters further, we think a thorough use of Metcalfe's law should also distinguish between network participants, who use the network for its primary use case, and those who see it primarily as an investment opportunity. The participation of the latter group might eventually start to decline, because some of the external factors discussed in Part V might weigh on the return outlook. Additionally, the number of speculative network participants might also start to decline in case of ongoing success. Expected returns should eventually start to decline simply because prices cannot go to infinity and because higher prices might weigh on the attractiveness of the primary use case. The Ethereum network might see increased competition from other, similar technologies if Ether prices continue to rise.

Using data between August 2015 and June 2021, the model's fair price estimate changes substantially if we assume that the currently reported number of active users will in equilibrium be much smaller as speculative addresses eventually leave the market. For instance, if the number drops to 500,000 addresses, the fair price estimate more than halves; if only 10% of the users remain, the price will drop by more than 95%.

Given the limited ability of these models to provide out-of-sample guidance, we think it is essential that investors who seek direct exposure to distributed ledger technologies—whether through a direct investment in a crypto ecosystems or through companies that have a high exposure to such networks—carefully assess the underlying technologies and the addressable market the platform might be able to serve.

Table 2

Network valuations linked to size of underlying user base
Example refers to Ether valuations

Assumed number of active addresses (in thousand users)	75	250	500	750
Fair value estimate (in US dollar)	29.7	311.4	1,202.6	2,649.1

Source: Bloomberg, UBS, as of 1 September 2021

We think relevant aspects include:

I. the primary use case and its addressable market;
II. the competitive differentiation the network offers and the barriers for new entrants;
III. its current and future adoption, for example the number of active users and developers;
IV. its governance standards and the exposure to regulatory risks;
V. the existing and future supply of native tokens and coins;
VI. the options to develop and extend the network to future use cases, for example whether it has an embedded programing language for smart contracts.

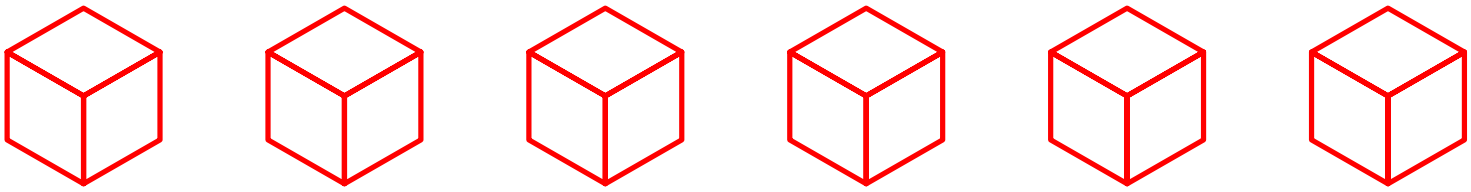
To conclude, with valuation methods for DLTs and crypto ecosystems still in their infancy, we are not aware of an approach or combination of approaches that enjoys the same credibility as the standard valuation methods used for traditional assets—equities, bonds, or currencies—and alternative assets. In addition to the economic relevance of the primary use case and the other factors discussed above, investors therefore face an additional challenge in determining to what extent current prices already reflect the potential business opportunity. The lessons from traditional markets are also relevant in the digital world: investing in a company with great prospects can still result in large losses if the stock is bought at an expensive level. And of course, the opposite experience is equally relevant.

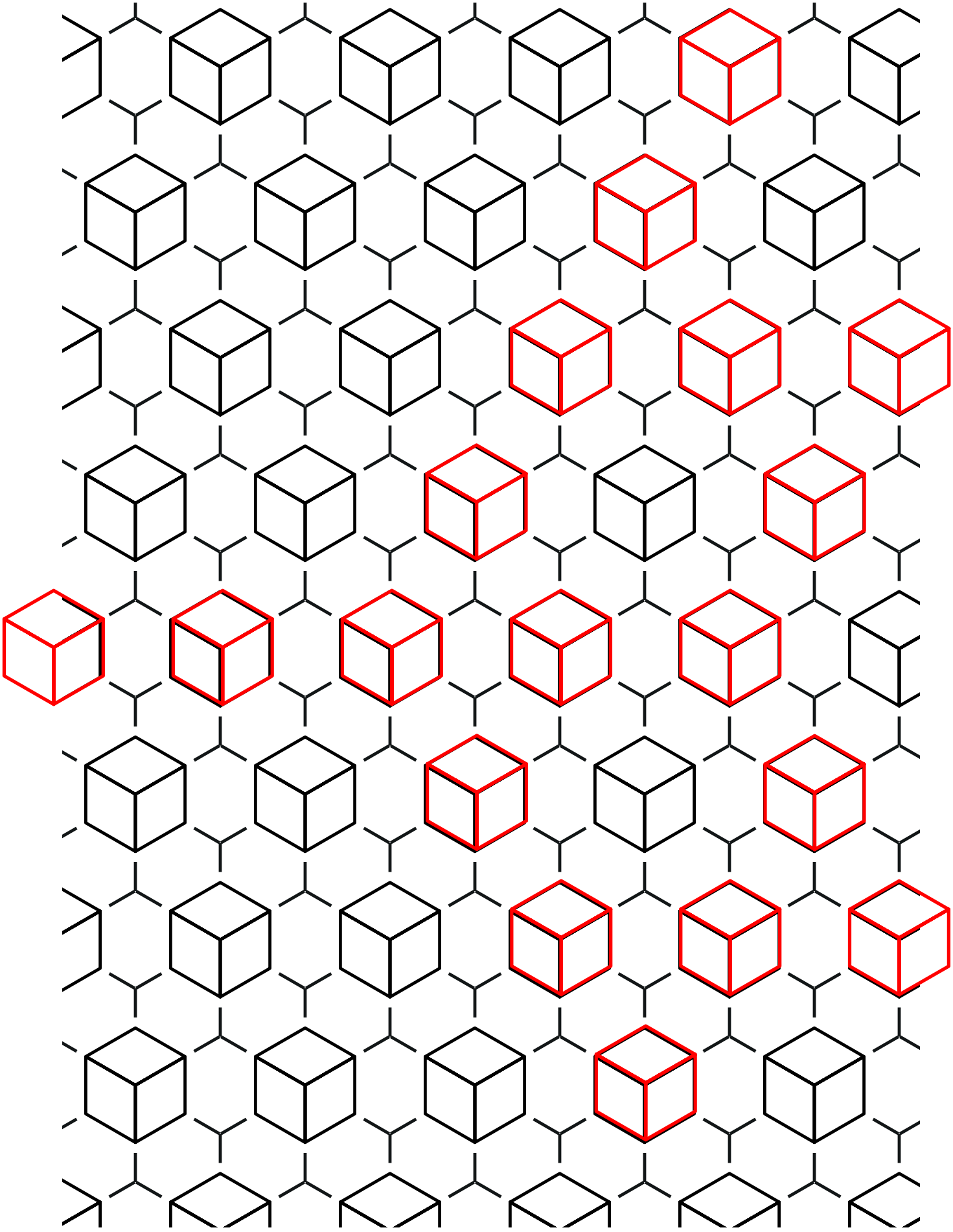
Concluding thoughts

We hope you found our long journey through the world of digital assets enjoyable and interesting. Our aim is to equip you with the necessary know-how to explore this brave new world and to share our views on the investment opportunities and risks.

We think applications based on distributed ledger technology are here to stay, so investors and entrepreneurs should spend enough time understanding the risks and opportunities involved. We have identified several sectors and companies that we think offer interesting investment opportunities at this juncture, and we will continue updating our views in this area.

Cutting through the noise and hype is essential. We applaud your decision to have spent the time reading through our research and wish you great success as you travel onwards in your journey. We're also happy to be your trusted companion as you move forward, whether you are taking the first steps or moving onto more adventurous endeavors.





Deep dive

Bitcoin ain't gold

Debates over Bitcoin and other cryptos' legitimacy as a store of value have drawn constant attention from institutional and retail investors alike. The COVID-19 pandemic and central banks' unconstrainted money printing have resurrected well-aired concerns about the valuation of fiat money over the long run—one reason for Bitcoin's frequent comparison to gold.

Advocates of Bitcoin, the benchmark for finite cryptos, argue it is the millennial generation's equivalent of—or competitor to—gold. Like gold, it is borderless, has no central control over supply, is recognized globally, and its supply is limited. Similarly, after mining, both deliver investors no yield. But enthusiasts argue its low relative storage costs, nearly infinite divisibility, and ease of transport make it a much better store of value than gold in the long run.

In our opinion, such assessments overlook the fact that the two assets serve different purposes and are functionally distinct. Unlike gold's dual nature (i.e., as a currency and commodity), Bitcoin's only source of demand is investment at this stage. We see this difference and others reflected in terms of their price dynamics, but also in their performance within a portfolio context. So, is Bitcoin a better store of value or hedge than gold? In short, no. And in this chapter we explain why.

Are cryptos a store of value?

Whether or not an asset is a store of value is a critical question for anybody contemplating the merits of investing in that asset. We define a store of value as anything that preserves its value over the long run. For example, in inflation adjusted terms, the price of gold has been resilient over at least the last century and a half[1].

This question is particularly relevant when investing in crypto assets given their brief history. Crypto enthusiasts argue that Bitcoin's scarcity and ease of storage mean it will surpass other traditional stores of value like gold. There are around 18.7 million Bitcoins in circulation today, out of its total supply of 21 million. Bitcoin is equivalent to an around USD 750bn market at current prices (USD 40,000 per BTC); for reference, the US equity market is worth around USD 47tr and the gold market close to USD 12tr.

About scarcity, history shows us that assets with essential real-world applications—for which Bitcoin generally lacks—have been much more successful as stores of value in the long run, like equities and real estate. Art, gold, wine, and vintage cars are good examples of non-yield-bearing assets that benefit from scarcity but still have clear use cases. In fact, the premiums attached to these possessions encapsulate their benefits—the asset's aesthetics or exclusiveness make it a distinct asset. Such factors can be outside the usual financial considerations. Furthermore, stores of value must have stable price trends. With cryptos, we've seen extreme price volatility of between 50% and 100%.

To act as stores of value, in general, cryptos need to meet three characteristics: liquidity, universal acceptance, and essential real-world application.

- *Liquidity:* Some enthusiasts argue that with the emergence of designated exchanges and greater institutional involvement, the liquidity of Bitcoin and other crypto assets have increased. Recent data on the number of bitcoin transactions per second (as a function of its market capitalization) shows a different picture, with the number declining to less than 10 (vs. 30 in 2016–17). Anecdotal evidence suggests that bid-ask spreads for bitcoin remain wide and varied, suggesting liquidity remains a challenge.

- *Universal acceptance:* Bitcoin and other crypto coins have made progress from a social recognition standpoint, particularly among younger investors. But generally, the lack of essential real-world applications will likely slow the pace of broader acceptance and so on. Other stores of value have greater practical use. For instance, jewelry demand and central bank ownership help underpin gold's broader appeal as a store of value.

- *Real-world application:* Bitcoin's volatility, as well as for other cryptos, is unlikely to abate until it has broad underlying economic use, which could smooth out periods of severe selling pressure. Gold's key driver is US real interest rates. As a non-yield-bearing asset, higher/lower real interest rates erode/boost gold's appeal because they decrease/increase investment demand from speculators and exchange-traded funds. Also, as gold prices fall, jewelry demand provides an important counterbalance to waning investment interest.

Of course, Bitcoin enthusiasts also value its first-mover status. We believe this needs closer examination in an industry with rapid technology innovation and fast-changing consumer preferences. History suggests that it's difficult in such a market to maintain the benefit of first-mover advantage for long.

Nothing prevents other cryptos from replacing existing ones over time, such as more efficient ones, and thereby adding to the overall total supply of "finite" coins or tokens. The argument that Bitcoin is unique because of its first-mover status is not overly convincing, in our view, and likely insufficient to re-

1 Oxford Economics, 2011

place the relevance of an essential real-world economic use as a requirement for its longer-term success.

Finally, policy makers can inhibit the use of crypto coins and tokens as an accepted store of value simply by making them non-convertible (see the section below). As we discussed, an asset only has value if it can either be used, sold, or admired. Thus, whether crypto assets can be a store of value over the long run, by definition, will require further observation—and it may succeed or fail.

Is Bitcoin just gold in a digital form?
We discuss these differences in more detail below under the following headings:

I. Production – supply
II. Ownership and sources of demand
III. Behavior in a portfolio context
IV. A changing regulatory environment

1. Production – supply
One of the most referenced similarities between gold and finite crypto assets like Bitcoin is scarcity. The World Gold Council highlights above-ground stocks of the yellow metal grew by just below 2% per year through mine production over the last two decades. The stock of Bitcoin is currently increasing at an annual rate of close to 3% and is engineered to slowly decline to zero growth around the year 2140.

If we compare gold mining to Bitcoin, there is greater concentration with the latter. Gold mines are well distributed globally. Australia, Canada, China, Russia, and the US make up the top five miners, but various Latin America and African countries also produce large quantities of the yellow metal. Importantly, no continent captures more than 25% of aggregate production.

Beijing's recent ban on crypto mining activities in China has been a blow to the overall proliferation of mining networks, although greater dispersion of miners could be beneficial in the longer term. Still, given the decentralized and anonymous nature of the industry, legal and regulatory challenges are noteworthy risks facing the future growth of crypto assets (unlike gold). In fact, curbing mining activity in gold has historically favored a higher gold prices; the opposite has been true for Bitcoin so far.

2. Ownership and sources of demand
Ownership is also highly concentrated in cryptos. Estimates suggest around 95% of Bitcoin is held by 2% of all accounts. Bitcoin advocates contend it's less centralized than that, arguing such reports include misleading statistics, as an address belonging to a crypto exchange can hold funds for millions of individuals. Nevertheless, estimates by crypto commentators still claim 2% of the Bitcoin network's entities own more than 70% of assets (Bloomberg, 2021).

Demand for gold can be broken into four key categories: jewelry, technology, investment, and central banks. Jewelry is a key part of the gold market (34% of demand), with purchases often deeply connected to cultural and religious beliefs, especially in India and China. A smaller percentage (around 7%) is used in industrial applications like technology hardware. It's this dual purpose—investment and consumption—that truly sets the yellow metal apart from cryptos as well as other assets. So, while gold performs well during periods of heightened financial market uncertainty, it can also benefit from strong economic expansions, driven by loose monetary policy. We have not seen this price behavior of Bitcoin during adverse market environments, nor has the linkage between gold and Bitcoin gone up.

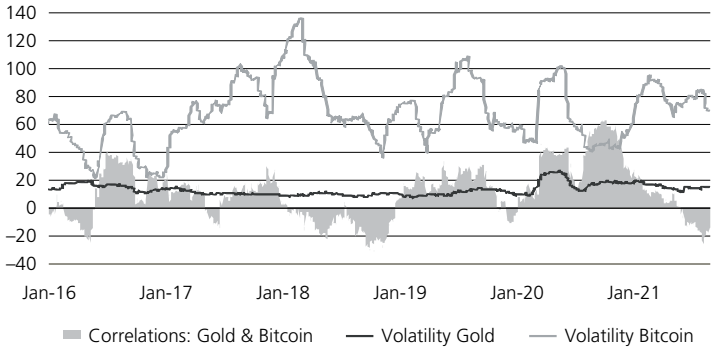
3. Behavior in a portfolio context
Crypto assets and gold play very different roles in a portfolio: the former is held primarily as a speculative investment while the latter is held for insurance purposes. This is because coins like bitcoin are far too volatile.

Indeed, over the past two years, bitcoin has been three times more volatile than the S&P 500 and four and a half times more volatile than gold. For volatility to come down, Bitcoin—as well as any asset in general—will need to achieve three dynamics: abundant liquidity, public acceptance, and economic usefulness. Most notably, businesses are not accepting cryptos widely as a means of payment right now. Until that happens, prices will likely continue to swing wildly. Gold, in contrast,

Figure 24

Bitcoin and gold – correlations and volatility

Daily data 3-month rolling window, in %



Source: Bloomberg, UBS, as of 1 September

does enjoy that criteria—flush liquidity, consumer acceptance, widespread use—and so prices are more stable. For instance, as gold prices slip, jewelry or central bank buyers will emerge and act as a backstop to falling prices. Also, growth in mine supply declines whereas bitcoin supply is predetermined; so lower prices don't result in lower supply.

In this context it's worth highlighting the low correlation between gold and bitcoin: From –0.5 to 0.5 with an average of around 0.20 (since 2016). This means that the two assets do not follow similar price trends and therefore act more as complements to one another (versus competitors). During periods of market drawdowns, gold has had a negative correlation to equities, while Bitcoin has been seen to rise and fall. So, when equity markets slump, Bitcoin may follow the markets lower while gold tends to be more resilient.

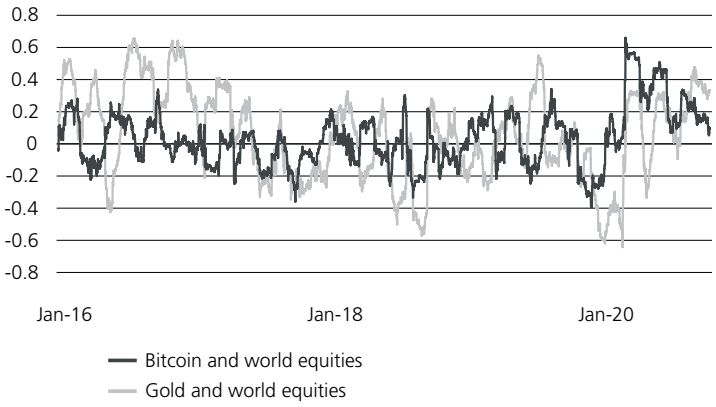
Liquidity is also important in managing portfolio risks. Gold trades in a well-established and liquid market, with trading volumes exceeding USD 180bn a day on average in 2020, according to the World Gold Council. By contrast, Bitcoin spot trading volumes—which can vary widely from source to source and are often difficult to verify—were estimated to be less than USD 2bn on average in 2020, with a range up to USD 10bn so far in 2021 (WGC). Gold's liquidity in periods of market stress is a key attribute of the yellow metal; it was especially appreciated during the early breakout of the COVID-19 pandemic.

In our portfolio analysis, when we added gold, the overall volatility of the portfolio for balanced and equity investors declined and the risk-adjusted returns improved. This underscores the different purpose of gold versus Bitcoin in a portfolio context. In fact, we argue that adding Bitcoin to a portfolio may warrant a higher allocation to gold to improve risk-adjusted returns and lower maximum drawdowns.

Figure 25

Bitcoin and gold link with global equities

3-month rolling correlation window, daily data



Source: Bloomberg, UBS, as of 1 September 2021

4. A changing regulatory environment

Bitcoin and other digital assets still face significant regulatory risks, which need to be taken into consideration. Cryptos are receiving greater attention from authorities and regulators following the increase in institutional participation and the swift rise in market capitalization. Meanwhile, central banks are developing their own digital assets known as central bank digital currencies, which—in some areas—could compete with cryptos in the future. In this sense, crypto assets could become victims of their own success. Gold is not subject to any such risks.

Bottom line

Our analysis reinforces the view that gold and cryptos are functionally distinct and don't serve the same purpose as investment assets. They also behave differently in a portfolio context—i.e., they have different volatility profiles and are broadly uncorrelated. During our sample period, adding Bitcoin to a portfolio provided higher returns but much more volatility which does not suit all investors. Moreover, our calculations show that adding Bitcoin to a portfolio doesn't provide any diversification benefits. Adding gold, by contrast, lowered volatility and improved risk-adjusted returns for a balanced and equity portfolio. To answer the question of whether crypto assets are a store of value, we believe they first need to meet the three characteristics to become a reliable store of value. Determining this requires further observation—and cryptos may succeed (or fail) in the end. And when comparing the two, it's also important to acknowledge the regulatory risks facing Bitcoin and other cryptos (while gold faces no such overhang).

Key coins and tokens

Over the last few years, the number of cryptos has soared. The first, in 2009, was Bitcoin, but there are now close to 6,000 cryptos, according to coinmarketcap.com, although a significant number of these cryptos are not actively used or traded.

The table on the next page provides a list of 15 cryptos selected due to their market cap and media presence. We grouped them into three categories (coins, stablecoins, and tokens) and ranked them by market capitalization. It also looks at the use of these cryptos, which include payment and smart contract and other service applications.

Table 3

An overview of the key cryptos

Name	Launch date	Market cap	Current supply/max supply backdrop	Backdrop	Potential use case
Bitcoin (BTC)	2009	USD 886bn	18.8mn BTC / 21mn BTC	The world's first crypto, described in a 2008 whitepaper by Satoshi Nakamoto. Transactions are conducted on a peer-to-peer basis, verified by the network and recorded on a blockchain without the need for an intermediary to facilitate transactions.	Payment
Ethereum (ETH)	2015	USD 404bn	117mn ETH / unlimited	A decentralized software platform, using a blockchain system, that enables construction and implementation of smart contracts and DApps. Ether (ETH), Ethereum's native crypto, is used to pay fees associated with using the Ethereum network. The Ethereum platform uses a proof of work consensus mechanism.	Infrastructure platform (deploying smart contracts and Dapps)
Cardano (ADA)	2017	USD 88.7bn	32bn ADA / 45bn ADA	Like Ethereum, Cardano is a decentralized software platform that enables the construction and implementation of smart contracts and DApps. ADA is Cardano's native crypto. The Cardano platform uses a proof of stake (PoS) consensus mechanism.	Infrastructure platform
Binance Coin (BNB)	2017	USD 78.1bn	168mn BNB / 168mn BNB	A utility crypto that operates as payment method for trading fees on Binance Exchange. Binance coin is also the native crypto of the Binance Smart Chain (BSC), a decentralized software platform, similar to the Ethereum and Cardano platforms. The BSC platform uses a PoS consensus mechanism.	Infrastructure platform
Ripple (XRP)	2013	USD 55.5bn	46.54bn XRP / 100bn XRP	XRP is a real-time settlement system and native crypto of the XRP Ledger blockchain system. XRP is more centralized than other cryptos, with transactions verified by pre-determined nodes. A small amount of XRP is deducted from the total supply as transaction fee.	Payment
Dogecoin (DOGE)	2013	USD 36.3bn	131.1bn DOGE / Unlimited	Based on the popular "doge" internet meme, the digital currency was forked from Luckycoin—a fork of Litecoin, which in turn is a fork of Bitcoin. It is often used in online tipping over social networks and exchanged between peers and content creators.	Payment
Solana (SOL)	2020	USD 32.2bn	290.7mn SOL / unlimited	Solana is a decentralized blockchain platform. As the platform can handle smart contracts, its designed to facilitate the creation of dApps. Solana also aims to improve scalability by making use of a proof-of-history (PoH) consensus combined with the underlying proof-of-stake (PoS) consensus of the blockchain.	Infrastructure platform
Polkadot (DOT)	2016	USD 29.7bn	987.6mn DOT / unlimited	Polkadot's blockchain protocol allows any type of data to be sent between any type of blockchain, thus facilitating cross-chain transfer of data, making a range of blockchains interoperable with each other. DOT is Polkadot's native crypto.	Infrastructure platform
Bitcoin Cash (BCH)	2017	USD 11.9bn	18.8mn BCH / 21mn BCH	Bitcoin cash (BCH) is a fork of bitcoin. BCH aims to be a scalable version of bitcoin, thus allowing it to be used as a medium of exchange. Faster and cheaper transaction processing is achieved by increasing the block size.	Payment
Litecoin (LTC)	2011	USD 11.5bn	66.8mn LTC / 84mn LTC	Litecoin, a fork of bitcoin, was designed to provide fast and low-cost payments. Litecoin uses a different cryptographic algorithm to Bitcoin for during the mining process.	Payment
Stablecoins					
Tether (USDT)	2014	USD 65.6bn	65.5bn USDT / Unlimited	USDT is a stablecoin that aims to keep its value constant in U.S. dollar terms. The token's linkage to the USD is achieved holding highly liquid fixed income linked assets such as commercial papers (main allocation), fiduciary deposits, cash, reserve repo notes, and treasury bills in reserves. That said holders of USDT have no guarantee or right to exchange the token for real USDs.	Payment
USD Coin (USDC)	2014	USD 27.4bn	27.4bn USDC / Unlimited	USD Coin is a stablecoin. The central consortium behind USDC has pegged it to USD and is mainly backed by cash and cash equivalents as well as other fixed income instruments. The token runs on the Ethereum blockchain.	Payment
Dai (DAI)	2017	USD 6.1bn	6.1.bn DAI / unlimited	DAI is a decentralized, Ethereum-based stablecoin whose issuance and development is managed by the Maker Protocol. DAI's price is soft-pegged to the US dollar. The collateralized assets backing DAI are other cryptos instead of fiat and are held within smart contracts rather than by institutions.	Payment
Tokens					
Uniswap (UNI)	2018	USD 18bn	611.6mn UNI / 1bn UNI	Uniswap is a Decentralized Exchange (DEX) platform running on the Ethereum blockchain on which users can trade cryptos. UNI is Uniswap's governance token, which provides holders voting power on future developments and changes to the Uniswap exchange.	Platform governance through voting rights
Chainlink (LINK)	2017	USD 12.1bn	449mn LINK / 1bn LINK	Chainlink's blockchain oracle network provides inputs and outputs for smart contracts on any blockchain. A blockchain oracle network is a system connecting smart contracts with external information, serving as a bridge between blockchains and the 'off-chain'/outside world. LINK is Chainlink's native crypto.	Service platform (Pulling data for or push data from contracts)
Polygon (MATIC)	2017	USD 8.7bn	6.49bn MATIC / 10bn MATIC	The Polygon network is a scaling solution for the Ethereum network that aims to provide faster and cheaper transactions on the Ethereum network using Layer 2 solutions (blockchains that run alongside the Ethereum blockchain). MATIC is the native crypto of the Polygon network.	Service platform (scaling the Ethereum network)
Aave (AAVE)	2017	USD 5.3bn	13.15mn AAVE / 16mn AAVE	Aave is a decentralized money market platform running on the Ethereum blockchain that allows users to lend and borrow cryptos. AAVE is the platform's native crypto, providing holders voting rights on future developments of the platform and also discounted fees while using the platform.	Platform governance through voting rights

Source: CoinMarketCap, UBS, websites of individual coins and tokens, as of 1 September 2021

Glossary

The glossary below provides different types of terminologies and key concepts of the digital asset domain and serves as a reference to the terms introduced in our report. The terms are grouped into four categories: Basics, technology, ecosystem of digital assets and crypto slang terms that are most used by people engaging in crypto discussion on social networks.

Basics

Altcoin
Any crypto alternative to Bitcoin.

Cryptography
Techniques for secure communication without third parties.

Decentralized application (Dapp)
Applications that run on a P2P network of computers rather than one central computer, with no single controlling entity.

Decentralized autonomous organization "DAO"
A form of business organization relying on a smart contract with no conventional management structure.

Governance token
A token that is used to govern the operations and influence the direction of a project.

Initial coin offering (ICO)
ICOs are a way of raising capital to fund the development of a crypto asset. An investor can buy into an ICO by investing in the crypto offered by the issuing entity.

Mining
The process by which transactions are verified and added to the public ledger known as the blockchain, which is often the means through which new units of a crypto are created (e.g., Bitcoin).

Satoshi Nakamoto
The pseudonym of the creator or creators of the Bitcoin protocol and whitepaper.

Smart contract
Smart contracts are computer programs stored on a blockchain that are executed automatically once a set of predetermined conditions are met.

Stablecoin
A type of crypto that is designed to maintain a stable value by pegging itself to a reserve asset like the US dollar.

Utility token
Tokens designed specifically for a pre-defined use case.

(Wallet) Address
An alphanumeric character string used to send and receive transactions on a blockchain network.

Whitepaper
Document released by a crypto project that gives investors technical information about its concept, and roadmap for how it plans to grow and succeed.

Technology

51% attack
When one or a group of miners control more than 50% of the network's mining hash rate or computational power, thereby compromising the integrity of the system.

Difficulty
A measure of how hard it is to validate a new block on a blockchain.

Fork
Forks create an alternate version of the blockchain. Soft forks allow some form of compatibility between the two chains, whereas hard forks create an entirely new crypto on a new blockchain.

Gas
A term used on the Ethereum platform that refers to a unit measuring the computational effort associated with calculating the costs of smart contracts operations and transactions on the blockchain.

Gas price
A term used on the Ethereum platform that refers to the price you are willing to pay for a transaction.

Genesis block
First ever block recorded on its respective blockchain network, also referred to as Block 0 or Block 1.

Halving
An event in which the total rewarded bitcoins per confirmed block halves, happening every 210,000 blocks mined.

Hash
A function that takes an input and then outputs an alphanu-

meric string known as the hash value. Hashes confirm transactions on the blockchain.

Hash rate
The speed at which a computer or mining hardware is able to calculate new hashes. Measured in hashes per second.

Immutability
The inability to change or be changed. One of the core features behind Bitcoin and blockchain technology.

Interoperability
Concept of allowing blockchains to be compatible with each other and build upon each other's features and use-cases.

Node
A node is a computer that is connected to a blockchain network that serves a variety of purposes, including validating transactions.

Off-chain
Transactions that occur off a given blockchain network that may be later reported or batched together before they are submitted to the main chain.

On-chain
Transactions that occur on a given blockchain network, reflected on the public ledger.

Oracle
Oracles are third-party information service providers that send secure and reliable external real-world data to a smart contract, thereby bridging the real world with the blockchain.

Phishing
A phishing attack is a computer-based attack method that is used to gain sensitive information to access accounts. These attacks are confidence tricks carried out by malicious third parties posing as trustworthy entities to gain access to accounts.

Proof of stake
Consensus mechanism that rewards block validators according to the amount of coins they have at stake.

Proof of work
Consensus mechanism involving solving computationally intensive puzzles to validate transactions and create new blocks.

Transaction block
A collection of transactions on a blockchain network, gathered into a block that can then be hashed and added to the blockchain.

Transaction fee
A small fee imposed on some transactions sent across a blockchain network. The transaction fee is awarded to the miner that successfully hashes the block containing the relevant transactions.

Trustless
Blockchain is called a trustless system where consensus is achieved between participants who do not have to trust each other.

Ecosystem

Consensus protocol
A process by which computers in a network, called nodes, reach an agreement about a set of data.

Digital signature
Mathematical scheme for verifying digital messages or documents which satisfy two requirements: have authenticity (from a known sender) and integrity (not altered in transit).

Howey test
Test used to determine whether or not an asset is a security.

Ledger
A physical book or a digital computer file where monetary and financial transactions are tracked and recorded.

Mining farm
Collection of many miners, often in a warehouse or large data center devoted to mining cryptocurrencies.

Online storage/hot wallet
Storing cryptocurrencies in devices or systems connected to the internet.

Offline Storage/cold storage/cold wallet
Storing cryptocurrencies in devices or systems not connected to the internet.

Permissioned blockchain
A blockchain in which the network owner(s) decides who can join the network and issue credentials necessary to access the network. Opposite to a permission less network.

Permissionless blockchain
Permissionless means that users and developers do not need any permission to transact and use the blockchain.

Private blockchain
A blockchain or distributed ledger that has a closed network where participants are controlled by a single entity.

Protocol
Set of rules that define interactions on a network, usually involving consensus, transaction validation, and network participation on a blockchain

Public address
Cryptographic hash of a public key, allowing the user to use it as an address to request for payment

Public blockchain
Globally open network where anyone can participate in transactions, execute consensus protocol to help determine which blocks get added to the chain and maintain the shared ledger.

Public key and private key
Public keys represent a wallet address that can be sent out to other people on the network. Private keys, on the other hand, are an alphanumeric string of data only known to the owner that grants access to the funds. Private keys can be thought of as a password that enables an individual to access their crypto wallet.

Qualified custodian
A regulated custodian who provides clients with segregated accounts and often places coins or tokens in cold storage (see above).

Staking
Process through which users lock their crypto assets on a network as part of a consensus mechanism and are financially rewarded to do so.

Tokenization
Process where real-world assets are turned into something of digital value called a token.

Vanity address
Cryptocurrency public address with custom letters and numbers, picked by its owner.

Validator
Participant on a proof-of-stake blockchain involved in validating blocks for rewards.

Yield farming
Earning interest by investing crypto in decentralized finance markets.

Slang

Diamond hands
Strong holders that 'hodl' a crypto for the end goal, despite all the risks that lie ahead.

FUD
Anything intended to instill 'fear, uncertainty or doubt'

HODL
A term originating in a misspelling of 'hold' in a drunken post on a Bitcoin forum in 2013 that turned into a meme. It is used to indicate when a person holds on to their crypto rather than selling it.

Lambo
The car that people often refer to in their excitement over getting rich from cryptos.

Moonboy
Someone who invested a tiny amount in a micro-cap crypto, usually with no great future prospects, and thinks they will be driving a 'lambo' in a few days.

Mooning/going to the moon
When a crypto price is rising rapidly, it is 'going to the moon' or 'mooning.'

Paper hands
Weak holders that sell their crypto the minute fear sets in the market.

Pump and dump
To pump up the price of a random crypto and then sell out a position (dump), causing the price to tank and wiping out accounts that bought into their pump.

Rugpull
An ill-natured maneuver where developers of a crypto project abandon the project and run away with investors' funds.

Shill
To energetically promote a crypto project with the goal of creating more demand for the it, thereby increasing the price for personal gain.

Source: CoinMarketCap, ConsenSys, CoinGecko, UBS, as of September 2021

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